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INTERNET FOR A MOBILE GENERATION

2002

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FOREWORD

This is the fourth in the series of "ITU Internet Reports" (previously known as "Challenges to the Network"). The first three editions looked at "Telecommunications and the Internet" (in 1997), "Internet for Development" (in 1999), and "IP Telephony" (in 2001). This edition, entitled "Internet for a Mobile Generation", examines the possibilities and challenges emerging from the convergence of two distinct sectors of the telecommunication economy, the Internet, and mobile telephony.

Chapter one of this report, the ***Introduction*****,** defines the mobile Internet in the larger context of technological convergence and market demand. Chapter two, ***Technologies and applications***, provides a technical overview of high-speed mobile networks and available services and applications for the mobile Internet. It also examines the competition or co-existence of various network technologies. Chapter three, ***Market trends***, takes a look at the changing landscape and the commercial challenges involved in creating a mass market for mobile Internet services. Chapter four, ***Regulatory and policy aspects***, discusses the hurdles faced by regulators and policy-makers in a converging market environment. Chapter five, ***Case studies***, summarizes a selection of examples taken from country case studies carried out by ITU, looking at how individual countries are approaching, or have approached, licensing and deployment of 3G. Chapter six, ***Conclusions: Towards a mobile information society***, looks ahead to the broader societal implications of the mobile Internet.

Some of the research for this report, including the case studies, was carried out under the "New Initiatives Programme", launched in 1999 (http://www.itu.int/ni). Under this programme, a workshop on the *Licensing of third-generation mobile* was held in Geneva on 19 and 20 September 2001 (http://www.itu.int/3g).

ITU is committed to playing a positive role in the development of the Internet and to extending the benefits of new information and communication technologies, such as mobile technology, to all the world's inhabitants. This is in line with Resolution 101 of the Plenipotentiary Conference (Minneapolis, 1998), which calls upon ITU to "*fully embrace the opportunities for telecommunication development that arise from the growth of IP-based services*". The ITU Internet Reports are hopefully a significant contribution to that commitment.

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The statistical tables were compiled by Tad Reynolds with the assistance of Esperanza Magpantay and Nathalie Delmas. The report was edited by Joanna Goodrick and formatted by Yolanda Azélart. The 3G case studies programme included contributions from Christopher Addy-Nayo, Martin Hilbert, Staffan Hultén, Ben Petrazzini, Audrey Selian, Robert Shaw, Lara Srivastava, Yoshihisa Takada, Pablo Valiente, and Xu Yan. The cover design is by Jean-Jacques Mendez.

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Some of the data contained in this report is taken from ITU's "World Telecommunication Indicators Database". The Database is available on CD-ROM, or via the Internet as a subscription service. All of ITU's indicator reports and databases are available for purchase, on the Internet, at http://www.itu.int/indicators.

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2G: *Second-generation mobile network or service.* Generic name for second generation networks, for example GSM.

2.5G: *Second-generation enhanced.* Name given to enhanced 2G networks, for example GPRS and cdmaOne.

3G: *Third-generation mobile network or service.* Generic name for third-generation networks or services under the IMT-2000 banner, for example W-CDMA.

3GPP: *Third Generation Partnership Project.* Collaboration agreement bringing together a number of telecommunication standards bodies, with the objective of producing globally applicable technical specifications and technical reports for a third-generation mobile system based on evolved GSM core networks and radio access technologies that they support, i.e. Wideband CDMA (W-CDMA). See http://www.3gpp.org.

3GPP2: *Third Generation Partnership Project 2.* Collaborative third-generation telecommunication standards-setting project comprising North American and Asian interests. The objective of this project is to develop global specifications for 3G CDMA2000 technologies. It can be said to be the CDMA2000 counterpart to 3GPP. See http://www.3gpp2.com/.

Access charge: Amount paid per minute, charged by network operators for the use of their network by other network operators. Also known as *interconnect charge*.

ADSL: *Asymmetric Digital Subscriber Line.* A technology that enables high-speed data services to be delivered over twisted pair copper cable, typically with a download speed in excess of 256 kbit/s, but with a lower upload speed.

Air time: The minutes of calls a subscriber makes or receives from a mobile phone. Also referred to as *talk time*. This term is mainly used in RPP environments (see *RPP*).

AMPS: *Advanced Mobile Phone System*. An analogue cellular telephone service standard utilizing the 800 to 900 MHz band (and recently also the 1'800-2'000 MHz band).

Analogue: Transmission of voice and images using electrical signals. Analogue mobile cellular systems include AMPS, NMT and TACS. Contrasts with digital.

ATM: *Asynchronous Transfer Mode*. A transmission mode in which the information is organized into cells; it is asynchronous in the sense that the recurrence of cells from an individual user is not necessarily periodic.

Bandwidth: The range of frequencies available to be occupied by signals. In analogue systems it is measured in terms of Hertz (Hz) and in digital systems in bit/s per second (bit/s). The higher the bandwidth, the greater the amount of information that can be transmitted in a given time. High bandwidth channels are referred to as broadband which typically means 1.5/2.0 Mbit/s or higher.

Base station: A radio transmitter/receiver and antenna used in the mobile cellular network. It maintains communications with cellular telephones within a given cell and transfers mobile traffic to other base stations and the fixed telephone network.

Bit (binary digit): A bit is the primary unit of electronic, digital data. Written in base-2, binary language as a "1" or a "0".

Bit/s: *Bits per second*. Measurement of the transmission speed of units of data (bits) over a network. Also kbit/s: kilobits (1'000) per second; Mbit/s: megabits (1'000'000) per second, and Gbit/s: Gigabits (1'000'000'000) per second.

Bluetooth: A radio technology that makes possible transmitting signals over short distances between mobile phones, computers and other devices.

Broadband: Although there exist various definitions of broadband that have assigned a minimum data rate to the term, it may be defined as transmission capacity with sufficient bandwidth to permit combined provision of voice, data and video, with no lower limit. Effectively, broadband is implemented mainly through ADSL, cable modem or WLAN services.

Browser: Application that retrieves WWW documents specified by URLs from an HTTP server on the fixed-line Internet. Displays the retrieved documents according to the Hyptertext Markup Language (*HTML*).

Cable modem: A technology that allows high-speed interactive services, including Internet, to be delivered over a cable TV network.

CAGR: *Compound Annual Growth Rate*. See the Technical Notes in the Annex.

CDMA: *Code Division Multiple Access*. A technology for digital transmission of radio signals based on spread spectrum techniques where each voice or data call uses the whole radio band and is assigned a unique code.

CDMA2000: *Code Division Multiple Access 2000*. A third-generation digital cellular standard based on Qualcomm technology. Includes CDMA2000 1x, 1xEV-DO (Evolution, Data Optimized) and 1xEV-DV (Evolution, Data and Voice). One of the IMT-2000 "family" of standards.

cdmaOne: 2.5G mobile cellular standard (IS-95B) based on CDMA and backed by Qualcomm. The evolution from cdmaOne continues with the 3G standard, CDMA2000. The related 2G standard is known as IS-95A.

Cell: The geographic area covered by a single base station in a cellular mobile network.

Cellular: A mobile telephone service provided by a network of base stations, each of which covers one geographic cell within the total cellular system service area.

Channel: One of a number of discrete frequency ranges utilized by a base station to transmit and receive information from cellular terminals (such as mobile handsets).

Churn: Term used to describe the turnover in the number of subscribers to a network, typically measured monthly. There are several different ways of measuring churn (for instance, based on the subscriber base at the start or the end of the month) which means that comparisons between companies or between countries are not always meaningful.

Circuit-switched connection: A temporary connection that is established on request between two or more stations in order to allow the exclusive use of that connection until it is released. At present, most mobile voice networks are based on circuit-switching, whereas the Internet is packet-based. See also *Packet-based*.

Connectivity: The capability to provide, to end-users, connections to the Internet or other communication networks.

Coverage: Refers to the range of a mobile cellular network, measured in terms of geographic coverage (the percentage of the territorial area covered by mobile cellular) or population coverage (the percentage of the population within range of a mobile cellular network).

CPP: *Calling party pays*. Billing option typically used in mobile networks whereby the person making the call is charged for its full cost, in contrast to billing also the recipient of the call (see also *RPP*).

D-AMPS: *Digital Advanced Mobile Phone Service*. A digital version of AMPS, the original analogue standard for mobile phone service in the United States and now used in many countries. It is now called TDMA/IS-136. See also *TDMA*.

DCS-1800: *Digital Cellular System 1800.* GSM networks using the 1'800 Mhz frequency. See also *PCS*.

DECT: *Digital Enhanced Cordless Telecommunications*. A standard for cordless telephony originally established by ETSI.

Digital: Representation of voice or other information using digits 0 and 1. The digits are transmitted as a series of pulses. Digital networks allow for higher capacity, greater functionality and improved quality. Examples of digital cellular networks include GSM, CDMA, and TDMA.

DNS: *Domain Name System.* Databases located throughout the Internet that contain Internet naming information, including tables that cross-reference domain names with their underlying IP numbers.

Domain Name: The registered name of an individual or organization eligible to use the Internet. Domain names have at least two parts and each part is separated by a dot (e.g. itu.int). The name to the left of the dot is unique for each top-level domain name, which is the name that appears to the right of the dot.

DSL: *Digital subscriber line*. See also *xDSL*.

Dual-mode (also *tri-mode* or *multi-mode*)**:** Handsets that can work with more than one different standard and/or at more than one frequency.

e-commerce: *Electronic commerce*. Term used to describe transactions that take place online where the buyer and seller are remote from each other.

EDGE: *Enhanced Data rates for GSM Evolution*. An intermediate technology, still under development, that brings second-generation GSM closer to third-generation capacity for handling data speeds up to 384 kbit/s.

E-mail: *Electronic mail*. The exchange of electronic messages between geographically dispersed locations.

EMS: *Enhanced Messaging Service*. EMS is a text service allowing mobile users to send and receive short text messages from other mobile and PC users. Compared to SMS, EMS includes additional features such the transmission of simple melodies, graphics, sounds, animations and modified text as an integrated message.

End-user: The individual or organization that originates or is the final recipient of information carried over a network (i.e. the consumer).

ENUM: Standard adopted by Internet Engineering Task Force (IETF), which uses the domain name system (DNS) to map telephone numbers to Web addresses or uniform resource locators (URL). The long-term goal of the ENUM standard is to provide a single number to replace the multiple numbers and addresses for users' fixed lines, mobile phones, and e-mail addresses.

Exchange: See *Switch*.

FDD: *Frequency Division Duplex*. One technique used for wireless communications where the up link and down link are at different frequencies.

FDMA: *Frequency Division Multiple Access*. A cellular technology that has been used in the first-generation analogue systems (i.e., NMT, AMPS, and TACS).

Fixed line: A physical line connecting the subscriber to the telephone exchange. Typically, fixed-line network is used to refer to the PSTN (see below) to distinguish it from mobile networks.

Frequency: The rate at which an electrical current alternates, usually measured in Hertz (see *Hz*). It is also used to refer to a location on the radio frequency spectrum, such as 800, 900 or 1'800 Mhz.

Gateway: Any mechanism for providing access to another network. Entrance and exit to a communications network.

GDP: *Gross domestic product*. The market value of all final goods and services produced within a nation in a given time period.

GMPCS: *Global Mobile Personal Communications by Satellite*. Non-geostationary satellite systems that are intended to provide global communications coverage to small handheld devices.

GNP: *Gross national product*. The market value of all final goods and services produced in a nation's economy, including goods and services produced abroad.

GPRS: *General Packet Radio Service*. A 2.5G mobile standard typically adopted by GSM operators as a migration step towards 3G (W-CDMA). Based on packet-switched technology enabling high-speed data transmission (approx. 115 kbit/s).

GPS: *Global Positioning System*. Refers to a "constellation" of 24 "Navstar" satellites launched initially by the United States Department of Defense, that orbit the Earth and make it possible for people with ground receivers to pinpoint their geographic location. The location accuracy ranges from 10 to 100 metres for most equipment. A Russian system, GLONASS, is also available, and a European system, Galileo, is also under development.

GSM: *Global System for Mobile communications*. European-developed digital mobile cellular standard. GSM is the most widespread 2G digital mobile cellular standard, available in over 170 countries worldwide. For more information see the GSM Association website at: http://www.gsmworld.com/index.html.

Hand-off: A central concept of cellular technology, enabling mobility for subscribers. It is a process by which the Mobile Telephone Switching Office passes a mobile phone conversation from one radio frequency in one cell to another radio frequency in another as a subscriber crosses the boundary of a cell.

HiperLAN: *High-Performance Radio Local Area Network*. An ETSI standard that operates at up to 54 Mbit/s in the 5 GHz RF band.

HiperLAN2: *High-Performance Radio LAN Type 2*. Wireless LAN (specified by ETSI/BRAN) in the 5 GHz IMS Band with a bandwidth up to 50 Mbit/s.

HiperLAN2 is compatible with 3G WLAN systems for sending and receiving data, images, and voice communications.

Host: Any computer that can function as the beginning and end point of data transfers. Each Internet host has a unique Internet address (IP address) associated with a domain name and a permanent connection to the Internet.

HSCSD: *High-Speed Circuit-Switched Data*. An intermediary upgrade technology for GSM-based on circuit-switched technology and enabling data service speed of 57 kbit/s.

HTML: *Hypertext Markup Language*. The set of symbols or codes inserted in a file for display on a World Wide Web browser page and which contain the necessary information for the display of images and text on screen. Mark-up languages for translating Web content onto mobile phones include cHTML (compact), WML (wireless), xHTML (extensible hypertext) and XML (extensible).

HTTP: *Hypertext Transfer Protocol*. Hypertext is any text that cross-references other textual information with hyperlinks.

Hz: *Hertz*. The frequency measurement unit equal to one cycle per second.

IMEI: *International Mobile Equipment Identity*. Unique serial number used on mobile phones, typically those connected to the GSM network.

i-mode: *information mode*. A mobile Internet service launched in Japan in spring 1999 by NTT DoCoMo. The service is accessed over a packet-based network and the contents are viewed through a subset of the Hypertext Markup Language, cHTML.

IMT-2000: International Mobile Telecommunications. Third-generation (3G) "family" of mobile cellular standards approved by ITU. For more information see the website at: http://www.itu.int/imt.

Incumbent: The (former) monopoly service and network provider in a particular country.

Instant messaging (IM): Refers to programs such as AOL Instant Messenger and ICQ that allow users to exchange messages with other users over the Internet with a maximum delay of one or two seconds at peak times. Mobile versions of IM have also been launched in 2002.

Interconnection: The physical connection of telecommunication networks owned by two different operators. Network operators typically charge a per-minute fee for use of their network by other operators. See *Access charge*.

Internet: The collection of interconnected networks that use the Internet protocols (IP).

Internet backbone: The high-speed, high capacity lines or series of connections that form a major pathway and carry aggregated traffic within the Internet.

Internet content provider: A person or organization that provides information via the Internet, either with a price or free of charge.

IP: *Internet Protocol*. The dominant network layer protocol used with the TCP/IP protocol suite.

IP telephony: *Internet Protocol Telephony*. IP telephony is used as a generic term for the conveyance of voice, fax and related services, partially or wholly over packet-based, IP-based networks. In this report, IP telephony is used interchangeably with Voice over Internet Protocol (see *VoIP*). A third term, Internet telephony, is used when referring to IP Telephony conveyed partially or wholly over the Internet.

IPO: *Initial public offering*. The first sale of publicly tradable stock shares in a company.

IPSec: *Internet Protocol Security*. A technology for encrypting IP packets. An additional feature for IPv4 but a standard feature of IPv6.

IPv4: *Internet Protocol version 4*. The version of IP in common use today.

IPv6: *Internet Protocol version 6*. The emerging standard, which aims to rectify some of the problems seen with IPv4, in particular the shortage of address space.

ISDN: *Integrated Services Digital Network*. A digital switched network, supporting transmission of voice, data and images over conventional telephone lines.

ISP: *Internet Service Provider*. ISPs provide end-users access to the Internet. *Internet Access Providers* (IAPs) may also provide access to other ISPs. ISPs may offer their own proprietary content and access to online services such as e-mail.

ITU: *International Telecommunication Union*. The United Nations specialized agency for telecommunications. See http://www.itu.int/.

Java: Programming language developed by Sun Microsystems. Some versions of Java are likely to be used in the creation of mobile services. Java is primarily characterized by the fact that programs written in the language do not rely on a specific operating system.

JPEG: *Joint photographic Expert Group Compression Standard.* Standard for the compression and coding of still images.

LAN: *Local Area Network*. A computer network that spans a relatively small area. Most LANs are confined to a single building or group of buildings. However, one LAN can be connected to other LANs over any distance via telephone lines and radio waves. A system of LANs connected in this way is called a wide-area network (WAN). See also *WLAN*.

LBS: *Location-based services*. LBS make use of information on the location of a mobile device and user, and can exploit a number of technologies for the geographic location of a user. Some of these technologies are embedded in the networks and others in the handsets themselves. Location capability is already available to some level of accuracy (approx. 150 m) for most users of cellular networks. Increased accuracy can become available through location technologies such as GPS.

Local loop: The system used to connect the subscriber to the nearest switch. It generally consists of a pair of copper wires, but may also employ fibre-optic or wireless technologies.

Main telephone line: Telephone line connecting a subscriber to the telephone exchange equipment. This term is synonymous with the term *fixed line* used in this report.

MASP: *Mobile Application Service Provider*. MASPs provide the same service to mobile clients as regular application service providers provide to fixed-line clients, that is to say Web-based access to applications and services that would otherwise be stored locally.

m-commerce: *Mobile commerce*. Similar to e-commerce but the term is usually applied to the emerging transaction activity in mobile networks.

MDG: *Millennium Development Goals*. The 8 MDGs are global targets that 191 nations adopted at the UN Millennium Summit (September 2000). They include specific goals for human development and poverty eradication to be met by 2015.

MMS: *Multimedia Messaging Service*. MMS will provide more sophisticated mobile messaging than SMS or EMS. A global standard for messaging, MMS will enable users to send and receive messages with formatted text, graphics, audio and video clips. Unlike SMS and most EMS, it will not be limited to 160-characters per message.

Mobile: As used in this report, the term refers to mobile cellular systems and to mobile phones.

MP3: *MPEG-1 Audio Layer-3* (MPEG stands for Moving Pictures Experts Group). A standard technology and format for compression of a sound sequence into a very small file (about one-twelfth the size of the original file) while preserving the original level of sound quality when it is played.

m-tailing: *Mobile tailing*. Expression used in the billing and charging environment for mobile retailing.

MVNO: *Mobile Virtual Network Operator*. An MVNO can be defined as a mobile service provider that offers mobile services but does not own its own radio frequency. Typically, MVNOs lease capacity from operators, e.g. licensed 2G and 3G operators.

NMT: *Nordic Mobile Telephone system*. An analogue mobile cellular system developed in the Nordic countries.

Number portability: The ability of a customer to transfer an account from one service provider to another without requiring a change in number.

Packet: Block or grouping of data that is treated as a single unit within a communication network.

Packet-based: Message-delivery technique in which packets are relayed through stations in a network. See also *Circuit-switched connection*.

PAN: *Personal Area Network*. For the purposes of this report, a PAN is referred to as the interconnection of information technology devices within the range of an individual person, typically within a radius of 10 metres. For example, a person travelling with a laptop, a personal digital assistant (PDA), and a portable printer could interconnect these devices through a wireless connection, without the need for physical wiring. Conceptually, the difference between a PAN and a wireless LAN is that the former tends to be centered around one person while the latter has a greater range of wireless connectivity, typically serving multiple users.

PCS: *Personal Communication Services*. In the United States, refers to digital mobile networks using the 1'900 Mhz frequency. In other countries, refers to digital mobile networks using the 1'800 Mhz frequency (See also *DCS-1800*). The term Personal Communications Network (PCN) is also used.

PDA: *Personal Digital Assistant*. A generic term for handheld devices that combine computing and communication functions.

PDC: *Personal Digital Cellular*. A Japan-developed digital mobile cellular system. PDC has been adopted exclusively in Japan.

Peak rate: Term used for calls made during the busy part of the working day, at full tariff. Off-peak refers to calls made at other times, with discounted tariffs.

Penetration: A measurement of access to telecommunications, normally calculated by dividing the number of subscribers to a particular service by the population and multiplying by 100. Also referred to as *teledensity* (for fixed-line networks) or mobile density (for cellular ones), or *total teledensity* (fixed and mobile combined).

Pervasive computing: A concept which describes a situation in which computing capability is embedded into numerous different devices around the home or office (e.g. fridges, washing machines, cars, etc.). Also referred to as *ubiquitous computing*. *Pervasive communications* implies that the microchips in these devices are also able to communicate, for instance their location and status.

PKI: *Public Key Infrastructure*. PKI enables users of unsecure public networks such as the Internet to securely and privately exchange data and/or funds. This is done using public key cryptography, i.e. through the use of a public and a private cryptographic key pair that is obtained and shared through a trusted authority (e.g. certification authority). PKI provides a digital certificate that can identify an individual or an organization and directory services that can store and, when necessary, revoke the certificates.

POPs: The population within a mobile operator's licensed area that could theoretically be served. Confusingly, in the Internet world, the same abbreviation is used to refer to *Point of Presence* (*PoP*).

Portal: Although an evolving concept, the term portal commonly refers to the starting point, or a gateway through which users navigate the World Wide Web, gaining access to a wide range of resources and services, such as e-mail, forums, search engines, and shopping malls. A *mobile portal* implies a starting point which is accessible from a mobile phone.

PPP: *Purchasing power parity*. An exchange rate that reflects how many goods and services can be purchased within a country taking into account different price levels and cost of living across countries.

Proportionate subscribers: The number of subscribers of a mobile cellular operator based on ownership. Calculated by multiplying the mobile cellular operator's share of ownership (equity) in a particular subsidiary by the total number of subscribers.

Protocol: A set of formal rules and specifications describing how to transmit data, especially across a network.

PSTN: *Public Switched Telephone Network*. The public telephone network that delivers fixed telephone service.

PTO: *Public telecommunication operator*. A provider of telecommunication infrastructure and services to the general public. The term public relates to the customer rather than the ownership of the PTO. Also referred to as an operator, a service provider, a carrier, or a telco.

Public payphone: Typically supplied and operated by the incumbent carrier, public payphones have been a traditional method of encouraging widespread access to telecommunication facilities.

Roaming: A service allowing cellular subscribers to use their handsets on networks of other operators or in other countries.

RPP: *Receiving party pays*. Billing option whereby the person receiving a call is charged in addition to the person initiating the call (as opposed to only the caller paying, see *CPP*).

Server: (1) A host computer on a network that sends stored information in response to requests or queries.
(2) The term server is also used to refer to the software that makes the process of serving information possible.

SIM: *Subscriber identity module* (card). A small printed circuit board inserted into a GSM-based mobile phone. It includes subscriber details, security information and a memory for a personal directory of numbers. This information can be retained by subscribers when changing handsets. See also *USIM*.

SMS: *Short Message Service*. A service available on digital networks, typically enabling messages with up to 160 characters to be sent or received via the message centre of a network operator to a subscriber's mobile phone.

SMTP: *Simple Mail Transfer Protocol*. A protocol designed for the seamless transmission of electronic mail across an Internet using e-mail servers and clients.

Spectrum: The radio frequency spectrum of hertzian waves used as a transmission medium for cellular radio, radiopaging, satellite communication, over-the-air broadcasting and other services.

SSL: *Secure Sockets Layer*. A programme layer created by Netscape for managing the security of message transmissions in a network. SSL uses a public-and-private key encryption system, which also includes the use of a digital certificate.

Switch: Part of a mobile or fixed telephone system that routes telephone calls to their destination.

TACS: *Total Access Communications System*. An analogue mobile cellular system.

TCP: *Transmission Control Protocol*. A transport layer protocol that offers connection-oriented, reliable stream services between two hosts. This is the primary transport protocol used by TCP/IP applications.

TCP/IP: *Transmission Control Protocol/Internet Protocol*. The suite of protocols that defines the Internet and enables information to be transmitted from one network to another.

TDD: *Time Division Duplex*. One technique used for wireless communication where the up link and down link use the same frequencies.

TDMA: *Time Division Multiple Access*. A digital cellular technology that divides frequency into time slots. It is the prevalent technology of the second-generation digital cellular with three main versions: North American TDMA (IS-136); European TDMA (GSM); and Japanese TDMA (PHS/PDC).

TDMA IS-136: *Time Division Multiple Access IS-136*. A digital cellular standard earlier referred to as D-AMPS. For more information see the Universal Wireless Communications Consortium website at: http://www.uwcc.org/. See also *D-AMPS*.

Teledensity: Number of main telephone lines per 100 inhabitants. See *Penetration*.

Total teledensity: Sum of the number of fixed lines and mobile phone subscribers per 100 inhabitants.

UMTS: *Universal Mobile Telecommunications System*. The European term for third-generation mobile cellular systems or IMT-2000 based on the W-CDMA standard. For more information see the UMTS Forum website at: http://www.umts-forum.org/.

Universal access: Refers to reasonable telecommunication access for all. Includes universal service for those that can afford individual telephone service and widespread provision of public telephones within a reasonable distance of others.

URL: *Uniform Resource Locator*. The standard way to give the address or domain name of any Internet site that is part of the World Wide Web (WWW). The URL indicates both the application protocol and the Internet address, e.g. http://www.itu.int/.

USIM: *Universal Subscriber Identity Module* (card). A printed circuit board (similar to a SIM) that is inserted into a mobile phone. Adopted by W-CDMA operators for 3G mobile. Capable of storing much more information and has strong security functions compared with SIMs. Also referred to as *User Identity Module*, or UIM.

UTRA: *UMTS Terrestrial Radio Access*. The European third-generation mobile standard ETSI has agreed on which draws upon both W-CDMA and TDMA-CDMA proposals.

VoIP: *Voice over IP*. A generic term used to describe the techniques used to carry voice traffic over IP (see also *IP telephony*).

VXML: *Voice eXtensible Markup Language*. A new standard under development that uses voice to browse the Web.

WAP: *Wireless Application Protocol.* A license-free protocol for wireless communication that enables the creation of mobile telephone services and the reading of Internet pages from a mobile phone, thus being a mobile equivalent of HTTP (Hypertext Transfer Protocol).

W-CDMA: *Wideband Code Division Multiple Access*. A third-generation mobile standard under the IMT-2000 banner, first deployed in Japan. Known as UMTS in Europe. See also *CDMA*.

Website / Web page: A website (also known as an Internet site) generally refers to the entire collection of HTML files that are accessible through a domain name. Within a website, a webpage refers to a single HTML file, which when viewed by a browser on the World Wide Web could be several screen dimensions long. A "home page" is the webpage located at the root of an organization's URL.

Wi-Fi: *Wireless Fidelity*. Refers to the 802.11b specification for Wireless LANs from the Institute of Electrical and Electronics Engineers (IEEE). It is part of a series of wireless specifications which also includes 802.11a, and 802.11g.

Wireless: Generic term for mobile communication services which do not use fixed-line networks for direct access to the subscriber.

WLAN: *Wireless Local Area Network*. Also known as *Wireless LAN*. A wireless network whereby a user can connect to a local area network (LAN) through a wireless (radio) connection, as an alternative to a wired local area network. The most popular standard for wireless LANs is the IEEE 802.11 series.

WML: *Wireless Markup Language*. See *HTML*.

WWW: *World Wide Web*.
(1) Technically refers to the hypertext servers (HTTP servers) which are the servers that allow text, graphics, and sound files to be mixed together.
(2) Loosely refers to all types of resources that can be accessed.

xDSL: While DSL stands for digital subscriber line, xDSL is the general representation for various types of digital subscriber line technology, such as ADSL (asynchronous digital subscriber line), HDSL (high bit-rate digital subscriber line), or VHDSL (very high bit-rate digital subscriber line).

xHTML: *eXtensible Hypertext Markup Language*. See *HTML*.

XML*:* *eXtensible Markup Language*. An open standard for describing data from the W3C. It is used for defining data elements on a web page and business-to-business documents. By providing a common method for identifying data, XML supports business-to-business transactions is expected to become the dominant format for electronic data interchange.

List of Abbreviations and Acronyms

Note: This list includes abbreviations and acronyms not otherwise mentioned in the glossary. The list aims to cover the main terms used in this report, but is not exhaustive.

AIM	AOL Instant Messenger ™
ALI	Automatic location identification
ARPU	Average revenue per user
ATM	Automated teller machine
B2B	Business-to-business
B2C	Business-to-consumer
BREW	Binary Runtime Environment for Wireless
CGALIES	Co-ordination Group on Access to Location Information by Emergency Services
cHTML	Compact Hypertext Markup Language
CMOS	Complementary Metal Oxide Semiconductor
CTR	Click-through rate
CXML	Commerce Extensible Markup Language
ebXML	e-business Extensible Markup Language
ETSI	European Telecommunications Standards Institute
EU	European Union
FCC	Federal Communication Commission (United States)
FOMA	Freedom of Mobile Multimedia Access™
GATS	WTO General Agreement on Trade in Services
GHz	Gigahertz
GIF	Graphics Interchange Format
gTLD	Generic top-level domain
HDML	Handheld Device Markup Language
ICQ	"I seek you"
ICT	Information and communication technologies
ID	Identity
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IrFM	Infrared Financial Messaging
IMF	International Monetary Fund
IMTS	Improved Mobile Telephone Service
ISO	International Organization for Standardization
ITU	International Telecommunication Union
ITU-D	ITU Development Sector
ITU-R	ITU Radiocommunication Sector
ITU-T	ITU Standardization Sector

J2ME	Java2 Platform Micro Edition
LIF	Location Interoperability Forum
MASP	Mobile Application Service Provider
MeT	Mobile Electronic Transaction Initiative
MHz	Megahertz
MEXE	Mobile Station Application Execution Environment
MIC	Ministry of Information and Communication (Republic of Korea)
MIDI	Musical Instrument Digital Interface
MPHPT	Ministry of Public Management, Home Affairs, Posts and Telecommunications (Japan)
mTLD	Mobile top-level domain
NGO	Non-governmental organization
OECD	Organisation for Economic Co-operation and Development
OMA	Open Mobile Alliance
OSA	Open Services Architecture
PCMCIA	Personal Computer Memory Card International Association
PHS	Personal Handyphone System
PIN	Personal Identification Number
PPTP	Point-to-Point Tunneling Protocol
QoS	Quality of Service
SMP	Significant Market Power
SPU	ITU Strategy and Policy Unit
UIM	User Identity Module
UN	United Nations
USB	Universal Serial Bus
UTRA	UMTS Terrestrial Radio Access
VXML	Voice Extensible Markup Language
W3C	World Wide Web Consortium
WAV	Wave file
WAN	Wide Area Network
WEP	Wired Equivalence Privacy
WHO	World Health Organization
WIPO	World Intellectual Property Organization
WPKI	Wireless Public Key Infrastructure
WRC	World Radiocommunication Conference
WTO	World Trade Organization

1 CHAPTER ONE: INTRODUCTION

1.1 The mobile Internet

1.1.1 Are two better than one?

Mobile communications and the Internet were the two major demand drivers for telecommunication services in the last decade of the twentieth century. Combine the two—mobile Internet—and you have one of the major demand drivers of the first decade of the twenty-first century. That is the fundamental premise on which this report is based.

The origins of the **mobile** communications industry date from the licensing of analogue cellular communications services in the early 1980s. As recently as 1990, there were only 11 million subscribers worldwide, but the introduction of digital services in the early 1990s, combined with competitive service provision and a shift to prepaid billing, spurred rapid growth in demand. By the end of 2001, the number of mobile subscribers had grown to 945 million and mobile was on the point of taking over from fixed lines as the network with the most subscribers.

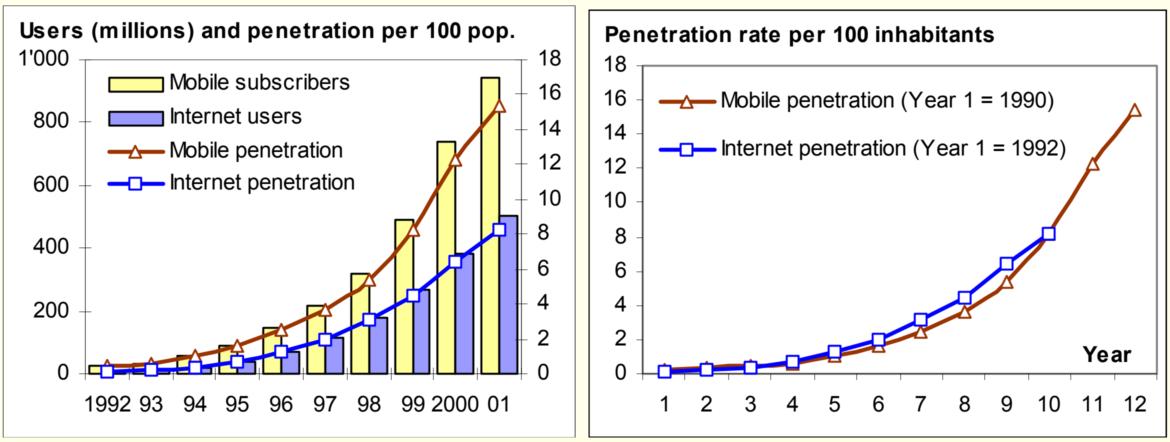
The origins of the **Internet** go back to 1969, but it was in the early 1990s, with the development of the World Wide Web and graphical browsers, that the Internet took off as a commercial undertaking. By the end of 2001, the Internet had passed the half billion user mark. Although the "dot.com" boom of the late 1990s proved to be short-lived, the Internet itself has continued to grow, adding more users and new applications. Internet revenues are still tiny by comparison with those of mobile communications, but the Internet has provided a platform for the development of e-commerce, which is now a generator of considerable sums of money.

As Figure 1.1 shows, the two industries have exhibited remarkably similar growth patterns since the start of the 1990s, but with a lag of about two years. The level of penetration of the Internet at the end of 2001 (8.2 users for every 100 inhabitants, worldwide) is almost identical to the penetration of mobile phones at the end of 1999. This two year lag might be explained by the fact that the formative moments in the growth of these industries occurred just under two years apart: digital cellphones were launched commercially on 1 July 1991 (by Radiolinja, in Finland), while graphical browsers were launched in April 1993 (the Mosaic browser, launched by the US National Center for Supercomputing Applications).

So, it requires no great leap of the imagination to believe that the convergence of mobile communications and the Internet will produce something big, perhaps even the mythical "sum that is bigger than its parts". In this view, the convergence of mobile communications and the Internet would produce innovations, new

Figure 1.1: Mobile and Internet: Identical twins, born two years apart

Digital mobile subscribers and Internet users (millions) and penetrations rates (per 100 inhabitants), worldwide



Source: ITU World Telecommunication Indicators Database.

applications and new services that would not otherwise be possible. For instance, the service of knowing the location of a particular mobile user, combined with the service of targeted advertising, should theoretically make it possible for local businesses to attract users that are passing by, within a certain radius. Thus, the mobile Internet could give birth to a whole new family of so-called "location-based services". These services, and other projected applications, have set business planners dreaming.

1.1.2 Definitions

But what exactly is the "mobile Internet"? The term is used in this report to refer to the convergence of mobile communication technologies with information and data communication services (such as e-mail and Internet). Eventually, these multimedia services will be further enhanced by the widespread introduction of mobile Internet Protocol (IP) networks.

Another term appearing in this report, "mobile communication", is used to cover all technologies that use radio communication, as opposed to fixed-line communications, for interactive point-to-multipoint communications. The term, as it is used here, excludes interactive point-to-point radio applications, like microwave. It also excludes *non*-interactive point-to-*multipoint* communications, like broadcast TV or radio. The term "mobile communication" is not intended to exclude devices that can be used in a stationary mode (for instance, a home computer connected to the Internet using a wireless LAN). But the focus is on "mobility"—in other words, use of devices that benefit from being untethered and which can easily be moved. Hence the title of the report: "Internet for a mobile generation".

A second clarification relates to mobile/fixed integration. The Internet itself is still primarily a wired network in its long-distance and international components, and probably always will be because the fibre optic cables that carry Internet traffic represent a considerable fixed investment and seem to have plenty of future scope for further development. Accordingly, the term "mobile Internet" is used primarily to refer to the *access network* that links users, and their devices, to the Internet, rather than to the transmission network, which provides long-distance and international connectivity.

A third clarification relates to scale. One way of distinguishing between different mobile access technologies is by the geographical range they typically cover. For instance, Bluetooth works well over short distances, measured in centimetres or a few metres; wireless LANs work over distances measured in tens or hundreds of metres, while cellular communications work over distances measured in tens or hundreds of kilometres. All of these different technologies are covered in the report, but the focus is on "mobility" and on future service development. The shorter distance technologies are complimentary to the longer distance ones and may, to some extent, be substitutable. For instance, users with a wireless LAN card have some degree of freedom to roam between "hotspots" where coverage is available.

A final clarification concerns the nature of the Internet. For the purposes of this report, the Internet means any network that uses the Internet Protocol, irrespective of whether it is a network open to use by the general public or only by a closed user group.

1.1.3 Mobile Internet convergence

In the broader sense, *mobile Internet* refers to the convergence of these two distinct sectors of the telecommunication economy. Convergence might be expected to take place at several different levels:

- Convergence may take place at the level of **terminals**. Thus, a handheld device may enable a user to browse a website, listen to streaming audio, send photos by e-mail, or perform any of the applications currently possible from a personal computer (PC) connected to the Internet. Similarly, it might enable a user with a portable PC to connect to the Internet, with a reasonable access speed, without requiring a fixed network connection.
- **Network** convergence may also take place**.** At present, most mobile voice networks are based on circuit-switching whereas the Internet uses a packet-based architecture. Future mobile networks, such as so-called third-generation (3G) networks, are migrating towards IP, which uses a packet-based architecture. This will facilitate the interchange of data between wired and wireless networks.

- Convergence of **services and applications** implies that the same types of services can be accessed from different types of terminal (e.g. sending text messages to a roaming user from a PC, or browsing the Internet from a handheld mobile phone) and different types of network (e.g. cable TV, mobile, fixed line). This is currently possible, but only at low speeds and with fairly rudimentary functionality. Both of these aspects will improve as the mobile Internet becomes a reality.
- **Corporate** convergence means that a company may choose to provide both mobile and Internet services. An example of this type of convergence is provided by the British company Virgin (www.virgin.co.uk), which is both an Internet Service Provider (virgin.net) and a mobile virtual network operator (Virgin Mobile), and lots of other things too. This has important implications for the way in which different types of service provider are regulated.

The convergence of mobile and the Internet should come as no great surprise. It is a logical step, and also a necessary one in order to make the most of the synergetic potential of these two sectors' technological development. But it will nevertheless be hard to achieve. As well as technical barriers, there will be regulatory and commercial barriers to overcome. For instance:

- Mobile/Internet convergence also requires some degree of convergence in the **numbering, routing and addressing systems** of the two sectors. Currently, the mobile sector uses telephone numbers (technically, E.164 numbers after the ITU-T[1] Recommendation which defines their structure), while the Internet uses universal resource locators (URLs) and e-mail addresses. One project to allow interchange of messages between the two is called ENUM.[2]
- Service convergence will also require some harmonization in the systems of **billing and interconnection** for the two sectors. Although the mobile world has generated a wealth of tariff options for consumers, notably through prepaid billing, the basic unit of measurement is still the call minute. By contrast, Internet billing is, for the most part, based on flat-rate tariffs and/or transaction costs. Reconciling these two systems leads to difficulties. Early experience with 2.5G and 3G mobile suggests that future mobile Internet tariffs will be a hybrid of subscription charges and volume-based usage charges. But this raises the possibility that profitable mobile voice traffic will be routed over data channels in order to bypass high per-minute charges, especially for call termination. Already, SMS traffic is routed over the data signalling channel and in the future, perhaps voice might be routed in packet form. This phenomenon of bypass is commonplace in the fixed-line world where, for instance, voice over Internet Protocol (VoIP) is used to bypass high international call charges and settlement fees. Conversely however, if volume charges are set too high to avoid voice bypass, then 3G may never take off.

The biggest challenge of all to the take-off of the mobile Internet is, however, the need to provide services and applications that consumers really want and for which they are willing to pay. In all the debate over the mobile Internet, this simple point has often been overlooked. But the worrying fact is that the early commercial services of 3G systems (using wideband CDMA) in Japan and elsewhere have failed to generate as many new subscribers as was expected. Similarly, some, though not all, 2.5G projects have delivered disappointing results. Overall, the story so far has been one of delays. But this is not the first time this has happened …

1.2 Convergence: *déjà vu* all over again?

Predicting future trends in technological convergence and market demand is always a risky business. The projected convergence between industrial sectors in the recent past provides some interesting comparisons:

- In the 1970s and 1980s, many forecasters predicted the imminent convergence of **telecommunications and computing** and corporate strategists designed business cases for mergers and acquisitions around the synergies that would be achieved.[3] The convergence was much delayed and when it finally arrived—with the development of the World Wide Web—many of those same corporate strategists did not recognize it straight away. The fundamental breakthroughs that enabled the Web to become a multi-billion dollar industry came neither from the large telecommunication operators, nor the major IT companies, but rather from the academic research community (e.g. CERN in Geneva) and from start-ups (e.g. Netscape).

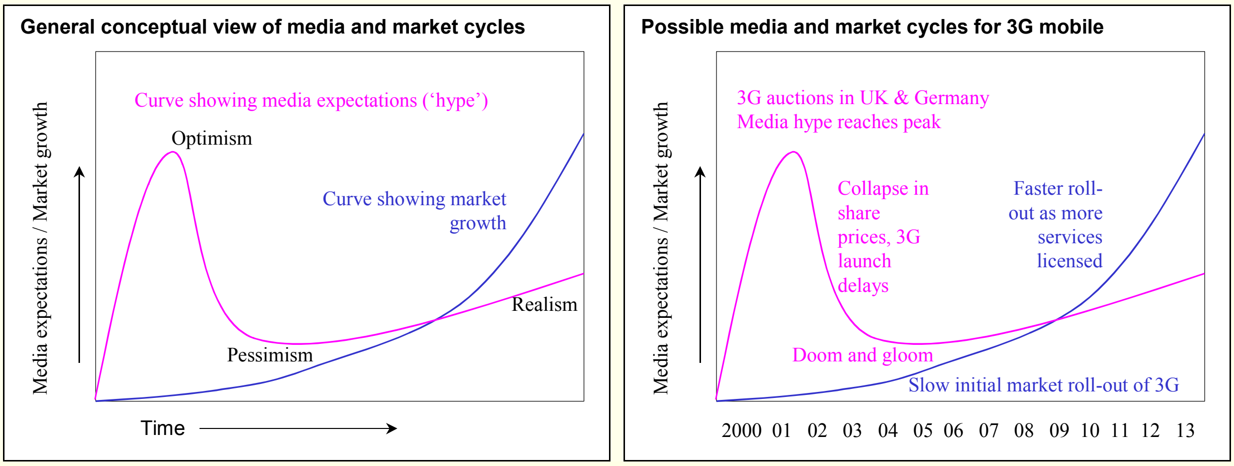
- In the early 1990s, many forecasters predicted the imminent convergence of **telecommunications and broadcasting**, and again many corporate strategists planned mergers and experimental trials.[4] Most of these were based on the assumption that a converged telecom and broadcasting company could deliver services like video on demand, or interactive television, hence creating new demand among consumers. While there is undoubtedly potential demand for these services, the trials showed a mismatch between the price at which services could be delivered (high) and the price at which consumers would buy (low). Furthermore, similar services could be delivered through multi-channel television or through media streaming on the Internet. Convergence did happen, but not in the manner expected.

Although the anticipated convergence between mobile communications and the Internet is different from the examples of convergence described above, these cases nevertheless offer a few pertinent lessons:

- It always takes longer than you think. Mobile/Internet convergence will almost certainly happen, but we should not necessarily expect to see the commercial fruit of the technological convergence for some ten to fifteen years yet. Nevertheless, even if it does not happen straight away, that does not mean it will never happen.
- The media and the market follow different cycles. As illustrated in Figure 1.2, the "hype" generated by a particular technological development often falls flat before market development begins to take off. Consequently, the popular view is that a particular development has "failed", whereas the more accurate explanation is that market development has not yet got going properly.
- Convergence may cannibalize existing markets. Far from creating a new revenue stream, mobile/Internet convergence may, in the short-term at least, merely substitute one market for another. For instance, the fees that consumers currently pay for sending SMS messages over second-generation (2G) mobile phones may simply be diverted to pay for multimedia messaging. The total amount spent on messaging may grow only slowly, or may even fall, if consumers find that the greater bandwidth available enables them to send simple text messages more cheaply.
- Pioneers get burnt fingers. Those companies that attempt to push convergence forward, and make corporate strategies on that basis, often end up losing money or, at best, failing to recoup their investments. In the context of mobile/Internet convergence, it is the investments made to acquire licences to provide 3G mobile services, especially in Europe, that now look to be at risk. To date, more than US$ 100 billion has been invested in acquiring the licences, even before network construction and service roll-out costs are taken into account.

Figure 1.2: Media hype precedes market growth

Conceptual view of the expansion and collapse in media hype that typically precedes actual market development for a particular innovation, and its application to 3G mobile



Source: ITU.

Those who forget their history are condemned to repeat it, so it is with some caution that the pioneers of this new wave of convergence must prepare their business plans. The mobile Internet offers many exciting new opportunities, but also many difficult challenges, particularly for those firms that already have existing revenue streams to protect.

1.3 Challenges to the industry

The first edition of the ITU Internet Reports series, published in September 1997, was entitled "Challenges to the Network: Telecoms and the Internet". That report was concerned with the challenges that the Internet was raising for the fixed-line public switched network, in particular those of providing high-speed access for users and high capacity data transfers between networks. This edition, the fourth in the series, could equally have been entitled "Challenges to the industry: Build the network", because the reality is that the network which will be needed to sustain the mobile Internet is still being built.

Exploiting the new opportunities offered by the mobile Internet will require high levels of capital investment, possibly higher than ever before in the telecommunication industry. Yet the industry's relations with the investment community, especially the world's stock markets, are as bad as they have ever been since the first privatizations of public telecommunication operators began in the 1980s. Investors want to see proof that a market for the mobile Internet exists. But operators can't provide that proof until they build the networks. Because of this "chicken and egg" conundrum, the mobile Internet is potentially the biggest gamble the telecommunication industry has ever taken on.

This report looks at the challenges posed by mobile/Internet convergence in the following ways:

- Chapter two, **Technologies and applications,** provides and overview of the main technologies for the Mobile Internet and looks at the technological challenges ahead, especially the likelihood of substitutability between different technologies such as 3G, Wireless LANs, Bluetooth and others that help bring high-speed Internet access to mobile users, via radio waves.
- Chapter three, **Market trends**, looks at the commercial challenges involved in creating a mass market for mobile Internet services. What are the prospects for market development, and what lessons can be learned from the early experiences with 2.5G and 3G systems?
- Chapter four, **Regulatory and policy aspects**, looks at the challenges to policy-makers and regulators in creating the right environment for the market to develop. This includes processes of licensing but also deals with issues that arise in the post-licensing environment, for instance related to competition policy, interconnection and network sharing.
- Chapter five, **Case studies**, reviews how policy-makers and regulators in a range of countries have responded to the challenges. This chapter draws on case studies on the licensing of 3G mobile systems in a variety of countries at different levels of socio-economic development, and draws a number of lessons from the diverse experiences these cases present.[5]
- Chapter six, **Conclusions—Towards a mobile information society**, looks ahead to the broader challenges to society that are posed by the mobile Internet. In so doing, the chapter considers some of the issues that are likely to be debated at the World Summit on the Information Society (WSIS) to be held in two phases, in Geneva, from 10 to 12 December, 2003 and in Tunis in 2005.[6]

The final part of the report contains a series of **Mobile Internet statistical tables** that present the latest available data for more than 200 economies worldwide in terms of their adoption of mobile communications and the Internet. The tables include a specially prepared Mobile/Internet Index that attempts to gauge the likelihood of adoption of the mobile Internet in different economies.

[1] ITU-T is the Telecommunication Standardization Sector of the International Telecommunication Union (ITU).

[2] ENUM is not an acronym but rather is the name of a working group of the Internet Engineering Task Force (IETF), which has been working on a system to allow inter-working between telephone numbers and Internet addresses. For more information, see the ITU website at: http://www.itu.int/osg/spu/enum/index.html.

[3] As an example, the merger between AT&T (telecommunications) and NCR (computing), which took place in 1991, was predicated upon the anticipated convergence between telecommunications and computing. In the event, the merger failed to deliver the expected benefits and AT&T demerged NCR in 1995, just as the World Wide Web was being widely commercialized.

[4] Examples of investments made on the presumption of telecommunications and broadcasting convergence include, for instance, the investment by US Bell Operating Companies in UK cable television companies in the early 1990s. Examples of trials of video-on-demand systems were detailed in the 1995 ITU *World Telecommunication Development Report: Information Infrastructures*.

[5] The case studies were carried out in the context of two ITU research projects: on the licensing of 3G mobile (see www.itu.int/3G) and on Internet diffusion in the ASEAN region (see www.itu.int/asean2001). The full texts of these and other ITU country case studies can be found on the ITU website at http://www.itu.int/osg/spu/casestudies/index.html. The materials are also available on CD-ROM (see publications information inside the front cover of this report).

[6] See the Summit website at http://www.itu.int/wsis/.

2 CHAPTER TWO: TECHNOLOGIES AND APPLICATIONS

Although for most users, the mobile Internet will primarily mean multimedia applications, delivered to handheld devices with colour screens, for the industry itself it is the progress in the underlying technology that is the most exciting aspect. Faster speeds and increasingly efficient use of spectrum allow data, text and video to be handled seamlessly alongside voice.

This chapter provides an overview of the main technologies and applications for the mobile Internet. First, we consider the evolution of mobile systems, with a particular emphasis on third-generation systems. In section 2.2, alternative network technologies such as wireless local area networks (WLAN) and Bluetooth are presented. Section 2.3 considers two of the most popular methods for Internet access from mobile devices, WAP and i-mode. Section 2.4 examines the phenomenon of mobile messaging, and section 2.5 looks at mobile Internet content, including location-based services and format harmonization. Section 2.6 considers some of the security features necessary for the development of the market. Finally, in section 2.7, we summarize the trends towards convergence and interoperability.

2.1 From 2G to 3G

Major stages in the technological development of mobile telecommunications are commonly described in terms of "generations". "First-generation" (1G) mobile technology refers to the analogue cellular systems that first appeared in the late 1970s and early 1980s. This phase of development was characterized by a wide range of different systems, many of which became popular in one or two countries only. "Second-generation" (2G) technology refers to today's digital cellular systems (first deployed at the start of the 1990s)[1], such as GSM (Global System for Mobile Communications), PDC (Personal Digital Communications), TDMA (Time Division Multiple Access), and CDMA (Code Division Multiple Access). While 2G networks were developed under a number of proprietary, regional and national standards[2], "third-generation" systems (3G), were developed from the outset on the global stage, during the 1990s, under the leadership of the International Telecommunication Union (ITU) and specifically under the IMT-2000 (International Mobile Telecommunications) banner. Much effort has gone into the development of a single interoperable global standard for 3G systems, in order to avoid the market fragmentation that had characterized the 1G and 2G worlds.

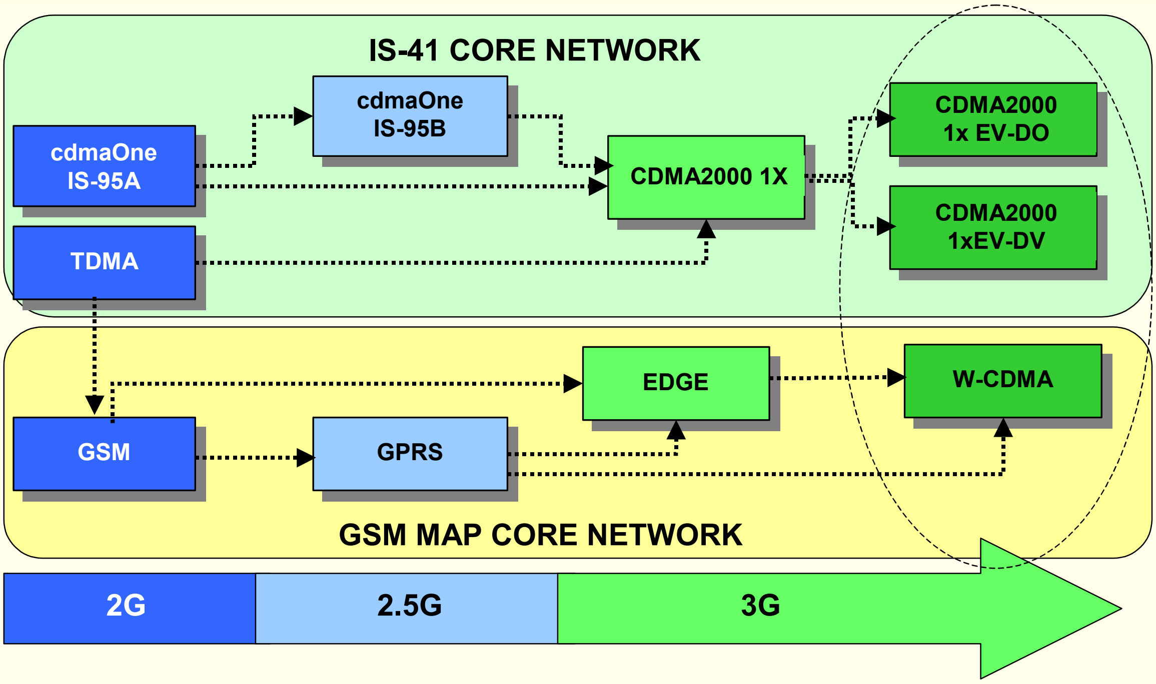
2.1.1 Migration paths

Second-generation mobile networks were primarily circuit-switched networks and differed from their 1G predecessors through the use of digital rather than analogue technology for signal processing. Digital technology manages scarce frequency bands more efficiently and provides higher quality transmission for the development of features such as speech security and data communications.

Although the direct introduction of 3G is warranted in some cases, as exemplified in the case of Japan's NTT DoCoMo, a sudden jump from today's 2G networks to 3G networks will generally not be feasible. Rather, a migration path is more likely to be followed over so-called "2.5G" technologies. There is no universally agreed migration path. Depending on market structure and the level of 2G deployment, 2.5G services such as GPRS (General Packet Radio Service) or cdmaOne may precede 3G deployment (see Figure 2.1). Moreover, early 3G networks will not necessarily be entirely packet-based or IP-based from the start; network evolution is likely to occur over some time as systems are tested and proven.

Although the shift to 3G is a radical one entailing the building out of completely new networks, the transition from 2G to 2.5G services is likely to be accompanied by a more significant conceptual shift than that from 2.5G to 3G, in that it introduces the notion of "always-on" communications. The shift from 2G to 2.5G, for instance, already implies a transition from minute-based to volume-based billing, bringing the billing methods used for the Internet and mobile sectors on to a more common ground. A further important feature of 2.5G services is the capacity to provide higher speeds, meaning that traditional voice services will be increasingly accompanied by a variety of interactive multimedia offerings. Table 2.1 sets out the main 2G and 2.5G network standards and their respective speeds.

Figure 2.1: Possible migration paths from 2G to 3G



Note: TDMA (Time Division Multiple Access), GSM (Global System for Mobile Communications), GPRS (General Packet Radio Service), CDMA (Code Division Multiple Access) W-CDMA (Wideband CDMA), EDGE (Enhanced Data Rates for GSM Evolution)
Source: ITU.

2.1.2 3G systems, or IMT-2000

It was in the mid-1980s that the International Telecommunication Union (ITU) began its work on IMT-2000[3] or standardization of so-called third-generation (3G) mobile systems. The 1992 World Radio Conference (WRC)[4] identified the 2 GHz band for the global deployment of IMT-2000. Eight years later, the 2000 WRC allocated additional spectrum for 3G services in three frequency bands: one below 1 GHz, another at 1.7 GHz (where many second-generation systems currently operate) and a third band in the 2.5 GHz range. This effectively gave a green light to the mobile industry worldwide to start deploying IMT-2000 networks and services. Many economies, such as Australia, Hong Kong, China[5], and most European countries, have allocated spectrum for 3G (see Table 4.1 in Chapter four), although, as of August 2002, few services have been made commercially available. The few countries that have begun deploying 3G services include Japan[6], the Republic of Korea[7], Brazil, Canada and the United States.

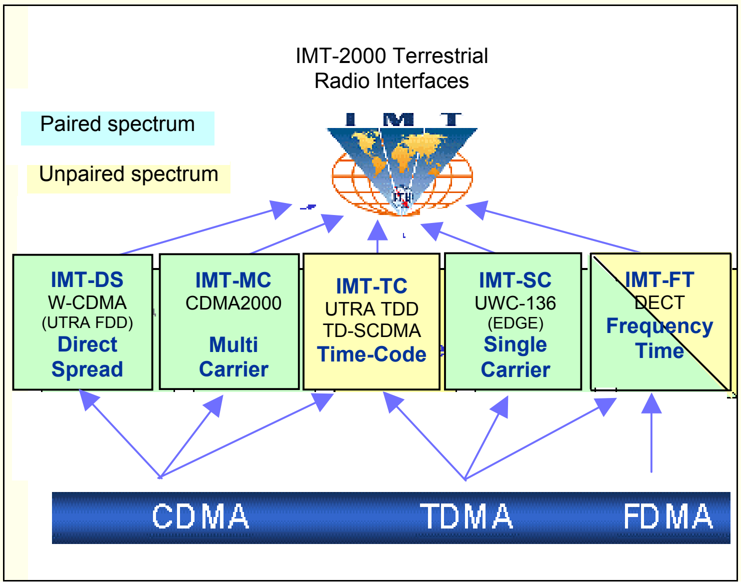
Despite these concerted global efforts at standardization, there remain different approaches to 3G technology. The major industrialized economies were unable to agree on a single standard. The result was an IMT-2000 standard with a number of "flavours", that is to say five possible radio interfaces based on three different access technologies (FDMA, TDMA and CDMA). Thus far, the vast majority of industry attention has been directed towards the CDMA technology, and in particular Wideband CDMA or W-CDMA (known in Europe as UMTS[8]) and CDMA2000 (including CDMA2000 1x).[9] Thus far, national licence allocation has been limited to these two radio technologies, though China is likely to license a third technology, TD-SCDMA. Figure 2.2 sets out the five IMT-2000 radio interfaces.

Table 2.1: Second-generation and 2.5G mobile network standards

Standard	Description	Maximum speed*
GSM (Global System for Mobile Communications)	GSM is the most widespread 2G standard for mobile telephony. The circuit-switched technology is used in over 170 countries (in Europe and most of the Asia-Pacific region).	9.6 kbit/s
GSM - HSCSD (High-Speed Circuit-switched Data)	HSCSD is a GSM based protocol able to transmit data at around four times the speed of GSM by using four radio channels simultaneously.	57.6 kbit/s (2G)
IS-136/TDMA	A standard based on ANSI-136/TDMA (Time Division Multiple Access), which divides a frequency into time slots and gives users access to a time slot at regular intervals. ANSI-136 is used in the US and Central/South America.	14.4 kbit/s (2G)
PDC (Personal Digital Cellular)	Used exclusively in Japan, this standard is based on TDMA technology.	28.8 kbit/s (2G)
IS-95A/CDMA	A standard based on ANSI-95A CDMA (Code Division Multiple Access) technology which codes and spreads all conversations across a broad band of spectrum (1.25 MHz), allowing a large number of users to simultaneously share the same carrier. ANSI-95A has been deployed in the Americas and parts of the Asia-Pacific region.	64 kbit/s (2G)
GPRS (General Packet Radio Service)	A packet-switched wireless protocol as defined in the GSM standard, offering 'always on' access to data networks. Transmission speed will initially be less than the maximum. GPRS 2.5G services were deployed in Europe in 2001.	171.2 kbit/s (2.5G)
IS-95B/CDMA	IS-95B improves upon IS-95A by providing higher data rates for packet- and circuit-switched CDMA data, thus qualifying as a 2.5G standard. This evolution continues with CDMA2000, which is the 3G version based on ANSI-95.	115 kbit/s (2.5G)

Note: Speeds given are maximum speeds. For comparison, the 3G mobile network standard W-CDMA can enable maximum speeds of 2 Mbit/s.
Source: ITU.

Figure 2.2: The IMT-2000 family of terrestrial radio interfaces



Note: ITU recently approved the CDMA2000 1x, 1xEV-DO and 1xEV-DV networks, first commercially deployed in Korea, as part of the IMT-2000 IMT-MC standard.[10]
Source: ITU.

One way in which 3G network technology is distinct from 1G and 2G mobile standards is that it was developed with two main principles in mind: the maximization of network capacity and the availability of multimedia services independent of user location. A GSM network, for instance, uses the GSM standard at the handset level, for the radio interface as well as in its core network[11], whereas for IMT-2000 systems, a separate standardization process applies to the radio network and to the core network. The advantages of IMT-2000 over 2G networks include the capability to provide a variety of infotainment services such as games, news, music, audio and video programming coupled with high-speed Internet access. These networks are intended to provide users with the ability to communicate with anyone at anyplace and at anytime. Their deployment promises converged fixed and mobile, voice and data services.

Typically, 3G systems will provide data rates at a minimum of 144 kbit/s[12] for all radio environments and 2 Mbit/s in low-mobility and indoor environments, though these high speeds will not be available in the initial service offerings. They will also allow for symmetrical and asymmetrical data transmission, which means that they can be used either for real-time communication or for downloads.

Evolution towards an "all-IP" platform

Existing mobile access systems are mainly used for voice communications and typically use transmission speeds of 9.6 kbit/s, 32 kbit/s, or 64 kbit/s. At these speeds, they are unable to distribute complex content such as music and dynamic images, considered by many to be the future mainstay of the mobile business. 3G access systems will provide higher speeds of transmission, but the flexibility and scalability of circuit-switched networks will remain limited, hence the attraction of turning to packet-based networks (i.e. IP networks) for the future.

Given the widespread view that IP network transport will provide a more effective platform for data and Internet offerings than its circuit-switched predecessors, organizations such as ITU[13], the Third-Generation Partnership Project (3GPP) and 3GPP2[14] have been working towards the standardization of these next-generation mobile IP networks. They are formulating a vision for systems beyond IMT-2000, which would enable speeds of up to 10 Mbit/s.

An all-IP network has a number of advantages over current networks. First, IP is compatible with, but independent of, actual radio access technology, that is to say it allows the core network and radio technologies to function independently. Therefore, a core IP network provider could support a wide range of access technologies, such as W-CDMA, the IEEE 802.11 series[15], Bluetooth[16] and so on.

However, the current Internet Protocol version 4 (IPv4) was not intended to cater for the huge demand for IP addresses that is now being witnessed. This means that, once it has run out of addresses, some will stand to be left without even one IP address, with the risk that the gap between the "information rich" and "information poor" may increase further still.[17] Moreover, the demand for IP addresses is set to grow in the future: it is estimated that by 2015, a single user might require an average of ten IP addresses: this is due in part to a trend towards ever smaller and more pervasive computer and/or communication devices used in a variety of applications, including medicine, home automation, security, and so forth. In response to this trend, the telecommunication industry is planning to adopt an upgraded version of the Internet Protocol, called IPv6 (IP version 6).[18] This protocol has the capability of providing each user with a million uniquely addressed and individually locatable IP devices. It will also enable automatic, so-called "plug-and-play" address configurations, thereby reducing the administrative workload for linking new devices.

IPv6 is a timely development for 3G mobile, as it facilitates the delivery of "always-on" customized mobile Internet services. Moreover, as mobility increases, an IPv6 environment will also facilitate the constant updating of databases that will be required for routers to deliver information to any user location at any time. It also embeds privacy and security features as an integral part of the standard, rather than in a separate protocol as is the case with IPv4.

2.2 Wireless LANs and PANs

While mobile voice communications were one step in transforming the way people communicate, wireless data communications are set to go one step further, through network technologies such as wireless local area networks (WLANs) and personal area networks (PANs), enabling such possibilities as sending and receiving e-mails in a moving bus (see Box 2.1), accessing company data from a conference room, or sharing wireless Internet connections in the home. These networks are based on technologies that enable substitution for wider-scale networks at shorter geographical ranges, depending on the coverage afforded by the technology in question.

2.2.1 Different networks for different ranges

The networks with the largest coverage area are current 2G and future 3G mobile networks. 3G is expected to eventually provide full global roaming. A second group of networks covers a smaller area (around 100-150 metres) and includes WLANs. PANs are the networks with the shortest range of communication, covering an area of about ten metres (see Figures 2.3 and 2.6).

The various ranges make each network ideal for different types of traffic. The shorter-range PANs are perfect for cable replacement among peripherals, and other close point-to-point communications. WLANs are better suited for local, high-speed networking of buildings or homes. The broadest coverage, offered by 3G, is best for connecting away from buildings with WLANs, in more remote locations, or in transit. In general terms, the shorter the range, the faster the network and the cheaper the service will be.

While there are wireless technologies in development for all three sizes of networks, this section focuses on the two technologies that have the most immediate promise: wireless LANs and *Bluetooth* (a type of PAN).

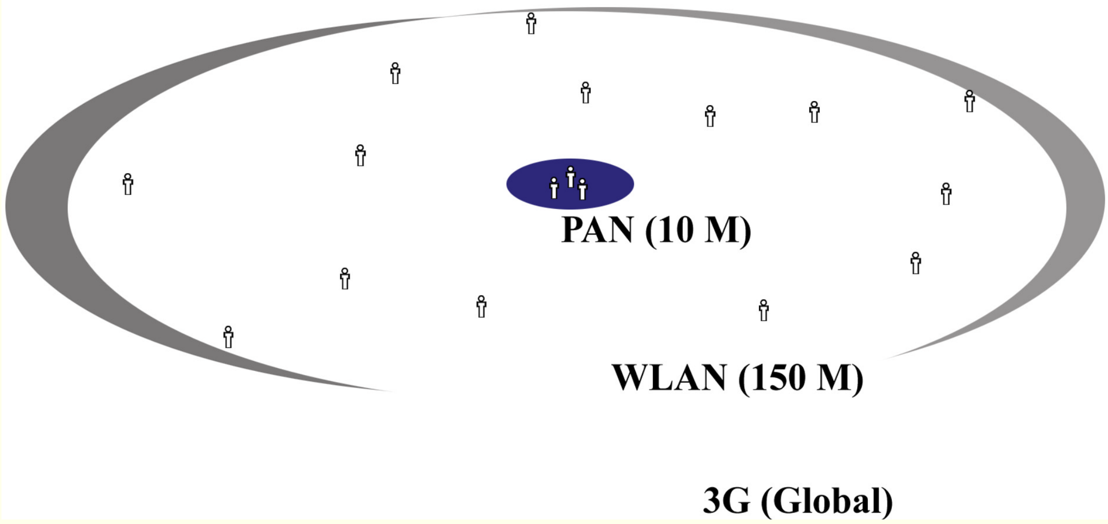
Box 2.1: Broadband on the bus: The convergence of wireless LANs and 3G

The University of California San Diego introduced the world's first CyberShuttle offering mobile, high speed Internet access to its passengers in April 2002. The bus travels for some 15 to 20 minutes between the campus and the nearest train station and users can connect to the Internet with a wireless-enabled laptop or PDA for the duration of the ride.

The wireless network consists of an 802.11b access point (WLAN) mounted in the bus. This access point is connected to the Internet. A CDMA2000 1xEV-DO wide area data network provides 2.4 Mbit/s transmission speed, allowing passengers to access their e-mail, browse the Web, and even enjoy high-speed audio/video streams. While the trip may be short in duration, it highlights the potential of service development as 3G and WLANs move closer towards convergence.

Source: UCSD/California Institute for Telecommunications and Information Technology.

Figure 2.3: Approximate wireless ranges



Note: Not to scale.
Source: ITU.

2.2.2 Introduction to wireless LANs

The rapid success of WLAN technology took most of the world by surprise. Even amid sluggish computer sales, users are buying up wireless networking equipment at a considerable rate. This is partly because, although wireless networking has been around for many years, it has only recently been available at an attractive price to consumers and businesses. WLANs have also found a particular market niche for households with several Internet users. By means of a WLAN router, each member of a household can have access to the Internet simultaneously through a single Internet connection. The connected computers throughout the house can share files and printers just as if they were connected via a traditional local area network (e.g. Ethernet), such as those typically used in the workplace.

Businesses and other institutions are also rapidly embracing wireless LANs, notably in older buildings, convention centres, schools, factories, and other locations where installing wiring poses a challenge. WLANs are also ideal for temporary use by conference attendees, as they can be set up quickly in conference rooms without the need for additional wiring. Wireless networks also perform a very important function for employees on the move, enabling them to roam with their laptop computer, while maintaining a connection to the Internet and the corporate Intranet. In addition, not only do WLANs allow numerous users connection via a single access point, but, once installed, further users can be added easily. This is particularly appealing in locations such as airports and cafés with high numbers of transient users.

Other, non-conventional business users are also finding wireless networks a valuable asset. For instance, shopping trolleys in grocery stores can be equipped with wireless devices that send signals back to the network and plot the course of shoppers as they make their way through the store. Managers can then adjust the placement of the most popular or profitable goods to the highest traffic areas.

The medical profession has also benefited from the growth of wireless technology. Doctors and nurses can carry personal digital assistants (PDAs) with wireless connections in order to access a patient's medical records, rather than carrying multiple medical charts. Any changes in a patient's status can be entered in the PDA at the patient's bedside and relayed instantaneously back to the network for timely reports and analysis.[19]

2.2.3 The structure of a wireless LAN

A WLAN is defined as a local area network of which at least one segment uses wireless technology. Mobile devices access the "wired" network by connecting to an access point on the network. This access point is physically connected to the wired network and acts as a receiver and transmitter, passing traffic back and forth between the wired network and mobile clients equipped with wireless cards. It is worth noting that the phrase "wireless LAN" is somewhat of a misnomer, given that the wireless network typically forms part of a "wired" LAN, to which it is connected.

2.2.4 Types of wireless LAN

Like most emerging technologies that are typically based on a number of competing standards, of which only one or two are likely to survive, the arena of wireless networking is somewhat of a battleground in which the various contenders are jostling for the best position (see Table 2.2, which sets out the various wireless networking standards). In the North American market, the early favourite is 802.11b, a standard developed by the United States Institute of Electrical and Electronics Engineers (IEEE). It is also commonly known as Wi-Fi (Wireless Fidelity).[20] Strictly speaking, Wi-Fi is actually a certification that manufacturers can apply to their products once they pass the requisite interoperability criteria.[21] Companies such as Apple, Cisco, Lucent, and 3Com support the Wi-Fi standard. Wi-Fi is very popular and controls the vast majority of the WLAN market despite some inherent security flaws. HomeRF follows closely, with the support of several other manufacturers including Motorola, Siemens, and Proxim.[22]

While the standards debate between Wi-Fi and HomeRF continues in North America, Europe has been developing its own standard, known as HiperLAN. Founded by Tenovis (Bosch), Dell, Ericsson, Nokia, Telia, and Texas Instruments, HiperLAN is a consortium of equipment manufacturers hoping to recreate the Wi-Fi phenomenon using more recent technology.

Both HomeRF and HiperLAN incorporate quality of service (QoS) control in their standards while Wi-Fi does not. At present, this makes HomeRF and HiperLAN more suitable for time-sensitive data and video services: a few seconds' delay in e-mail delivery does not have the same impact as a similar delay in a voice conversation. In order to enhance competitiveness, the IEEE is working on a standard called 802.11e, which will eventually add QoS elements to the Wi-Fi (802.11b) standard.[23]

Table 2.2: Wireless networking standard comparisons

Name	Speed	Range	Frequency	Notes
802.11b (Wi-Fi)	11 Mbit/s	100 m	2.4 GHz	Most popular and widespread[24]
802.11a	54 Mbit/s	50 m	5 GHz	Newer, faster, higher frequency
802.11g	54 Mbit/ss	100 m	2.4 GHz	Fast and should be compatible 802.11b
802.11e	NA	NA	NA	Improves 802.11 a, b and g with QoS
RadioLAN	10 Mbit/s	35 m	5.8 GHz	Specializes in wireless bridges
HomeRF	1 Mbit/s	50 m	2.4 GHz	Replaced by HomeRF2
HomeRF2	10 Mbit/s	100 m	2.4 GHz	QoS, better encryption, not widespread
HiperLAN2	54 Mbit/s	150 m	5 GHz	European standard, QoS, for voice/video
Bluetooth	1 Mbit/s	10 m	2.4 GHz	Personal Area Network [not WLAN]
Infrared LAN	4 Mbit/s	~20 m	350'000 GHz	Same room only, no negative health effects

Source: ITU.

2.2.5 A question of frequencies

Competition between these standards is fuelled by the fact that they are essentially restricted to operating over one of two frequencies, 2.4 GHz or 5 GHz. The reason for this is that both of these frequencies have been set aside for public use in most parts of the world as "unlicensed spectrum", setting wireless makers on their toes to take advantage of them. The 2.4 GHz band is the most popular among wireless devices, and carries with it inherent benefits and disadvantages. Although the equipment is among the cheapest and most widespread, many different technologies use the 2.4 GHz frequency (Bluetooth and HomeRF2 also use the 2.4 GHz frequency, in addition to microwave ovens and some types of cordless phone) and the band is becoming increasingly congested, resulting in the risk of interference and slower data transfer rates.

As a result, several standards, namely the 802.11a, RadioLAN and HiperLAN2 standards, have taken advantage of the less-crowded 5 GHz band (see Table 2.2). This band holds much promise because fewer devices operate in it, thereby avoiding some of the interference that affects the 2.4 GHz frequency. The 5 GHz band also has the advantage that the standards were developed later, and can accommodate faster speeds than earlier standards using the 2.4 GHz range. The quandary is, therefore, that the 5 GHz range standards are ideal, particularly given their capacity for higher speeds, but they cannot elbow their way to the top owing to competition from the proliferation of equipment and networks already operating in the 2.4 GHz band. Conversely, those operating in the 2.4 GHz band suffer from quality of service problems due to overcrowding.

The 5 GHz standards are also facing some competition from an old, revitalized foe. Just as 802.11a products (at 5 GHz) are coming onto the market, the IEEE is working on a standard known as 802.11g that offers the same speed as 802.11a, but which operates in the 2.4 GHz range. This standard will offer backward compatibility with the existing Wi-Fi infrastructure. Notwithstanding Wi-Fi's position as the most popular of these standards to date, it may be some time before an effective standard materializes as a global favourite.

2.2.6 The advantages and disadvantages of WLANs

While wireless LANs can be extremely useful, by dint of their very nature, they can pose a higher security threat than their wired network counterparts. For instance, while access to an internal LAN usually requires penetration into a physical building, a wireless LAN can often be tapped into from outside the "wired" building, or even from across the street. Therefore, without the proper safeguards, unsecured networks can become the target of unauthorized, and undesirable, infiltration and interception.

Most wireless networks have some level of encryption available to protect sensitive data. However, this encryption should only be considered as a first line of defence. The most popular wireless standard, Wi-Fi, uses WEP (Wired Equivalence Privacy), which was never intended to protect sensitive data. As its name implies, its main objective was limited to bringing the level of security up to the level used in a fixed network. WEP has some serious security flaws and has been shown to be vulnerable to programs like AirSnort (see Box 2.2). For most networks therefore, another form of encryption is desirable. Fortunately, there are many solutions for securing wireless networks such as the RADIUS (Remote Authentication Dial-In User Service) protocol and PPTP (Point-to-Point Tunneling Protocol), which offer end-to-end encryption. According to some estimates, however, more than 60 per cent of all wireless networks fail to make use even of the WEP encryption that comes built into their networks.[25] While WEP isn't perfect, it should always be activated, apart from in exceptional cases, such as Internet access points designated exclusively for public use (e.g. Internet cafés and airports).

Some have speculated that 3G services will be squeezed out by WLANs as they proliferate around the world. However, there are a number of applications and benefits that remain strictly within the realm of 3G, and are likely to guarantee its continued existence. For example, while WLANs offer speeds from five to 25 times faster than 3G, they are not suitable for exclusive use while in transport. 3G services, on the other hand, are ideal for communication in moving vehicles since mobile operators have hand-off technology already in place. 3G networks are also ideal for any outdoor applications away from WLAN infrastructure. Thus, rather than competing head on, WLANs and 3G networks are in fact complementary technologies, interlinking very different areas of a network. But it may be difficult to persuade 3G licence owners, who have paid billions of US dollars for spectrum, that they do not face a threat from companies exploiting unlicensed spectrum free of charge.

Box 2.2: Stumbling, snorting, and "war driving" to a wireless network near you

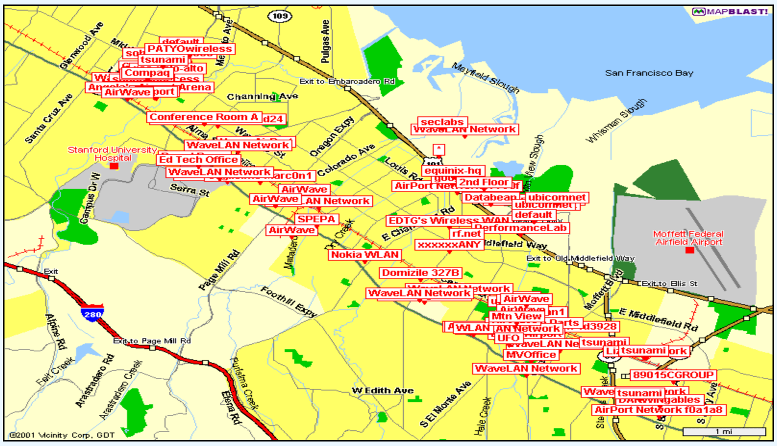
"War drivers" are likely to have already scanned any existing wireless network and published their findings on the Web. In fact, they may have already drawn an "X" with the network's information in chalk on the pavement outside to notify other wireless users of the network (see right-hand figure below). Without proper security, a wireless network is accessible to anyone with a laptop computer, a US$ 70 wireless card, and a free wireless scanning program such as NetStumbler.[26] War drivers are driving around in cities across the world trying to stumble on wireless networks, some for leisure, others for free Internet access, and others still for serious hacking. The term "war driving" is derived from "war dialling," a brute force method used by hackers for locating insecure computers by dialling through phone numbers. The newest incarnation is easier, cheaper, and much more popular than its namesake, and is currently more legal.

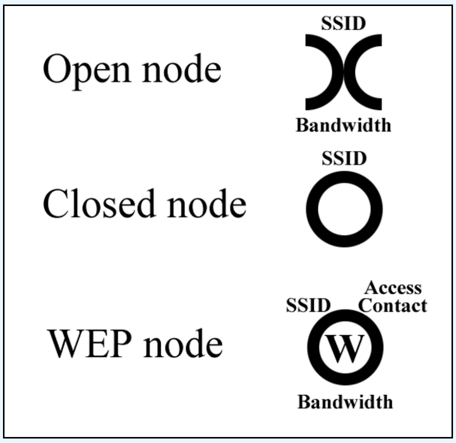
NetStumbler runs on a laptop and continually scans for wireless networks from a car being driven around, capturing information about all networks it comes across. War drivers can "discover" large numbers of networks in business districts in a matter of minutes. With an additional GPS connected to the computer, NetStumbler will pinpoint the physical location of the network on a map that can be loaded into national/worldwide databases on the Web and made available to anyone. The map below shows actual "war driving" results in San Francisco, California, in the United States. While a detected network is not necessarily invaded, war drivers report that the vast majority of networks use absolutely no encryption and leave their connections and networks wide open to the public. Many stumblers attach antennae to their computers and are able to connect to unsecured networks up to one kilometre away. Not only do these stumblers search out wireless networks, they publish their findings on the pavements where others can benefit from their results. This "war chalking" saves other passers-by the trouble of scanning for the network because the information they need to connect is literally written on the street.

The fact that war drivers are looking for wireless networks in neighbourhoods as well as business districts highlights the need for vigilant security on all wireless networks. Passive security won't keep up with active stumblers. All unsecured networks are at risk, even those using WEP encryption on the most popular Wi-Fi equipment. This is due to the fact that war drivers and stumblers armed with another free program, called AirSnort, can take advantage of a design flaw in the WEP standard for Wi-Fi networks and obtain encryption keys. AirSnort passively monitors transmissions and can easily compute the encryption key when it gathers between 100 Mb and 1 Gb of network traffic, often possible within one day of heavy network activity.[27]

It is therefore vital to secure wireless networks with supplementary encryption. Even casual home users with no "sensitive" data should at least use the highest level of WEP. One consoling factor is there are so many networks that are left wide open, that WEP may indeed keep hackers moving on, if only temporarily. Fortunately for the smaller user, there are many security solutions available to encourage war drivers to keep driving, looking for other targets.

Map showing detected WLANs in San Francisco, California, United States, and chart of "war chalking" codes.





Note: SSID stands for Service Set ID, in other words the name of the network.

Source: DIS, http://www.dis.org/wl/maps (right-hand graphic); War chalking results adapted from blackbeltjones.com.

While both WLANs and 3G services make a niche in the market, several other technologies are drastically increasing the range of wireless networks. Mesh and ad hoc networks are evolving that turn all users into network transmitters, thus quickly expanding the wireless network beyond its fixed roots. At the same time, new directional antennae for mobile base stations are also rapidly increasing the range of mobile networks.[28] These new technologies could give wireless networks the final push they need to be able to offer truly seamless connectivity.

2.2.7 Bluetooth and PANs

An Ericsson trademark, Bluetooth[29] was developed by a consortium including IBM, Intel, Nokia, Toshiba and Ericsson. The Bluetooth Special Interest Group (SIG)[30] was formed in 1998 to promote the technology and included over 2'500 member companies in April 2002. The technology was first designed to replace proprietary cables, connectors linking electronic devices such as mobile phones and laptop computers. This concept has expanded to include desktop PCs, digital cameras, MP3 players, PC monitors, and PDAs. The advantages go beyond eliminating awkward cables to the provision of local on-demand wireless connection from device to device as well as between devices and network resources. Bluetooth uses a combination of circuit and packet technologies, and slots can be reserved for both synchronous and asynchronous transmission. Devices can establish and maintain seven simultaneous connections. The system consists of a radio, a baseband, link management and host terminal interface functions. At a current maximum speed of 1 Mbit/s, the data rate for Bluetooth is higher than the maximum data rate on GPRS and 3G networks, but lower than current WLAN standards. Due to its low radio power, Bluetooth is ideal for small, battery-powered personal devices.

The promise of Bluetooth is in its ability to offer a universal means for devices to connect to one another. Instead of having a multitude of protocols and connections such as Serial, Parallel, IEEE 1394/Firewire/iLink, USB, Ethernet/RJ45, PCMCIA, Compact Flash, Smart Media and others, enabled devices will all be able to communicate in close range over a Bluetooth wireless connection. Just as the Internet's TCP/IP protocol opened up communication between different types of computer operating systems, (e.g. Macintosh, Windows, UNIX, etc.) Bluetooth should be able to offer the same interoperability for a wide range of devices.

A number of compelling Bluetooth applications are now appearing on the market. PC connections allow for accessories such as a keyboard, mouse, or monitor to be connected wirelessly, as well as other non-traditional devices. Video camera manufacturers have introduced Bluetooth-enabled cameras that can transfer video between the camera and the computer wirelessly. Bluetooth is also making its way into mobile phones equipped with 2G and 3G connections, giving them an Internet connection to share with any other Bluetooth devices in the near vicinity. A Bluetooth-enabled computer can, for example, browse the Internet using the user's mobile phone connection even when the mobile phone is in the user's pocket.

In the future, other devices could also take advantage of Bluetooth connectivity. Mobile phones used in a Bluetooth-equipped home environment could also tap into the home phone connection rather than using more expensive mobile connectivity. Bluetooth-enabled PDAs or remote controls could be used to manage all Bluetooth devices in a house, including TVs, stereos, computers, and video cassette recorders (VCR). A single remote controller could finally do away with different controls for different products, creating a universal command language.

While this universal nature conjures up some fascinating possibilities, Bluetooth also faces a number of potential problems. Bluetooth may suffer from interference with other devices such as Wi-Fi networks, microwave ovens and cordless phones, as these all operate in the increasingly crowded 2.4 GHz band. While a Bluetooth-enabled refrigerator may seem appealing, it will need to be kept at a safe distance from the microwave oven!

Bluetooth is also exposed to the same wireless security threats as other wireless networks and users should avail themselves of additional protection for any sensitive data that flows across the network. Although it has a good level of encryption protection, this only applies after an initial link is established. However, the initial key exchange can be vulnerable since it takes place via a side-band channel (e.g. voiced exchange of four-digit personal identification numbers).[31] In some sense, this can be likened to sending out passwords on postcards.

Bluetooth devices in particular also require more security as they are always listening for connections from other devices, and thus always open to malicious detection. Indeed, as a general rule, always-on networks require more vigilant security at all levels. This may pose a problem for average home users, who may not have the technical experience, or understanding, to apply manufacturers' instructions correctly. Given that, unlike other electrical household gadgets, these devices can communicate with the outside world, the risk factor is considerably higher. This implies the need for careful security planning from the initial technological exchange to the end-user, taking account of the scope for human error.

2.3 Mobile Internet platforms

There a number of methods and services for connecting mobile devices to the Internet. This section considers two of the main competing services: WAP, which is predominantly in use in Europe and Asia, and i-mode, which was first developed on the Japanese market. It is important to note that WAP is a protocol, rather than a proprietary service limited to a single operator: many operators in Europe and Asia offer WAP services. "i-mode" on the other hand, is the brand name for NTT DoCoMo's packet-based mobile Internet service. i-mode has seen such popularity, (and is now spreading to new markets), that it merits separate consideration.

2.3.1 Wireless Application Protocol (WAP)

Wireless Application Protocol (WAP) was born out of industry collaboration that began in 1997 between Motorola, Nokia, Ericsson and Openwave. WAP was one of the first attempts to develop a standard for the delivery of Internet content to mobile phones and PDAs (personal digital assistants). Currently, WAP is the *de facto* standard on GSM networks and is also used to a certain extent in the United States and Asian markets such as India and Japan.[32] In general, WAP over 2G has been neither a technical nor a commercial success. Over a circuit-switched 9.6 kbit/s connection, downloading Web pages is a slow and—owing to per-minute billing—expensive process, earning it the nickname of the "Wait and Pay" service. Moreover, content formatted for WAP-enabled devices has been limited, largely due to the complexity of WAP's Wireless Markup Language (WML) for translating Web content. Despite a huge vendor push to promote the technology, especially at the ITU TELECOM 99[33] event, most consumers perceived WAP as a technology waiting for higher connection speeds. In contrast to the spontaneous success of SMS, it can be said that WAP services suffered in most cases from the negative consequences of premature "hype".

In its favour, WAP is designed to be independent of underlying network and bearers, meaning that it can be run on CDMA networks as well as on GSM. In order to make content available to the mobile phone user, a condensed version of the standard Internet Protocol (IP) is used for formatting and transferring information.

A WAP session is launched when a user accesses the built-in browser to make a request in WML, derived from HTML (Hypertext Markup Language) and adapted especially for wireless networks. The request passes through a WAP gateway, which retrieves the information either in WML format or in HTML format. A WAP-enabled phone is equipped with a simple built-in microbrowser to facilitate the viewing of Internet content. Most of the intelligence is stored on the WAP gateway. Thus it can take up to thirty seconds for the phone to make a connection with the WAP gateway, when the so-called "handshake" occurs. Once the WAP gateway retrieves the information requested by the user, that information is sent back from the gateway directly to the mobile phone, for viewing through the WAP microbrowser. Due to limited handset functionality, the information delivered in the early days of WAP was generally restricted to black and white text.

The main reasons behind the relative failure of WAP as a mobile Internet platform on GSM 2G networks can be summarized as follows: extended waiting periods for downloading, ineffective billing models, lack of content availability in WML and inappropriate (monochrome) interface for viewing Web content. It is hoped that the always-on capabilities of 2.5 and 3G networks will increase the functionality of WAP, by doing away with slow downloads and per-minute billing. Many industry players are also pinning their hopes on the release of version 2.0 of WAP in 2001 (see Box 2.10, section 2.6). This will bring WAP more in line with i-mode and Internet content (see section 2.5.6). Others are less optimistic and believe that WAP's usefulness is being eroded by the convergence with new technologies such as Java, and that the introduction of high-speed networks will not necessarily translate into increased content and service availability.

2.3.2 i-mode

Japan's NTT DoCoMo launched its mobile Internet connection service, "information-mode" or i-mode, in February 1999. The main applications available through i-mode-enabled handsets are e-mail, information services and applications such as Internet banking and ticket reservation. Although the most popular services remain those that enable person-to-person interaction, such as messaging, subscribers frequently download images of cartoon characters ("mobile wallpaper") and ring tones. Other Japanese mobile operators began competitive Internet connection services in 1999 (KDDI group launched EZweb and the J-Phone group launched "J-Sky"). In Europe, E-Plus in Germany and KPN in the Netherlands are now offering a similar service.[34] AT&T in the United States has also adopted the concept for its 2.5G networks, labelling it "mMode".[35] In June 2002, KG Telecommunications concluded a contract with NTT DoCoMo to begin providing an i-mode service to its GPRS subscribers in Taiwan, China.[36] BASE in Belgium plans to launch an i-mode service in September 2002.

When i-mode was first introduced in Japan, only 13 per cent of the country's population was online. In its first year of operation, DoCoMo's subscriber base rose beyond the level that the country's main ISP (NiftyServe) had reached after 15 years. Through its i-mode service, DoCoMo has become the world's second largest ISP after AOL (reckoning by the number of subscribers). In June 2002, DoCoMo had over 33 million i-mode subscribers, representing over 82.5 per cent of its total cellular (PDC) subscriber base.[37] According to the Telecommunications Carrier Association of Japan, over 50 million Japanese or 73.5 per cent of the mobile subscriber base in Japan subscribe to some kind of mobile Internet service.[38]

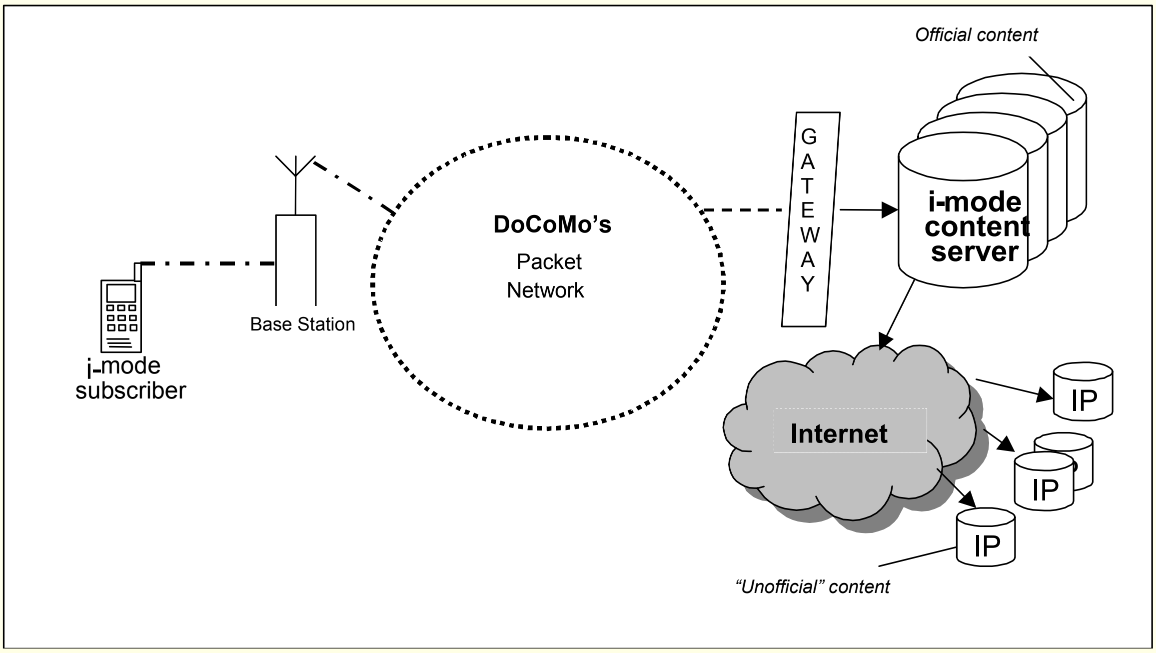
An i-mode enabled phone allows users to access customized Internet content over a packet-based network. Web content for i-mode is developed using compact hypertext markup language (cHTML), a subset of HTML coding which is used to create typical Web pages. The i-mode system does not use the open source WAP but uses instead a special set of simplified HTML tags, which are closer to traditional Web formatting than the early days of WAP's WML (Box 2.10). Data is transmitted over a packet-based network at the transmission speed of 9.6 kbit/s. The structure of the i-mode network is illustrated in Figure 2.4.

On the i-mode server, there are both "official" and "unofficial" content sites. For official sites, there is a contractual arrangement between DoCoMo and the content provider under which DoCoMo collects the content charge and keeps a commission of 9 per cent while forwarding the rest onto the content provider. This has provided tremendous incentives for the development of compelling local content. In the case of "unofficial" websites, users must pay the owner of the content directly. Unofficial sites that charge for access are therefore rare, given that electronic payment methods in Japan are limited and few credit cards are in circulation. In April 2002, i-mode users had access to over 3'000 official content sites and 53'000 unofficial sites.

NTT DoCoMo commercially launched its FOMA ((Freedom of Mobile Multimedia Access)[39] 3G service in October 2001. The operator now provides an enhanced i-mode for its 3G users, known as "i-motion". This service offers short audio and video content transmitted over the carrier's packet-based network. i-motion content can also be distributed using conventional Web servers.

The main reasons for the success of i-mode are its packet network and billing system; revenue-sharing agreement with content providers; the use of compact HTML for viewing Web content, and the positioning of DoCoMo as ISP and mobile operator in one. The use of Japanese characters on mobile keypads has also facilitated the take-up of Internet services. Moreover, DoCoMo had significant control over handset manufacturing, the i-mode gateway and content formatting. This is in sharp contrast to WAP, which runs over circuit-switched networks and for which few operators have developed equitable revenue-sharing scheme with content providers.

Figure 2.4: The structure of DoCoMo's i-mode network



Source: ITU, 3G Mobile Policy: The Case of Japan (2001), available at http://www.itu.int/3g.

2.4 Mobile messaging

The most widely used mobile data service in the 2G world involves person-to-person data communications: i.e. simple text messaging and mobile e-mail. Mobile e-mail has been taken up in North America, primarily through Blackberry[40] handsets, originally designed as data-only handsets, but which are now equipped to support GSM voice services too. In Japan, exchanging e-mails is popular among i-mode users, while, in other regions using the GSM platform, the "short message service" (SMS) has been extremely popular, and its popularity is set to grow: the GSM Association estimates that 24 billion SMS messages were sent over GSM networks in May 2002[41] alone, compared with 15 billion a year earlier, and it estimates that 360 billion messages will be sent in 2002. Also, in a recent study, SMS is the dominant data contributor to the ARPU (average revenue per user) of European operators. Mobile messaging is expected to remain one of the "killer applications" of the mobile Internet.

SMS is a two-way simple text service for sending short (160 characters) alphanumeric messages to mobile phones. SMS can be used for both "point-to-point" as well as cell-broadcast modes. The service is not unlike e-mail as it involves the asynchronous delivery of text messages, with the difference that messages are delivered directly to a mobile handset and can thus be received by the user anywhere and at anytime. Once a message is sent, it is stored at the SMS message centre until it is successfully delivered or "forwarded".[42] As it is charged for according to the number of characters, however, SMS is not suitable for lengthy communications—a 640-character message costing four times as much as a 160-character one. SMS can originate either on a mobile phone or through a Web-based SMS service. Already, a number of instant messaging (IM) providers have introduced services whereby Internet users can send and receive SMS (see Box 2.5).

In contrast to WAP, the phenomenal growth of SMS was predominantly user-driven, rather than the result of any targeted marketing efforts. In fact, operators hardly expected this simple technology to become a popular service and a significant revenue booster. Once the potential of SMS became clear, however, companies began exploiting the broadcast mode and offering a wide array of billable information services. These services include local and international news, stock updates, weather forecasts, banking information, travel information. However, users have also been receiving unwanted SMS and the prevention of mobile spamming is now high on the agenda of many regulators (see Chapter four).

Box 2.3: The joy of txt

The evolving literature of "texting"

At 160 characters in length and as the name indicates, SMS messages are short. This has led to some creativity in the use of the written word. In order to convey a maximum amount of information using a limited number of characters, users have had to challenge the rules of grammar, syntax and punctuation. Common abbreviations include: THX for 'thanks', RGDS for 'regards', UOK for 'are you ok'? W/O for 'without', GR8 for 'great', VBG for 'very big grin' and WSLS for 'you win some, you lose some'. Emoticons, the use of symbols in the shape of a face to denote emotion, are even more ubiquitous in SMS than they have been in e-mail messages:

:-))	very happy	**:-||**	angry
%-)	confused	**8-]**	person with glasses
:'-(	crying	**[:-(**	frowning
:-*	kiss	**:-|**	not talking
:-@	screaming	**:-o**	surprise

In 2001, the UK Newspaper *The Guardian Unlimited* ran a Mobile Poetry contest.[43] The following entry by Julia Bird was chosen as the "most creative use of SMS 'shorthand'" in a poem:

> **SMS**: /a txt msg pom./ his is r bunsn brnr bl%,/ his hair lyk fe filings /W/ac/dc going thru./I sit by him in kemistry,/ it splits my @toms/ wen he :-)s @ me.
>
> **Translation**: /a text message poem/ his eyes are bunsen burner blue,/ his hair like iron filings/with ac/dc going through/I sit by him in chemistry,/ it splits my atoms/ when he smiles at me.

Poetry is not the only form of emerging "texting literature". Another example is the SMS soap opera, for example those run in Germany by E-Plus and high-tech company Materna in Spring 2001. Subscribers of the service receive the latest stories and experiences of the eight fictitious soap characters on their mobile phone once a day from Monday to Friday. Each soap opera episode is delivered over three SMS messages (up to 480 characters). Updates on the popular "Big Brother" programme are also available through SMS on a number of European networks.

Source: BBC News, The Guardian.

The delivery of SMS has also interested the airline industry, with Singapore airlines being one of the first to offer in-flight SMS for passengers: users are able to send SMS to any mobile phone in the world.[44] Two-way messaging will become available once airlines begin offering broadband in-flight connections. Also in Singapore, SingTel is expanding its SMS service to ordinary home and office phones (see Box 2.4).

SMS evolution: EMS and MMS

As the phenomenal success of SMS seems to indicate, person-to-person messaging will most likely continue to drive mobile data revenues for some time. Correspondingly, the adoption of EMS (enhanced messaging service) and MMS (multimedia messaging service), in combination with the increased use of prepaid services, are likely to become crucial drivers of the mobile Internet.

EMS is similar to SMS in terms of the store-and-forward process, but also includes additional features, such as the transmission of a combination of simple melodies, pictures, sounds, animations, and modified text as an integrated message. The combination of several short messages together will be a key technical feature of EMS.

MMS, based on a new global standard, will provide more sophisticated messaging than EMS and SMS, allowing users to send and receive messages with formatted text, graphics, audio and video clips. MMS will require new network infrastructure as well as MMS-enabled handsets. Unlike SMS and most EMS, MMS are not limited to 160-characters per message.

Currently being adopted by many network operators and handset manufacturers, MMS will soon become a standard feature and the default messaging mode for mobile phones. The first MMS-enabled products became commercially available in early 2002. For instance, in April 2002, Westel began offering an MMS service in Hungary in cooperation with Ericsson.[45] Swisscom is making its MMS service available as of 3 June 2002, free of charge for the first four months.[46] The first operator in Asia to offer MMS was Hong Kong's leading cellular operator, Hong Kong CSL Ltd. (CSL). Like other European operators, CSL is trying to find ways to create a larger initial MMS user base: for instance, it allows MMS-enabled phone users to send messages to PC users.[47]

MMS supports standard image formats such as GIF and JPEG, video formats such as MPEG 4, and audio formats such as MP3, MIDI and WAV. MMS standardization over GSM, GPRS and W-CDMA is being managed through 3GPP.[48] MMS-type messages can be sent over 2.5G and 3G networks. Phones with built-in digital cameras are quite popular in Japan and the Republic of Korea, where services similar to MMS are already available. Table 2.3 lists the commercially available MMS services as of June 2002. Subscribers wishing to use MMS services are finding the choice of handsets fairly limited, particularly in Europe, where the Sony Ericsson T68i[49] is the only colour MMS handset on the market. Nokia will be launching its 7650 series in July 2002, but will be pricing it at a prohibitive US$ 600.[50]

In February 2002, a number of key industry players formed the MMS Interoperability Group, a coalition designed to ensure that MMS messages flow smoothly between different mobile service providers. The eight companies (Sony, Ericsson, Comverse, Nokia, Motorola, Siemens, Logica and CMG) will develop systems to test interoperability and address any technical problems as they arise.

It is to be noted that SMS, along with its successors EMS and MMS are not only person-to-person messaging services, but also allow the distribution of content to mobile devices. In this respect, they are a transmission protocol in the same manner as WAP. In fact, many content providers currently base their services on SMS rather than WAP, mostly due to the fact that premium content can be easily billed through SMS. However, in the long run, as WAP and services like i-mode gain momentum worldwide, the use of messaging protocols for the delivery of content services will be limited.

Box 2.4: Fixed SMS in Singapore

SingTel brings SMS mania to the ordinary telephone

A text-to-speech system being introduced by Singapore's incumbent operator, SingTel, will allow mobile users to send SMS to fixed-line numbers. The system will read aloud the SMS messages to fixed-line recipients. Recipients will then be able to record voice messages which will be passed along to mobile users. In July 2002, the operator plans to introduce fixed-line devices with display panels and added functionality for sending text messages to both fixed and mobile phones. The retail price of these phones will range from US$ 45 to US$ 56. Mobile users will not be charged for sending SMS to fixed phones. Charges for voice-mail replies to text messages are to be announced later during the summer of 2002.

Source: Total Telecom News, 18 June 2002.

Table 2.3: The commercial launch of MMS services

Country	Operator	Launch Date (2002)
Norway	Telenor	March 12
Hong Kong, China	Hong Kong CSL	March 28
Germany	Vodafone D2	April 18
Hungary	Westel	April 18
Portugal	Vodafone Telecel	May 11
Italy	TIM	May 21
Portugal	TMN	May 22
France	Orange	May 30
UK	T-Mobile	June 1
Switzerland	Swisscom	June 3

Source: Global Mobile, 2002.

Mobile instant messaging

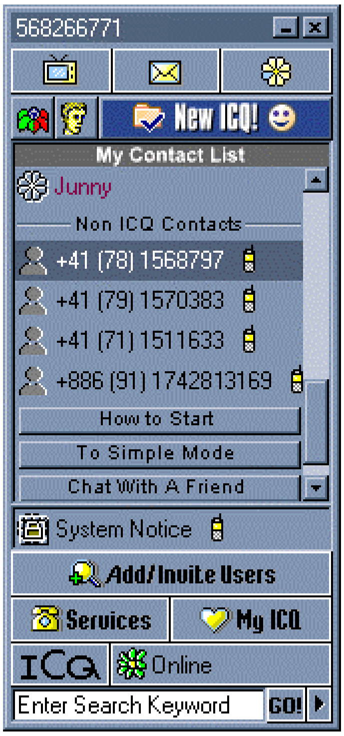
Along with the success of SMS, the growing user base of instant messaging (IM) services over the fixed-line Internet, such as AOL Instant Messenger[51] (AIM), MSN Messenger[52] and ICQ[53] has not escaped the attention of mobile operators.[54] IM traffic is rapidly surpassing e-mail traffic over the fixed Internet and mobile IM service providers intend to exploit the opportunity of combining the success of mobile SMS and Internet chat. Instant messaging provides the ability to exchange messages with other users over the Internet. It differs from ordinary e-mail in that the exchange of messages is instant, with a maximum delay of one or two seconds at peak times. IM makes a continuous exchange of messages simpler and quicker than ordinary e-mail and SMS. In order for IM to function, both users (who must typically subscribe to the same service) must be online at the same time, and the intended recipient must be willing to accept instant messages. Users have the capability to filter out messages from specific senders. Service providers offer the service free of charge to Internet users. Enhanced features now include Webcam support, animated characters and *emoticons*, computer games, file sharing, integrated e-commerce and the ability to make PC-to-PC or PC-to-phone calls using a microphone and speakers, or a headset.

There are various competing standards for fixed-line IM and industry critics have labelled the pioneer of the service, AOL as anti-competitive. AOL only allows its AIM users to communicate with other AIM users, and blocks messages from users that are subscribed to a different IM service.[55] The quest for IM interoperability is in its infancy, but initiatives like "Jabber" may pave the way. Jabber is an open source, instant messaging platform based on XML and operates differently from other proprietary instant messaging systems. It enables users of different IM platforms to communicate with each other. This will bring IM more in line with future mobile Internet services that are moving towards XML (see section 2.5.6). Similarly to e-mail, a suffix is added to each address after the "@" sign (for instance user@yahoo), enabling the Jabber server to read addresses from different messaging systems and locate them.

Mobile IM solutions are similar to wireline IM solutions, in that each user is given a unique nickname, the ability to create a contacts list and exchange messages with other users. Some mobile services give the location of the contacts as part of the "presence information" helping the user decide which users to communicate with. Mobile IM can use SMS as the delivery mechanism, although the graphical interface is sub-optimal. The service can also run over WAP. Mobile operators have already started offering IM services over their networks. For instance, AT&T, Sprint and Voicestream in the United States have partnered with AOL to provide AIM to their subscribers through text messaging.[56] Since April 2002, AIM is available to subscribers of mMode[57] over high-speed GPRS networks. Unlike the Internet version, early services are being billed "per message". However, much like its Internet precedent, mobile AIM users can only communicate with other (mobile and fixed) AIM users. Handset manufacturers are also investing in the development of mobile instant messaging solutions: Ericsson, Sony, Motorola and Nokia are working together to create an interoperable standard for mobile IM[58], allowing message exchange between users of competing services. Instant messaging services have now begun offering two-way SMS messaging (from PC to mobile phone and vice versa).

Box 2.5: Chatting between the wired and wireless

SMS and Internet Instant messaging: blurring the boundaries



Users of an Internet instant messaging client ICQ can now send and receive SMS messages with mobile phone users. This marks the first step in the move towards truly fluid, mobile instant messaging.

The system works as follows. First of all, the ICQ client initiates the SMS message to a mobile phone. The message from the ICQ user is forwarded to the gateway of one of the participating mobile operators. This initial SMS message contains a return "number" the SMS user can reply to. This reply number does not correspond with a particular user, but rather serves as an ICQ gateway to route the reply back to the original ICQ sender.

The communication is not instantaneous because it still makes use of the SMS network. However, ICQ-SMS connection is a good example of how messaging between the Internet and mobile worlds are merging.

2.5 Mobile Internet content

The number of information and entertainment services targeted at mobile phone users is continually on the rise. i-appli and i-mode services already provide a variety of games, video clips, dating services and gambling opportunities. The frequent download of logos and ring tones on 2G networks is a good indication of the strong trend towards consumer adoption of digital content. Mobile entertainment services are getting more sophisticated as transmission speeds and handsets evolve. These are likely to represent a significant portion of mobile revenues over the next few years. Not only is content becoming more plentiful and varied, but the potential methods via which users can access content are also multiplying. One of the more interesting applications involves "codepoint" technology, which enables a mobile user to 'scan' for Internet content (see Box 2.6).

Unlike in the early days of WAP, operators and service providers are beginning to realize that the requirements of mobile Internet users differ significantly from their wireline counterparts. Mobile usage is typically characterized by short bursts of activity, such as checking stock reports, playing short games, reading the latest news or gossip. The manner in which mobile users consult content does not mirror fixed Internet use. The main interest of the user of a mobile handset is to save time. Their "browsing" behaviour is typically objective-driven, rather than exploratory and generally limited to under 10 minutes (see Figure 2.5). Although this may change slightly when flat-rate tariffs for mobile Internet become more commonplace, the mobile Internet will remain dominated by targeted searches, rather than open–ended browsing.

Next to mobile messaging, **mobile gaming** has been said to be an important driver for the mobile Internet, Today, most mobile handsets are equipped with pre-installed games. On most devices, limited storage capabilities impose restrictions on the quality and sophistication of the gaming system. Some games involve multiple players communicating with each other through a wireless connection. For games played locally, however, no connection is initiated and thus the activity cannot strictly be labelled "mobile gaming".

A number of companies are already offering mobile gaming services. In Japan, DoCoMo has sold 13 million java-enabled i-appli handsets, which are specifically targeted at avid game players. M-gaming sceptics are concerned that games have already been developed on other platforms, such as home computers, consoles and interactive television, compared to which mobile phones and PDAs offer limited functionality. Nintendo, whose Game Boy is one of the world's best-selling video game, introduced the Game Boy Advance Mobile Phone Adapter in 2001. The adapter can connect any standard Japanese mobile phone to the Game Boy Advance console and allow users to play games online. In Europe, some operators are offering games via SMS or WAP but these are typically text-based, where a user receives text messages informing them of their status and offering a series of choices or moves. In Sweden, a technology which combines location positioning with SMS has encouraged the growth of SMS war games, whereby users track and "shoot" each other across the city of Stockholm.

With increased bandwidth and the convergence of mobile handsets, PDAs and pocket PCs, the mobile gaming experience will be considerably enhanced. One of the main issues facing games developers, operators and handset manufacturers is revenue generation. Networked games are clearly favoured as they encourage users to check in daily for scores and rankings, engage other users in a virtual competition and communicate decisions. Wireless games allowing users to track down and "fire" at other users are being developed as mobile entertainment reaps the benefits of location-based technologies. Furthermore, short-range game connectivity is being facilitated through technologies such as Bluetooth.

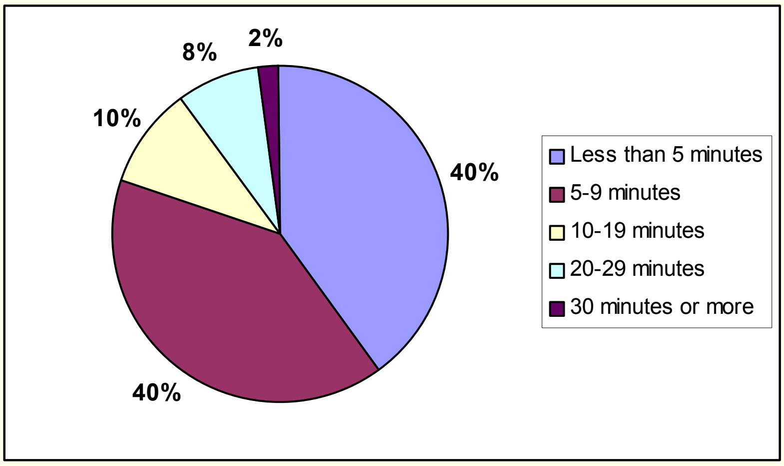
Box 2.6: Scan this

One of the possibilities for bringing content to the mobile phone involves the well-known retail system of bar codes. Soon, mobile users will be able to scan content on posters or other printed material through their phones. CodePoint software for PDAs and mobiles allows camera-enabled handsets to read visual symbols. The software interprets the symbols (such as barcodes), translating them into purely numeric codes, which are then mapped with Internet URLs. Through this system, the user is able to receive data directly from the content provider's website, just as though they had clicked on a hyperlink in a conventional browser.

Before this technology can be adopted, however, the software must be embedded in handsets and mobile phones with digital cameras must become more commonplace. Two companies involved in this area, Bango.net and International Wireless, are currently exploring partnership possibilities with handset manufacturers, with a view to developing a commercial service.

Source: Bango.net, International-Wireless, Wireless Week, July 2002.

Figure 2.5: Average length of mobile data sessions
Percentage of total respondents to a user survey



Source: Jupiter Media Matrix and BCG.

It is as yet unclear how much bandwidth will be required to enable widespread mobile gaming and whether revenues generated from the service will be sufficient to cover these bandwidth requirements. A clear business model is yet to be developed. NTT DoCoMo includes gaming sites as part of its i-mode official sites, and thus is able to share revenues with content providers through a nine per cent commission. In Europe, revenue models mainly consist of advertising, sponsorship and usage commissions. Game developers have not yet been able to charge subscription fees.

With the advent of colour screens and digital cameras, there has been much excitement about **mobile video services.** There are two types of mobile video services: person-to-person and broadcast. Mobile video messaging, a subset of MMS, and real-time video telephony both fall into the first category. Mobile video distribution services fall into the second category. DoCoMo was the first to offer a mobile video telephony service through its 3G videophone, FOMA P2101V. Over GPRS, users will be able to enjoy multimedia video messaging and small video clips. However, for real-time services such as streaming video distribution, mobile video telephony and videoconferencing, users will have to wait for higher-speed 3G networks to be available. The same applies to **mobile audio services**. Once again, Japan provides an example of early adoption (prior to 3G), through DoCoMo's M-Stage and KDDI's Keitaide services: the operators offer music on demand to their users over a PHS (Personal Handyphone System) network at 64.4 kbit/s.

More and more mobile phone users are requesting the delivery of targeted content and information to their handsets while on the move. To respond to this demand, a variety of **information services** are currently available, such as international news headlines, sports updates, traffic information, weather forecasts and stock quotes. Information services can either be static, time-critical, location-specific or a combination. Static information includes city guides, search engines, dictionaries and so on. Time-critical information may include share quotes and sports score updates. Location-specific information services include navigation assistance and **tracking services.** For the healthcare industry for instance, the main benefit of the mobile Internet is the transmission of patient information regardless of location. Physicians can access patient histories, laboratory results, pharmaceutical information, insurance details, and medical resources while on the road. Furthermore, mobile devices can be used for patient monitoring in hospitals and in the home.

Although content is being created by commercial players and available to mobile users for a fee, users themselves are not yet able to create Web pages or content for mobile devices. Thus far, this differs from the fixed-line Internet world, with a more open content development model that has encouraged, for instance, the phenomenon of *blogging*, or the creation of online diaries.

2.5.1 Content packaging: mobile portals

A mobile portal can be defined as a central website providing services and content to end-users accessing the Internet via mobile devices. Mobile portals aggregate content and services from a number of independent sources with a view to providing a customized experience for the mobile user. Content can include messaging, search facilities, targeted news and information services and transaction services. Portal service providers can focus on vertical or horizontal applications. Horizontal portals feature a wide range of common applications typically for the consumer market. Vertical portals are geared towards a particular market segment, such as finance, travel or sports. The most successful mobile portal thus far is clearly NTT DoCoMo's i-mode portal, which boasted over 33 million users in July 2002(see section 2.3.2).

Many established players are providing mobile portal services including manufacturers, operators and Internet portals.[59] However, "pure-play" mobile portals have also attempted to capture a share of the market. Examples of mobile portals include Vizzavi (jointly owned by Vodafone and Vivendi Universal), Lycos, Sonera, Excite and AOL.

There are a number of factors leading to the fragmentation which characterizes the mobile portal market. These include the large variety of terminal types, operating systems and browsers as well as content development languages and tools. There are also a number of open and proprietary standards for formatting and information presentation. The future success of the portal market hinges on harmonization and standardization of security features, as well as the development of privacy policies and anti-spamming legislation. The creation of appropriate and user-friendly billing models will also provide a significant impetus to portal development.

2.5.2 Transaction services

Transaction services include retail services, financial services and payment services. They fall under the general heading of "mobile commerce".

Already, mobile users can electronically purchase products and services using their mobile phone. In the retail world, these include instant price and product information, promotions and auctions. Through mobile-retailing, users can conveniently compare prices and services. They can also purchase tickets, check-in for flights, make cinema reservations or pay for parking without the need for exact change. Payment can be effected either through the user's monthly mobile telephone bill or via a third party service, such as PayBox[60] (see Box 2.7).

Charging for the download of ring tones, logos and cartoon characters on a mobile phone bill were the first attempts by mobile operators to charge for alternative services. At this time, mobile operators seem reluctant to expand these services by charging for value-added services through monthly bills. There has been rapid take-up of alternative services in countries such as Finland and Malaysia. In March 2002, Europe's Vodafone[61] and T-Mobile announced the development a common platform for mobile payments, which will allow users to store their personal details, credit card and debit card information on their mobile phones in order to purchase goods and services.[62]

Although vending technology is not widespread in Europe and North America, it is more or less ubiquitous in countries like Japan and Korea. This has led to its strategic combination with mobile technology. One of the most interesting applications, known as Cmode, was launched by Coca-Cola, NTT DoCoMo and Itochu Corporation in Japan in 2002 (see Box 2.8).

The advent of mobile payments is also opportune for developing countries, as it creates the ability to buy goods and services using a mobile phone. The ubiquity of cash in developing countries and unavailability of credit means that most citizens do not have credit cards. This makes online purchasing difficult . Cash is still king in many developing economies where citizens do not have credit cards nor would many qualify for one. This limits their ability to purchase over the Internet. But they do have mobile phones which could be used as mobile wallets with Internet purchases deducted from mobile bills or prepaid balances.

Box 2.7: Mobile money: The PayBox example

PayBox was founded in August 1999 and is 50 per cent owned by Deutsche Bank. It operates in five European countries: Austria, Spain, Sweden, Germany and the United Kingdom. PayBox allows users to pay taxi fares to drivers signed up with the service, and pay for goods and services at selected restaurants and retailers. The service works a bit like a debit card and is essentially a third-party message system, i.e. it sends a message to the user's bank after the user has authorized payment via a unique PIN code. PayBox also facilitates Internet e-commerce and money transfers. The following describes two different applications of the PayBox system.

Online Mobile Retailing

- At the checkout, the user selects to pay with paybox and enters his/her mobile phone number
- PayBox then calls the user on his/her mobile phone
- By entering his/her paybox PIN code, the user authorizes payment
- Confirmation is received via the mobile phone.
- Paybox debits the user's bank account and credits the purchase amount to the online shop

Person-to-Person Mobile Money Transfer

- User 1 calls a designated number (in the UK 08700 729269) and presses '1' to send money.
- User 1 then enters the mobile phone number of the recipient, User 2, and the amount for transfer.
- User 1authorizes payment by entering his/her paybox PIN code.
- Confirmation is received immediately to the mobile phone of User 1.
- Paybox debits the User 1's bank account and credits User 2's bank account.

Source: PayBox.

Mobile financial services were one of the first transaction services available over mobile networks. In order to counter the threat of "disintermediation" by mobile operators, banks have invested heavily in mobile banking. The EITO (European Information Technology Observatory) categorizes mobile financial services as follows: mobile banking (e.g. account balance, transaction history, funds transfers, bill payments, news & information), mobile brokerage (e.g. stock trades and quotes, alerts and notifications, portfolio management) and mobile insurance (e.g. travel insurance on demand) and customer care.[63] A recent example of mobile banking in Denmark enables consumers to withdraw cash from a traditional automated teller machine (ATM) using a mobile phone. The pilot project was announced at the end of April 2002 by ANCR Corporation, AU-System and Beamtrust.[64] This represents one of the first attempts to replace the magnetic-stripe card with a mobile phone for cash withdrawals. The user initiates the transaction by choosing the transaction type, account details and withdrawal amount on his/her mobile phone. When near the ATM, the consumer enters the security PIN into the phone, which then transmits these details to the ATM. The ATM then dispenses the cash.

Embedded SIM (subscriber identity module) cards, prevalent in the GSM world are being upgraded and adopted by 3G operators. These 3G USIM (Universal SIM) or UIM (User Identity Module) cards will be capable of storing sensitive information and financial information, such as credit card details and electronic wallets. A trial service operated by KDDI in Japan is set to start autumn of 2002, featuring secure UIM point-of-sale transaction services (see Box 2.9). It can be said that these embedded SIM cards are the early

Box 2.8: Unwire me a Coca-Cola : always Cmode

The latest consumer service in Japan for mobile users on the go is called "Cmode", a compound term combining i-mode and the initial "C" for Coca-Cola, Culture, Communication. The Coca-Cola Group plans to install 2'000 Cmode-compatible vending machines called "Cmo" by the end of 2002. "Club Cmode" members will be able to buy admission tickets to amusement facilities, pay-per-download of information content and local area information such as maps from the Cmo machines. The machines come equipped with printer, speakers and a display panel. To access members-only services, users must first register on an i-mode site "Coca-Cola Moments". Once at the machine, users pass their mobile phone over the sensor for product and user verification in order to take advantage of the services available.

The Cmo system and server will be made available to other service providers. This means that companies providing membership services and Cmo machines at their sites will be able to adapt the Cmo user interface for their particular needs and branding requirements. Partnerships with various content providers are planned in order to expand the range of services.

Source: NTT DoCoMo, Total Telecom News.

Box 2.9: The credit is in the pocket

KDDI's Wireless credit card

KDDI and four credit card companies will begin a trial credit card payment service with CDMA2000 1x handsets in 2002. The handsets for the trial service have UIM (Universal Identity Module) cards containing credit card information. An infrared port on the handset allows information to be transmitted to the point-of-sale terminals (POS) in most shops. This handset can also be used for shopping on the Internet: by performing mutual authentification between the handset and the online shop server, a greater degree of security should be ensured. In the future, a totally new mobile commerce market is expected to emerge as online shopping increasingly substitutes visits to physical outlets. Application services such as GPS, e-mail and electronic coupons will doubtless all play a role in this transformation of the shopping experience.

The secure transmission will use a standard developed by VISA based on IrFM (Infrared Financial Messaging) technology. KDDI opted for infrared technology rather than Bluetooth, due to security reasons. The UIM card will use SSL (secure socket layer), a secret key, and Java applets.

At the present time, under 15 per cent of adults own credit cards in Japan, and thus the number of mobile users that can avail themselves of such services is limited. However, in the future, banks and operators plan to extend this payment service to the large population of young mobile phone users, in the context of the evolving "next generation UIM technology".

Source: ZDNet Japan, April 2002.

precursors of an emerging trend, known as "pervasive computing". Pervasive computing refers to the presence of numerous, casually accessible (and sometimes invisible) computing devices. These can be mobile or embedded in the environment, but constantly connected to the Internet and other network structures.

2.5.3 Business applications

Mobile phone networks have drastically changed the way business is done. Plumbers, for instance, used to rely on answering machines to receive calls during the day and could only return calls in the evenings. Often, they could not respond quickly enough to an emergency because they were on the road and out of reach. Mobile networks have extended communication to the remote job site: plumbers can now use a mobile phone wherever they work to make appointments or solve urgent problems.

Just as mobile phones transformed business for plumbers, the mobile Internet will change the business landscape for data delivery. For example, businesses using large vehicle fleets can use two mobile technologies to track the location of any of their automobiles at a given time. The fleet can be equipped with a Global Positioning Service (GPS) device, which obtains latitudinal and longitudinal coordinates from a network of satellites. The onboard computer can then send this data to a central location using a wireless device. A computer at the central office then plots all the vehicles on a map and routes urgent calls to the closest vehicle. This kind of system is already being used extensively for parcel delivery services and is gaining popularity in other transport-intensive industries.

Network administrators are taking advantage of wireless services to shorten the downtime of mission-critical servers and computer equipment. Whenever there is a problem with the network, computer systems can send data messages to the phone or pager of a network engineer. The server can be configured to send out a detailed text message describing the problem, similar to the way an operating system notifies the user that a program has crashed. In addition, the network manager can send instructions and commands back as text messages, telling the computer to reboot or take some other form of action. This allows the engineer to make critical network decisions regardless of his or her physical location.

In the same way that network administrators can be notified of computer system crashes via mobile devices, so too can business users following financial markets be notified of "crashes" or other urgent matters. Financial users can set up instant mobile notifications if a stock reaches a certain point or if there is breaking news in a market they are watching. Users can also make secure trades based on timely information when on the move.

It is not only the large companies that stand to benefit from these mobile technologies. A day care facility can install a Web camera (Web cam) in its playroom for parents to monitor their children while at work. The data from the Web cam can be streamed over a secure Internet connection to both wired and wireless devices. Parents with multimedia phones and a 3G connection are able to watch and hear their children play even when they aren't close by. This type of service enables the childcare provider to attract customers and satisfies the needs of working parents concerned about leaving their children in a facility.

While there are many ways that mobile technologies can increase productivity, there is a need for enhanced security. As the workplace goes mobile, so does important and confidential information. Since sensitive data is constantly being transmitted through the air, businesses need to take extra precautions to ensure that their data stays private in transit. On the technical side, there are tools available to encrypt and protect network data but businesses also need to address the human element by educating their staff about network security. Some network administrators have been shocked to find they have a "rogue" wireless network in their building when they haven't secured their data for wireless transmission. There have been many cases where a technologically savvy employee installs a wireless access point under their desk, unbeknown to their employer, in order to gain some mobility at the office. These rogue access points are major security threats because they broadcast the company's network to anyone within a 150 metre radius. Box 2.2 sets out how easy it is to find these unsecured, wireless networks. As a result, businesses need to be aware of the risks associated with any mobile communication and take extra steps to ensure their networks stay secure.

While there are many benefits to mobile communication, its intrusiveness may also have a social toll as it provides a stronger meshing of work and private life. Workers may find it more difficult to leave the office at the office and employers may have more trouble keeping the home at home for employees. Society will need to continually re-evaluate just how much communication is enough communication.

Needless to say, the mobile Internet provides countless possibilities for the business world. It will keep people and companies in touch with the data they care about and depend on. However, businesses must take the time and care to protect their sensitive data and ensure a division between personal and professional life for their employees.

2.5.4 Location-based technologies and services

Location-based services (LBS) help locate the precise geographical presence of a mobile device and provide services based on this information. Technologies enabling location-based services can either be network-based or terminal-based. Network-based technologies include the widely available basic cell-ID service that uses existing network functionality to determine the user's location to 150 metre accuracy. This can be enhanced with additional network data to improve precision (enhanced Cell ID). Another example of a network-based method is TOA or Time of Arrival, where the access bursts determining a terminal's time of arrival are measured at three different base stations. Terminal-based positioning methods such as GPS (global positioning systems)[65] and assisted GPS (A-GPS) further increase the network's ability to locate devices in a very small area. There are also hybrid location technologies, which use both network capabilities and terminal measurements, such as OTDOA or "Observed Time Difference of Arrival". Organizations such as ETSI, 3GPP, and 3GPP2[66] are working on defining the core architectures needed to deliver location services. For 3G W-CDMA services, 3GPP has identified three valid location methods: Cell ID, OTDOA and A-GPS.

As mentioned above, Cell ID is already available on cellular networks, whereas OTDOA will require software upgrades and possibly additional hardware such as Location Measurement Units (LMUs). The major mobile vendors have recently set up the Location Interoperability Forum (LIF)[67] with the purpose of developing and promoting common and ubiquitous LBS solutions. The LIF's recommendations are intended to be independent of the network protocol and positioning technology.

A small number of handsets on the market have GPS capabilities available, such as Sony Ericsson's T206[68] and GARMIN's NavTalk.[69] The US first launched its GPS system of 24 satellites (NAVSTAR) in 1989 and the system became fully operational in 1995. The launch of the Galileo satellite programme will provide a similar European service.[70] Efforts are being made to ensure the interoperability of NAVSTAR and Galileo. GPS is the most accurate positioning technology available and can function independently of the network. Its independence means that it has the effect of reducing the operator's control over the service and the customer. In the case of GPS, the timed difference of reception of satellite signals is used to determine the device's position. This can be performed either entirely within the mobile terminal or within the network. The terminal–based method provides 10-40 metres accuracy and allows third-party LBS provision. Another method, known as Differential GPS, requires a "correction" signal from the network and is accurate to the metre and sub-metre level. Thus far, GPS-enabled devices have been more common on the cdmaOne and cdma2000 platforms than on the GSM and W-CDMA platforms. In May 2002, there were one million GPS-enabled devices in commercial use in Japan, Korea and the United States.[71]

According to a study by Forrester Research, user localization information (50m accuracy) will not be available on more than half of available handsets until 2005. There are a number of reasons for this. The large number and variety of location technologies is likely to inhibit the growth of location-based services, as it will be difficult to ensure a truly global service when technologies and standards differ from region to region. A roaming user may not be able to access certain services when outside his or her home network. Many essential geographic information services may be unavailable if the foreign network supports different services than the home network. Furthermore, without common standards, the plethora of location-based technologies may prevent operators and service providers from developing economies of scale and low-cost solutions. Another important barrier is the high investment required for most user location technologies. In addition, the added functionality cannot always be transferred to an operator's 3G infrastructure. Many operators are therefore waiting for the deployment of 3G networks before investing heavily in localization.

Although location-based services will be perfected with the introduction of higher-speed networks, there are a small number of such services over 2G networks. Japan's J-Phone, for instance, began offering a location-based service called 'J-Sky' in October 2000. In June 2001, DoCoMo also launched a location-based service for its i-mode handsets. The DoCoMo "i-area" service provides weather, dining, traffic and other information for over 400 areas in Japan. Information is organized according to the dialling code where the handset is located. Users can find search items about a specific area rapidly. To access the service, users simply go to the i-mode portal site and click "i-area" to view a large menu of i-area information. Since i-mode base stations automatically recognize the handset's area code, users do not need to enter their location. Information services already include the following: weather forecasts, local guides to shops restaurants and hotels, detailed searchable maps, 24-hour traffic updates. Interestingly enough, this service is not yet available on DoCoMo's third-generation handsets.[72] Along with J-Phone's J-Navi[73] service, these services have demonstrated that expensive location technologies and high-speed 3G networks are not always necessary for the provision of compelling location services.

Location-specific content can cover traffic and event information, transport schedules and navigation assistance. Location services can also serve to enhance personal protection for a wide range of target groups. A combination of these services with or without the use of GPS can help parents informed of the whereabouts of their children.[74] DoCoMo offers the "ima-doko" service, which allows parents to access the location of their children's PHS phone by fax, Internet or i-mode, but without the use of GPS technology.

Both the United States Government and the European Union are attempting to mandate location technologies for emergency services. Chapter six discusses these regulatory measures and explores the broader societal implications of LBS.

2.5.5 Programming languages

Given the wide array of operating systems, it is crucial to create a cross-platform standard for application development. One of the possible solutions is Java. Originally developed by Sun Microsystems in 1991, Java is a programming language used to develop a number of applications, such as utility programs, games, plug-ins etc. Users of Java-enabled devices can install new applications and games in order to personalize their devices and adapt them for particular uses. Java is a platform-independent programming language, that is to say that it can be installed on top of and independently of a device's operating system. The main problem with Java implementation is that it requires a significant amount of processor speed, storage and data.

Sun has now developed a scaled-down version of Java for smaller devices, Java2 Platform Micro Edition or J2ME. J2ME is transparent to the end-user and allows the customisation of content and applications even after the mobile handset has been sold to an end-user. The simplicity and flexibility of Java allows new applications to be downloaded as easily as ring tones or screensavers. The programming language provides a significant boost to the interface of mobile data services. Industry experts predict that by 2006, all digital mobile handsets will be capable of running wireless Java applications. ETSI (European Telecommunications Standards Institute) and GSM manufacturers Nokia, Motorola, Lucent and Nortel are working together on an implementation of J2ME for mobile phones: MExE (Mobile Station Application Execution Environment). The concept behind this collaboration is to ensure that MExE be built into mobile devices and provide a set of functionalities that can then be accessed by Java developers. Nokia announced in 2002 that it was aiming to have 100 million Java-enabled handsets in the market by the end of 2003.[75]

NTT DoCoMo was the first to launch a Java-enabled handset in January 2001. The "i-appli" (or i-application) service is an enhanced i-mode service and which enables the subscriber to download and run small Java applets. Applet access to information and entertainment falls into two categories: stand-alone applets and agent applets. Stand-alone applets, such as games, can be saved in the handset's memory. Agent applets are used for timely information alerts (such as stock quotes) and therefore must connect to a server to provide up to date information. The applets are usually around 10 kbytes in size and handsets can save at least five such applets in their memory. Size and applications available in i-appli will be further enhanced with the arrival of 3G. For instance, images currently use .GIF format, but 3G will allow viewing and storing in .JPEG format. In March 2002, there were 13 million i-appli users in Japan, up from 4.5 million in June 2001.

One of the competitors to Sun's Java is the programming language BREW (Binary Runtime Environment for Wireless) developed by Qualcomm. Although BREW operates independently of a handset's operating system, it only works with terminals that use Qualcomm's CDMA chipsets. For this reason, some operators in Asia and in Latin America, where CDMA2000 networks are being deployed, are considering its implementation. Korea's KTF mobile has recently adopted BREW for its mobile Internet service. At present, though, it is the only carrier to embed BREW in its phones and network,. On the other hand, there are already 20 million Java-enabled handsets in circulation. In June 2002, Verizon Wireless plans to launch a nationwide BREW service in the United States.[76] Industry experts predict that the Java language, due to its presence on the fixed-line Internet and the large pool of program developers will eventually emerge as the default programming language for mobile devices.

2.5.6 Mark-up languages and media formats

Although content is plentiful on the fixed-line Internet, the availability of digital content on the mobile Internet has thus far been limited. One of the key barriers is the complex effort needed to translate Internet content for viewing on mobile devices, mark-up languages being a key enabler for this translation. Over the last few years, mark-up languages have been developed for various applications. Up until now, a number of competing and incompatible languages are being used. In this regard, there are no concerted efforts to limit the number of mark-up languages. Moreover, specialized mark-up languages have evolved for specific applications: CXML (Commerce Extensible Markup Language) and ebXML (e-business Extensible Markup Language), for instance, are to be used for electronic commerce. VXML (Voice Extensible Markup Language) will facilitate voice-activated applications and voice recognition technology. The various languages have not been harmonized, even at the regional level. In Japan alone, for instance, KDDI's EZWeb uses a combination of WML (Wireless Markup Language) and HDML (Handheld Device Markup l\Language), J-phone uses MML (Mobile Markup Language) and DoCoMo uses cHTML (compact HTML).

It can be said that there are currently two dominant mark-up languages used in providing content to mobilephones: WML (Wireless Markup Language) developed by the WAP Forum and cHTML (compact HTML), developed by Access for DoCoMo's i-mode service. Compact HTML has seen much success in Japan but is sub-optimal for the delivery of the next generation of multimedia services. In the case of WML, there are incompatibility problems with different browsers, and with the Internet. As a result, WAP adoption has been slow. Having recognized these shortcomings, industry players have worked together for the acceptance of a new xHTML mark-up language. As discussed in Section 2.3.1, xHMTL has been incorporated into 2.0 version of WAP (See Box 2.10). xHTML uses the same syntax as HTML, and as such, will be easier to use for translation of HTML content. The adoption of xHTML by both the WAP Forum and NTT DoCoMo means a more consistent interface for users, but raises some backward compatibility issues. The GSM Association is recommending the use of dual browsers with WML and xHTML compatibility.

For the delivery of multimedia services such as audio and video, the standardized formatting of media and compression levels are crucial. As in the case of mark-up languages, there a number of proprietary and open standard formatting options for content developers, such as GIF, JPEG, MP3, ActiveMovie, Real etc… Industry associations such as the UMTS Forum are encouraging players to move towards harmonization through the adoption of the MPEG (Moving Pictures Experts Group) family of standards.

In sum, open user interfaces and software platforms are likely to create economies of scale for developers and manufacturers, resulting in a large and unified application market. This in turn will increase the take-up of new multimedia mobile services. On the other hand, the development of closed proprietary systems will lead to fragmentation and stunted market growth. Regulatory developments in this area are discussed in Chapter four.

2.6 Security features

The mobile Internet has enabled people to carry a device in their pocket that they can use to access to people and information around the world. However, without proper security, they may inadvertently be giving the world access to their pockets. Fortunately, there are two levels of security that allow people to keep personal information secure on mobile devices. The first level deals with security of the physical device while the second level protects information while in transit.

According to some estimates, there were 1.3 million mobile phones stolen in the United Kingdom in 2001 alone.[77] That number equates to roughly three per cent of the UK's 47 million cellular subscribers.[78] Mobile phones and other mobile Internet devices such as PDAs are an easy target for thieves because they are small in size, expensive, and can be used for free access on a phone until the phone is blocked by the provider. Equipment manufacturers and operators have responded to the threats by creating several tools to increase security.

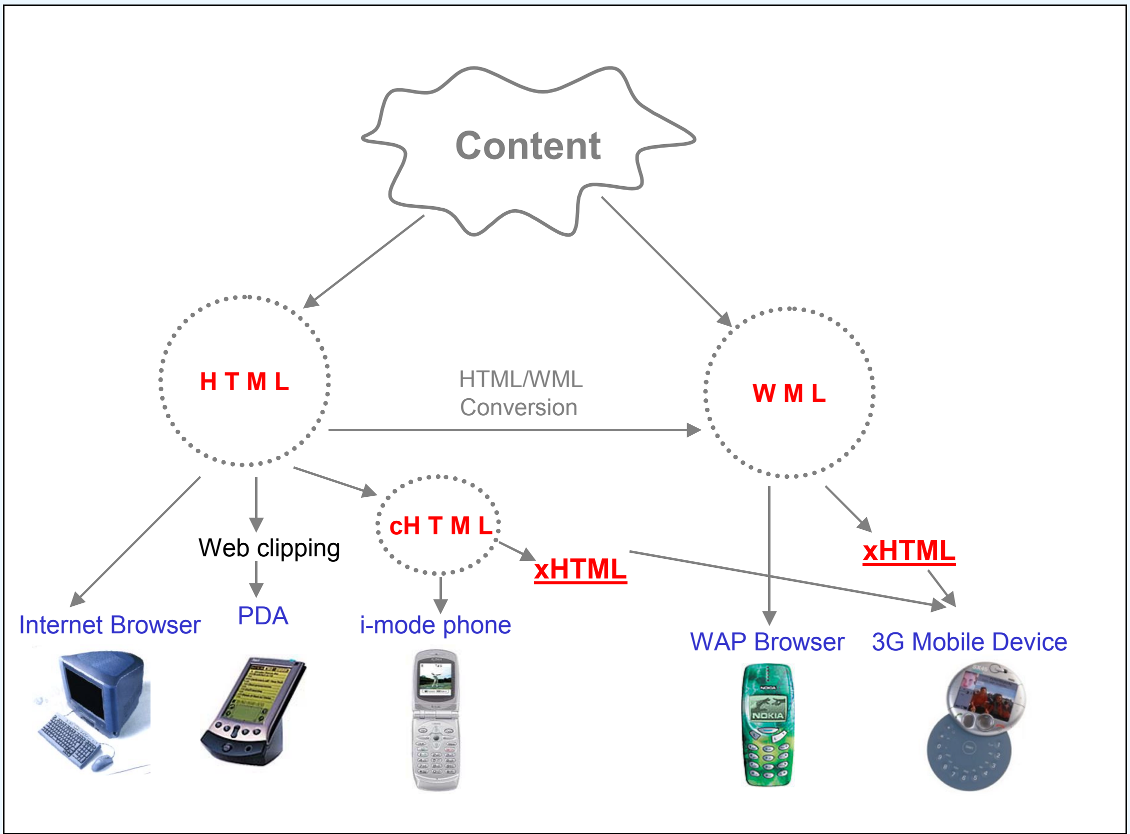
GSM network users store their information on a Subscriber Identity Module (SIM) card in the phone that can quickly be disabled by the provider if the phone is lost or stolen. This SIM card holds much of the phone's important information, including address books, private keys, and passwords in an encrypted state. This protects the user's key information from all but the most determined criminals.[79]

The SIM card (or in the 3G world, UIM or USIM) is also being expanded to increase data security for financial transactions and private communications. One of the concepts is to include a second, smaller smart card called a "WAP Identity Module" or WIM. This WIM would hold all the secure data on the phone such as keys and digital certificates as well as perform all of the encryption functions. This WIM card could either be built into the phone or slide into a slot on the phone and function like a credit card when making payments. There is even a hybrid model referred to as a SWIM, which would combine SIM and WIM functions onto a single chip.[80]

Box 2.10: WAP 2.0 and industry evolution to xHTML

The new Version 2.0 of WAP was released in the summer of 2001.The principal enhancement is the support of xHTML (extensible Hypertext Markup Language). Whereas the initial mark-up language for WAP, WML (Wireless Markup Language), did not ensure consistent layout across different services, xHTML is meant to facilitate content production for a broad set of platforms. It is a stricter evolution of the established Internet mark-up language, as it is based on HTML (Hypertext Markup Language), and ensures compatibility with existing Web design and presentation tools as well as with the earlier WML. It is hoped that it will make for easier browsing from Internet-enabled mobile devices, and easier design of those websites for use with mobile phones.

The use of xHTML will also allow WAP to develop alongside Japan's successful i-mode service in a common evolution towards XML (Extensible Markup Language). This means that content developers will be able to write applications for both PC and WAP Internet clients using a common language. XML has been recommended by the World Wide Web Consortium (W3C) and the WAP Forum as the optimal standard for mobile Internet content.



Source: WAP Forum, ITU.

Mobile operators are also able to track a phone, regardless of what SIM card is used, because each GSM phone has a unique International Mobile Equipment Identity (IMEI) number which is fixed to the actual handset, like a serial number.[81] While someone could replace the SIM card, it's much more difficult to modify the IMEI. The IMEI allows operators to block any use of the handset, regardless of the SIM card, on their network. The Dutch police have taken advantage of this unique IMEI number to incessantly "SMS bomb" stolen phones with anti-theft SMS messages every three minutes. This renders the phones inoperable for most use[82] and has been a success in the Netherlands where phone-related robberies have since dropped.

Mobile users can also employ Personal Identification Numbers (PIN); most mobile phones have a method whereby users can lock the phone when not in use with a 4-6 digit PIN code. This prevents unauthorized access in the event that the phone is lost or stolen, especially if the device locks after a pre-determined number of unsuccessful attempts. While the PIN number locks on devices are extremely useful in terms of physical security, most mobile users choose not to be bothered with inputting the PIN every time they want to use the phone and thus do not take advantage of all the security available to them.

While mobile providers and equipment makers have spent time trying to make the devices more secure, the largest effort has gone into securing the networks. The mobile network, by nature, is more vulnerable than other networks because the traffic is sent over the air.

Most network security is based on encrypting data, encoding on one end of the communication and decoding on the other. There are two main methods of securing a communication line, synchronous and asynchronous, and each has its own advantages. Synchronous encryption uses the same key (or code) on each side of the transmission to encode and decode information. Asynchronous encryption divides a key into two parts, one public and one private where a user can freely distribute her public key and then anyone else can encrypt messages that only she can decrypt and read using her private key. Secure networks usually make use of both methods: they use asynchronous encryption to pass along the key necessary to start a synchronous encryption process.

While the two types of encryption work fairly well, they are not always user-friendly or easy to use because of problems for the exchange of keys. This, however, is changing with the development of a "public key infrastructure" or PKI. The PKI distributes public keys for asynchronous encryption and certifies the people posting the keys are releasing the correct identification information. Its function can be likened to a government agency that issues passports or drivers licences, except that the PKI issues digital certificates. Due to size limitations, wireless devices require a simpler Wireless PKI (WPKI) that will still issue certificates and manage public keys, but in a more transparent way for end-users. As the PKI develops, mobile users should be able to establish secure communications over wireless networks and be confident about the identification of the party they are communicating with.

One of the implementations of encryption for mobile devices is called Wireless Transport Layer Security (WTLS). WTLS and its fixed connection counterpart TLS, both use a technology called Secure Socket Layer (SSL) for seamlessly encrypting data via a Web browser. This WTLS technology is adapted to WAP Web pages in order to allow users secure communications as well as to perform financial transactions over an encrypted connection.

Mobile services will benefit from security improvements on wireless devices and networks. Users will become more and more confident that their communications are secure and that they are dealing with the intended enterprise or person.

2.7 Conclusions: towards convergence and interoperability

The combination of mobile and Internet technologies has already transformed the way people interact with each other and the way business is done. Mobile data has not only been popular in developed economies, but has also made significant inroads in developing ones. Messaging services have brought information technology closer to groups that have traditionally had limited access to it, such as children and the deaf community. High-speed data services combined with additional functionality such as location information and improved security will further enhance the user experience.

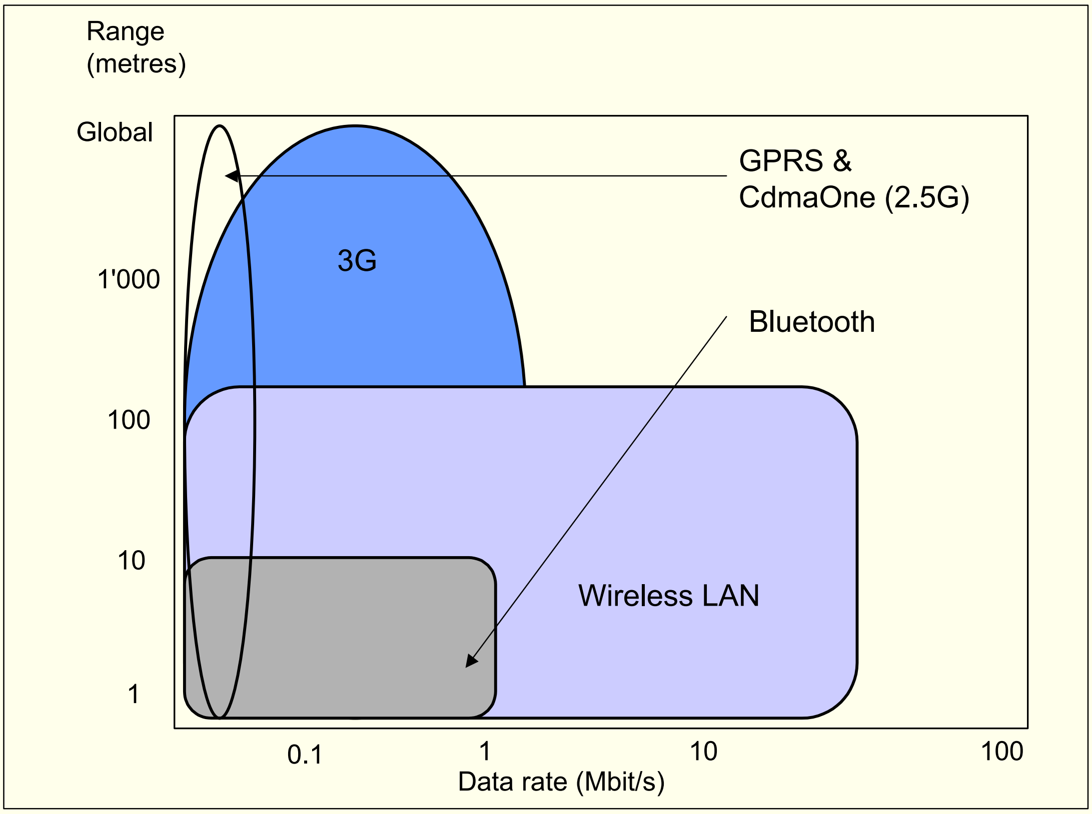
Although the majority of content on the fixed-line Internet is in the English language, the majority of Internet users in the world are not native English speakers. SMS and the mobile Internet offer an excellent opportunity for the development of multilingual content as well as culturally-relevant local content, thus enabling global access to the information society. The i-mode mobile Internet service in Japan is a telling example: the availability of content in Kanji and Japanese characters has contributed to increasing the country's Internet penetration two-fold since the service was launched in 1999. However, in countries where literacy poses a significant hurdle to the usability of certain technologies, developments such as speech to text translators, voice portals and voice recognition technologies[83] should be encouraged.[84]

Although mobile data services are already available on 2G platforms through WAP, i-mode and SMS, it is through the advent of 2.5 and 3G that users will begin to fully reap the benefits of the mobile Internet through always-on communications and multimedia applications. What we have learned from the success and failures of 2G technologies is that person-to-person messaging, simple interfaces and timely content delivery will be the key to future service development and revenue generation. A mere simulation of the fixed-line Internet experience will not compel users to take up data services. The development of an adequate payment system for mobile devices is also crucial to the delivery of paid content and services.

On a technical level, the viability of future 3G services will rely on continued efforts towards the seamless interoperability of radio interfaces and the evolution to an IP-based core network. At the service level, convergence between the fixed and mobile Internet is already a tangible occurrence, through services such as mobile instant messaging and fixed-line SMS. This interoperability will eventually encompass complimentary and alternative network technologies, such as wireless LANs, short-range connectivity technologies, fixed broadband networks etc. Regulators and industry players alike need to realize that there are a number of different options for providing mobile Internet services, and third-generation services must be considered in their global context. As Figure 2.6 indicates, 3G technologies are only a part of the overall picture.

Figure 2.6: Radio access systems for mobile data

Ranges and data rates



Source: Adapted from European Information Technology Observatory 2002.

[1] The first commercial launch of the GSM digital cellular system was in July 1991, by Radiolinja in Finland.

[2] The PDC standard, for example, is used exclusively in Japan.

[3] IMT stands for "International Mobile Telecommunications" Work is currently being carried out under the banner "IMT-2000 and systems beyond IMT-2000". For more information, see the ITU's IMT-2000 Web portal at http://www.itu.int/imt/ .

[4] ITU's WRC is held every two to three years and attempts to establish a global framework for the use of the radio spectrum. Its objective is to establish frequency allocations and regulatory procedures for the harmonious operation of global radiocommunication services.

[5] For the purpose of clarity, Hong Kong, China is hereinafter referred to as "Hong Kong".

[6] Japan launched 3G services in October 2001.

[7] CDMA2000 1x, available in Korea since October 2000, was faster than existing networks but did not initially meet ITU's requirements for IMT-2000. However, together with the latest evolution of this standard (1xEV-DO), CMDA2000 1x has now been approved by the ITU as an IMT-2000 standard, retroactively making Korea the first country to deploy 3G services commercially.

[8] UMTS stands for "Universal Mobile Telecommunications System". See the UMTS Forum website at http://www.umts-forum.org/.

[9] CDMA2000 is based on Qualcomm technology. See the CDMA Development Group website at http://www.cdg.org.

[10] See ITU Recommendation ITU-R M.1457-2.

[11] The same applies to TDMA (ANSI-136 digital mobile standard) and cdmaOne (ANSI-95, a CDMA-based digital mobile standard).

[12] In this publication, transmission capacity or "bandwidth" is measured in terms of kilobits per second (kbit/s) or Megabits per second (Mbit/s).

[13] ITU Working Party on IMT-2000 and Systems beyond IMT-2000. See http://www.itu.int/ITU-R/study-groups/sg/sg8/wp8f/index.html.

[14] See the 3GPP and 3GPP2 websites at http://www.3gpp.org/ and http://www.3gpp2.org/ respectively.

[15] The full name of IEEE is Institute of Electrical and Electronics Engineers. See Section 2.1.4 for an overview of the 802.11 series for Wireless LANs (Local Area Networks).

[16] See section 2.4.2.

[17] See "The European Commission says the Internet will run out of available addresses by 2005", 21 February 2002, http://www.informationweek.com/story/IWK20020221S0031. See also "EU sees IPv6 adoption as crucial to 3G success", http://www.idg.net/crd_idgsearch_2.html?url=http://www.infoworld.com/articles/hn/xml/01/04/27/010427hneuip6.xml?p=br&s=9.

[18] For more information, see the IPv6 Taskforce website (www.ipv6-taskforce.org) and the Task force report at http://www.ipv6-taskforce.org/PublicDocuments/IPv6TF-Report.pdf.

[19] See "High Tech and High Touch: Palm Pilots, Wireless Modems & Customized Software Enable Cedars-Sinai Physicians to Access Patient Updates from Anywhere, 24/7", July 10, 2001, Press Release Cedars-Sinai Medical Center, http://www.csmc.edu .

[20] Wi-Fi is also sometimes also referred to as Wireless Ethernet even though Wireless Ethernet actually encompasses all 802.11 technologies.

[21] See WECA, the Wireless Ethernet Compatibility Alliance, at http://www.weca.net/ .

[22] According to InStat/MDR, 70 per cent of all wireless LAN products sold in 2001 were Wi-Fi while the remaining 30 per cent of all wireless nodes were HomeRF.

[23] See "a, b, e, and g--What 802.11 means to me (and you, too)", 6 November 2001, ZDNet.com, http://www.zdnet.com/anchordesk/stories/story/0,10738,2822686,00.html.

[24] 802.11b arrived before 802.11a because the letters refer to the order in which the different standards were proposed.

[25] See "Exploiting and Protecting 802.11b Wireless Networks", 4 September 2001, ExtremeTech: http://www.extremetech.com/print_article/0,3428,a=13880,00.asp.

[26] See: http://www.netstumbler.com/.

[27] See: http://airsnort.sourceforge.net.

[28] See "Watch this airspace", 20 June 2002), The Economist, http://www.economist.com/printedition/displayStory.cfm?Story_ID=1176136.

[29] Bluetooth derives its name from Harald Blåtland , *alias* Bluetooth, a Danish king born in 980 A.D. who united Denmark and Norway under Christianity.

[30] See: http://www.bluetooth.com/sig/about.asp and http://www.bluetooth.org/.

[31] See: "Setbacks", March 12, 2002, ZDNet Tech Update, http://techupdate.zdnet.com/techupdate/stories/main/0,14179,2854261-2,00.html.

[32] KDDI's EZweb service, which is similar to the i-mode platform, uses WAP and a combination of WML and HDML (Handheld Device Markup Language). See: L. Srivastava, "3G Mobile Policy: The Case of Japan", *INFO*, Vol. 3, No. 6, December 2001, p. 465.

[33] For information on ITU TELECOM 99 see http://www.itu.int/telecom-wt99/homepage.html.

[34] E-plus launched its i-mode service in Germany in March 2002 and KPN Netherlands in April 2002. Both services will be available over the GPRS network. See: "Can i-Mode Give This Also-Ran a Lift?", *Business Week Online*, 1 April 2002, http://www.businessweek.com/magazine/content/02_13/b3776143.htm. See also: "KPN to launch i-mode with high hopes", 4 April 2002, Reuters, http://news.com.com/2100-1033-875740.html?tag=cd_mh.

[35] Services began in April 2002. See: "Americans in the mood for Mmode?", 16 April 2002, *Wired News*, http://www.wired.com/news/print/0,1294,51878,00.html . See also "AT&T debuts mMode wireless Web", 16 April 2002, CNet News, http://news.com.com/2100-1033-884026.html.

[36] See: "KG Telecom to Launch i-mode Wireless Service in Taiwan", 7 June 2002, 3g.co.uk News, at http://www.3g.co.uk/PR/June2002/3513.htm.

[37] PDC stands for Personal Digital Cellular, a digital mobile standard used exclusively in Japan. See NTT DoCoMo's subscriber growth statistics available at http://www.nttdocomo.co.jp/english/p_s/imode/index.html.

[38] Japan is not the only success story. At the end of 2001, more than 50 per cent of Korea's mobile users, about 15.8 million, were using a mobile Internet browsing service.

[39] The FOMA website is at: http://foma.nttdocomo.co.jp/english/.

[40] See http://www.blackberry.net/.

[41] See the statistics page of the GSM Association at: http://www.gsmworld.com/news/statistics/index.shtml.

[42] This is known as a "store and forward" process.

[43] The winning entries are posted at http://books.guardian.co.uk/games/.

[44] See: "Airline puts text messaging on flights", 24 April 2002, MSNBC, at http://www.msnbc.com/news/743191.asp?0si=-.

[45] See "World's first full-scale MMS services commercially launched in Hungary", 19 April 2002, Ericsson News, at http://www.ericsson.co.uk/news/1738.shtml.

[46] See "Swisscom lance son service MMS: des SMS avec son et images en plus", 29 May 2002, Le Temps, Switzerland.

[47] "MMS in Hong Kong: (Jump-) Start Your Engines", 31 May 2002, Asia-Pacific Perspective, Pyramid Research.

48 The 3GPP website is at http://www.3gpp.org/.

49 For more information on the T68i, see http://www.sonyericsson.com/T68i/.

50 "Western Europe: MMS Expectations Grow as European Operators Launch Commercially", 7 June 2002, Pyramid Research Perspective.

51 See AOL's Instant Messenger website at http://www.aim.com/.

52 See the MSN messenger site at http://messenger.msn.com/.

53 ICQ stands for "I Seek You". For more information, ICQ's home page can be found at http://Web.icq.com/.

54 According to Jupiter Media Metrix, instant messaging services boast 63 million users in the United States and 250 million users worldwide (est.) .

55 In January 2002, AOL blocked users of Trillian, a service allowing users to access multiple instant messaging programs from one interface. See "AOL blocks instant messaging start-up", 30 January 2002, CNET News, http://news.com.com/2100-1023-826625.html.

56 See http://www.mobile.att.net/aim. See also "AOL launches e-mail and IM for AT&T users", 23 April 2002, IDG, http://www.idg.net/ic_851542_6120_1-3097.html.

57 "mMode", a new service modelled after DoCoMo's i-mode service, was introduced in the US through AT&T in April 2002. See "AT&T debuts" mMode "wireless Web", 16 April 2002, CNET News, http://news.com.com/2100-1033-884026.html.

58 In February 2002, Ericsson held a successful trial of its Instant Messaging and Presence Server (IMPS).

59 Examples of portal providers include Nokia, BT, Sonera, NTT DoCoMo, Yahoo Mobile, Excite, Lycos and AOL.

60 See the Paybox website at http://www.paybox.net/.

61 In February 2002, Vodafone UK announced the launch of "m-Pay", a mobile payment solution for third-party goods. The target size of the payment would be between 5p and £5, of which Vodafone would keep 15 per cent per transaction. Vizzavi, the mobile portal owned jointly by Vodafone and Vivendi Universal will also use m-pay on similar terms.

62 Services are to be made available at the end of 2002. See "Vodafone and T-Mobile plan mobile payment system", 14 March 2002, Mobile CommerceNet, at www.mobile.commerce.net/print.php?story_id=1415 .

63 European Information Technology Observatory 2002, 10th Edition, Part Two.

64 The live pilot project is taking place in Denmark and involves cash withdrawals from three ATMs owned by Spar Nord Bank and Laan & Spar Bank. See "Wireless Phone Used to Withdraw Cash from ATM in Europe", 29 April 2002, 3g.co.uk, at http://www.3g.co.uk/PR/April2002/3271.htm.

65 There are currently two "public" GPS systems. The NAVSTAR system is owned by the United States and is managed by the Department of Defense. The GLONASS system is owned by the Russian Federation. While both NAVSTAR and GLONASS systems are global positioning systems, the NAVSTAR system is often used synonymously with because it was generally available at an earlier date.

66 ETSI stands for European Telecommunications Standards Institute (see www.etsi.org). 3GPP stands for third-generation Partnership Project (see www.3gpp.org) The third-generation Partnership Project (3GPP) is a collaboration agreement that was established in December 1998. The collaboration agreement brings together a number of telecommunications standards bodies which are known as "Organizational Partners". 3GPP focuses on developments for Wideband CDMA. 3GPP2 is the third-generation Partnership Project 2 (see www.3gpp2.org), which focuses more on CDMA2000 development, and radio transmission technologies supported by supported by ANSI/TIA/EIA-41.

67 The LIF is a global industry initiative, formed jointly by Ericsson, Motorola and Nokia in September 2000. See http://www.locationforum.org/.

68 See Sony Ericsson's press release "Sony Ericsson introduces a GPS-enabled tri-mode phone for CDMA systems – the T206", 5 March 2002, at http://www.sonyericsson.com/spg.jsp?page=gis&Redir=page%3DC2_1_22%26B%3Die.

69 See Garmin's website at http://www.garmin.com/products/navTalk/.

[70] On 26 March 2002, the European Union transport ministers released 450 million Euros (US$ 443m) in development funding for the Galileo programme. The European Space Agency also committed a similar amount. The total project cost for development and deployment is forecast to reach 3.4 billion Euros, with a 2008 operational date.

[71] "Qualcomm announces over one million subscribers serve gpsOne-enabled devices", 8 May 2002, Qualcomm. Available at http://www.cdmatech.com/press/releases/2002/020508gpsone_1million.html.

[72] See http://www.nttdocomo.com/new/contents/01/whatnew0628.html.

[73] The J-Navi service boasts 2 million hits per day.

[74] See "A Satellite baby-sitting service", 2 May 2002, Wired News, http://www.wired.com/news/business/0,1367,52253-2,00.html.

[75] European Commission Directorate-General Information Society, Accenture, "Digital Content for Global Mobile Services", February 2002. Nokia has also incorporated a software-only version of Java on its new communicator.

[76] The first wave of services will hit on 17 June 2002 when Verizon begins its national roll-out roll-out of downloadable applications on the BREW platform. Applications offered on 17 June 2002 will include games such as EA Sports™ Tiger Woods PGA Tour® Golf and JAMDAT Bowling from JAMDAT Mobile Inc.; entertainment services such as Mattel, Inc.'s Magic 8 Ball®; and musical ring tones from Moviso LLC, a wholly owned subsidiary of Vivendi Universal Net USA. See "Verizon Wireless to launch downloading service", 6 June 2002, Total Telecom, at http://www.totaltele.com/view.asp?articleID=52609&pub=tt&categoryid=625.

[77] See "The Quarter 1-2002 Mobile Phones Report", Continental Research http://www.continentalresearch.com/reports/reports/health.htm.

[78] ITU Data.

[79] An IBM research team found a security weakness in SIM cards that could be exploited by a determined hacker and has also recommended a solution. See "New Technology to Protect GSM Cellphones from Hacker Attacks", 7 May 2002), IBM Research News, http://www.research.ibm.com/resources/news/20020507_simcard.shtml.

[80] Nokia White Paper – Security Identity in Mobile Financial Transactions, January 2001.

[81] The IMEI number is 15 digits long and is the serial number of the phone. It's important to have the number in case the phone is stolen or lost. The following keystroke combination will display the IMEI number on a GSM device: *#O6#.

[82] See "Amsterdam bombards muggers", 14 December 2001, DPJS Etalage, http://www.minjust.nl/b_organ/dpjs/engels/sec_netherlands.htm.

[83] Developers are working on a mark-up language geared at voice recognition, Voice XML (Voice Extensible Markup Language). See: http://www.vxmlforum.org.

[84] For an example of an initiative aiming at encouraging the take-up of technologies across literacy levels, see "Community Knowledge Sharing," at http://edevelopment.media.mit.edu/comm_knowledge_sharing.html.

3 Chapter Three: Market Trends

3.1 Evolution of demand

While the Internet has been hailed as the ultimate tool for business and personal communications, it was in fact military and educational institutions that first made the Internet a reality. Until 1993, Internet demand came mainly from academics and technologically-savvy users. With the introduction of the World Wide Web and of graphical browsers in the early 1990s, the Internet went mainstream and its ensuing growth has been phenomenal.

Certain economies have had more success than others in attracting Internet users. Demand has been strongest in areas with unlimited local calls, such as Australia, Canada, Hong Kong[1], the United Arab Emirates, and the United States. These five economies had an average of 37 per cent more Internet users in 2001 than would be predicted on the basis of their GDP per capita alone (see Figure 3.1, left chart).[2] Some other countries, particularly those with highly concentrated urban populations such as Korea, have been able to meet demand for Internet access more easily than elsewhere.

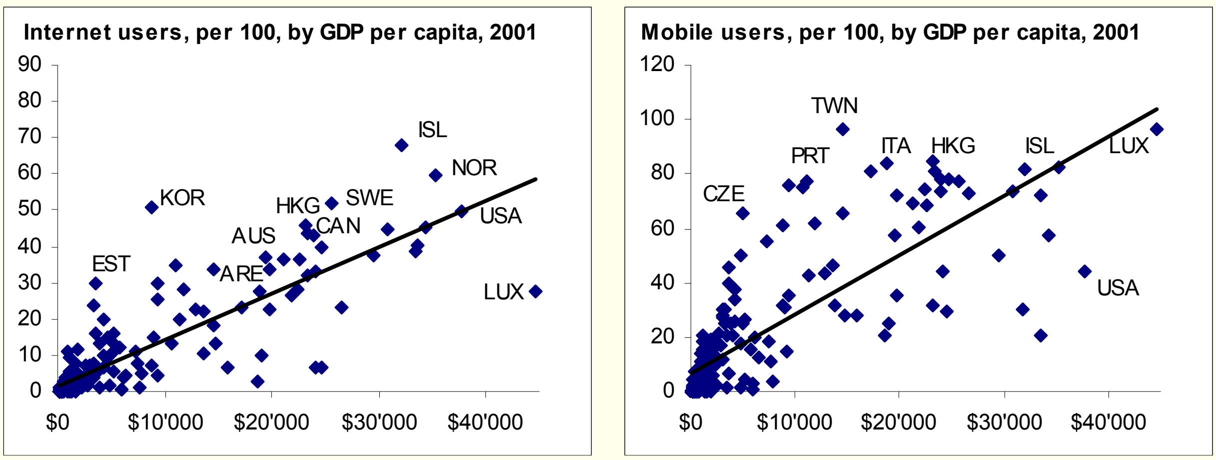
The history of mobile communications goes back much further than that of the Internet, but its commercial application is just as recent and it has followed a similar demand pattern. Analogue cellular networks were commercialized in the early 1980s and digital cellular ones in the early 1990s. In 1991, only one per cent of the world's inhabitants had a mobile phone. Astoundingly, only ten years later at the end of 2001, almost one in every six, or 948 million, of the world's inhabitants had a mobile phone (see Figure 3.1, right chart).[3]

3.1.1 Current trends

Most economies are seeing increases in demand for both Internet and mobile services. However, in some economies, one has been more successful than the other. This is due in part to the fact that many of the factors hindering fixed Internet access actually increase demand for mobile services, and vice versa.

Many economies have struggled to expand Internet access because PC access comes with high fixed costs. First and foremost, the cost of individual PC ownership has been prohibitive in all but developed economies. Second, most Internet users in the world still rely on dial-up Internet connections over a fixed phone line. Many operators are unwilling to build the necessary fixed-line infrastructure for fear of not recovering their costs. This problem is known as the "last-mile" problem, because wiring the last mile (or more accurately, the last few tens of metres) to each individual building is the most expensive and least cost-effective part of infrastructure deployment. As a result, in the absence of a fixed-line phone connection, even those users with access to a PC can find themselves without access to the Internet.

Figure 3.1: Internet and mobile users according to GDP per capita (2001)



Source: ITU.

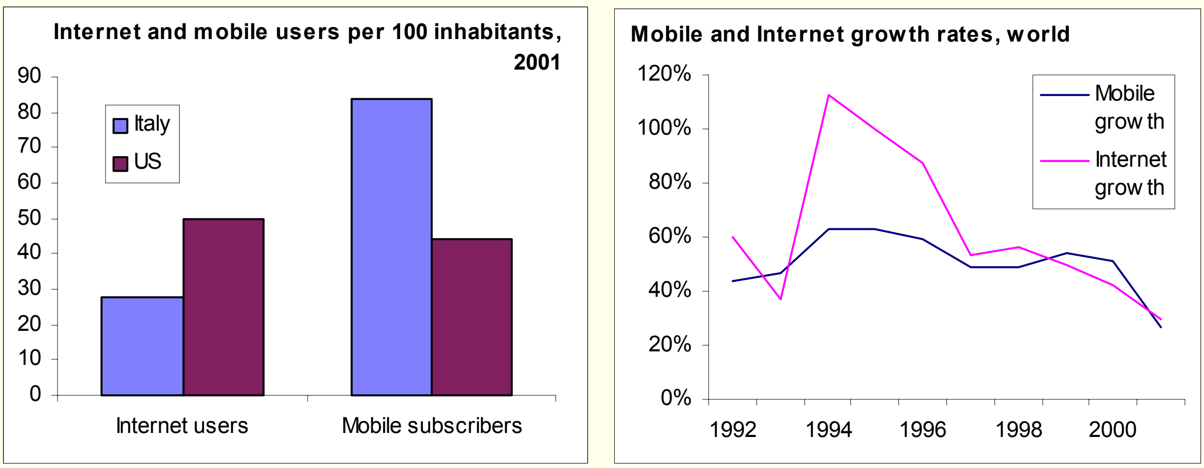
Some of the economies that have been struggling with high fixed Internet costs and the last-mile problem have been prime markets for mobile deployment. Mobile networks effectively eliminate the last-mile problem by using wireless technology rather than using fixed wires to connect people. The demand for mobile networks in many developing countries has been very strong and penetration rates have soared, reflecting a large pent up demand for ICTs prior to the arrival of mobile technology. Africa, for instance, was the first continent where mobile users exceeded fixed-line ones.

By contrast, some economies with strong Internet demand have been slow to expand their mobile markets, primarily due to existing billing structures. In North America, telephone customers usually pay a monthly fee which includes unlimited local calls, a practice which lends itself very well to rapid take-up of Internet access. However, unlimited local calling has significantly stunted early mobile growth. Typically, in such economies, a receiving-party-pays (RPP) system exists, whereby mobile users are charged for both incoming and outgoing calls. In contrast, in Europe and most of the GSM world, a calling-party-pays (CPP) system exists, whereby mobile users do not pay for incoming calls on their home network. Rather, fixed-line users pay a premium to contact mobile users. The result is that, in RPP unlimited call environments, mobile operators do not enjoy the same level of profits as they do not levy above-cost termination charges on fixed-line operators. In addition, mobile users are penalized for receiving calls, resulting in many phones being switched off and calls remaining unanswered. This has recently been improving as operators resort to bundled packages and flat-rate calling for mobile users (in India, for example). Nevertheless, there is an established pattern of economies with sizeable advantages in terms of Internet access suffering slow growth for mobile communications.

This inverse relationship between the Internet and mobile markets is well illustrated by the comparison of Italy and the United States, as shown in Figure 3.2, left chart. Both economies have high per-capita GDP, but each excels in a different market. Italy is one of the world leaders in mobile phone penetration, especially for prepaid use, but has been much slower to adopt the Internet. The United States, by contrast, has high Internet penetration rates but lags in mobile use (with relatively few prepaid users). In fact, Italy has almost twice as many mobile phones per capita than the US, while the US has twice as many Internet connections per capita than Italy. The rise of the mobile Internet is blurring the boundaries between these technologies and thus the current disparity may not last long.

The phenomenal growth of mobile has surpassed even the most optimistic projections and many economies now have more mobile phones than fixed lines (see Figure 3.3). This is true not only in developed economies, such as Austria, Finland, Hong Kong and Italy, but also in developing ones, such as Cambodia, Côte d'Ivoire and Uganda. By the end of 2002, it is predicted that there will be more mobile phones than fixed lines in the entire world.

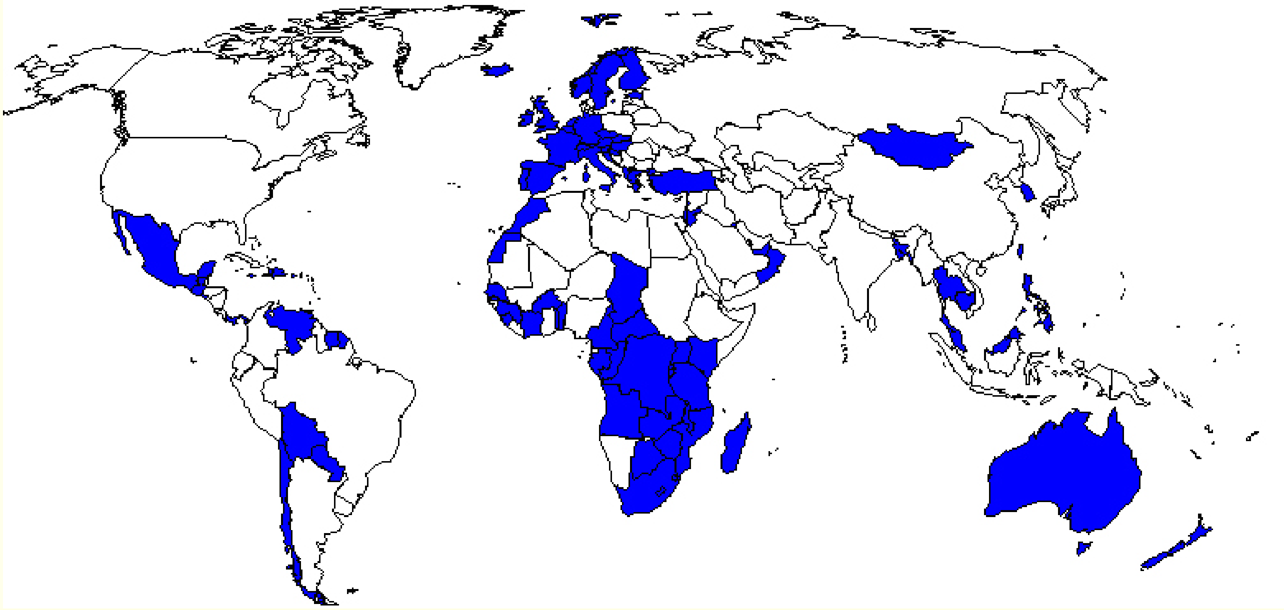
Figure 3.2: Historical Internet and mobile growth, strengths and weaknesses



Source: ITU World Telecommunication Indicators Database.

Figure 3.3: More mobile than fixed

Countries with more mobile than fixed telephone subscribers, 2001



Note: The map refers to the situation at year-end 2001. Shaded countries have more mobile than fixed.
Source: ITU World Telecommunication Indicators Database.

Another reason mobile penetration has increased so quickly is the advent of prepaid calling cards. Many users in developing countries do not have easy access to credit, which they would need to sign up for a fixed-line telephone. Operators in many countries have done away with the need for credit by adopting prepaid calling plans, thus attracting large numbers of new users. This has been a boon for mobile operators who previously couldn't provide access to those they considered to present credit risks. This results in a huge increase in the number of mobile users in developing and least developed countries that can now afford to have telephone service.

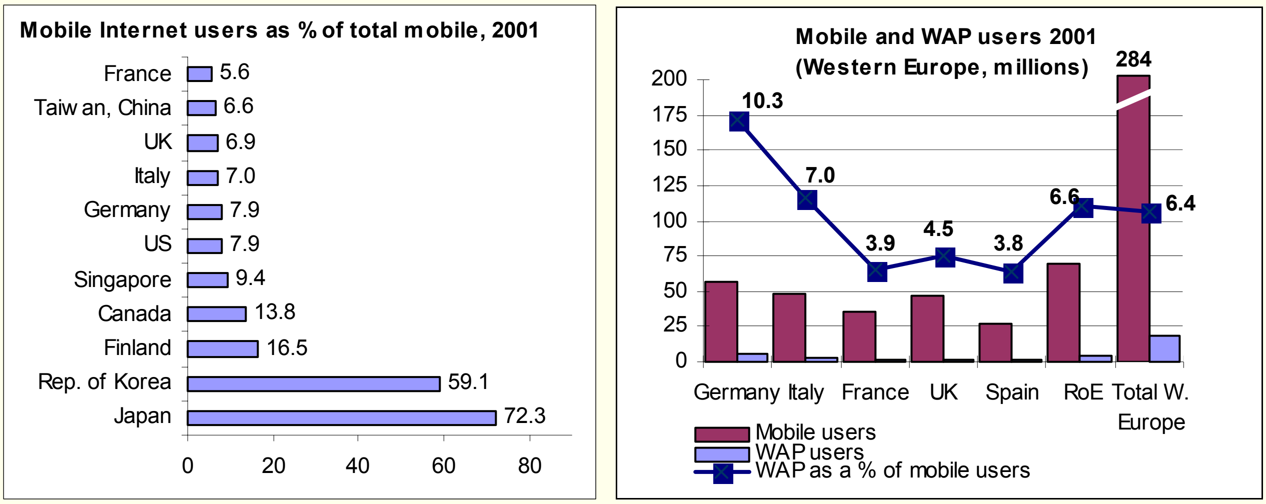
Developed countries have also been quick to adopt mobile technologies, but with different underlying user incentives. Users in developed countries adopt mobile phones primarily for mobility and convenience, rather than necessity, as most users also have fixed lines at work or home. The latest trend in developed countries is that users are choosing to drop their fixed connection altogether, rather than paying for both a mobile and fixed line.

3.1.2 Take-up of mobile Internet services

For the time being, both mobile and Internet use continues to climb (as shown in Figure 1.1, Chapter one), albeit at a decreasing rate (see Figure 3.2, right chart). As more users get online via a mobile phone, the world is very likely to undergo a transformation in the ways that people utilize the Internet. The Internet experience will shift in part to mobile devices as they become equipped with faster connections, better screens, and compelling content. The mobile Internet will not displace the fixed-line Internet, but will bring content in faster and increasingly convenient ways to the near billion mobile phone users. The beginnings of this shift have already taken place in several countries where mobile Internet services are offered, but they have met with varying degrees of success (see Figure 3.4, left chart). What these first experiences of the mobile Internet have shown, is that much of this success hinges on the business strategy of mobile operators and their collaboration with the many new players entering the market.

Figure 3.4: Mobile Internet around the world

Mobile Internet penetration and use in selected countries.



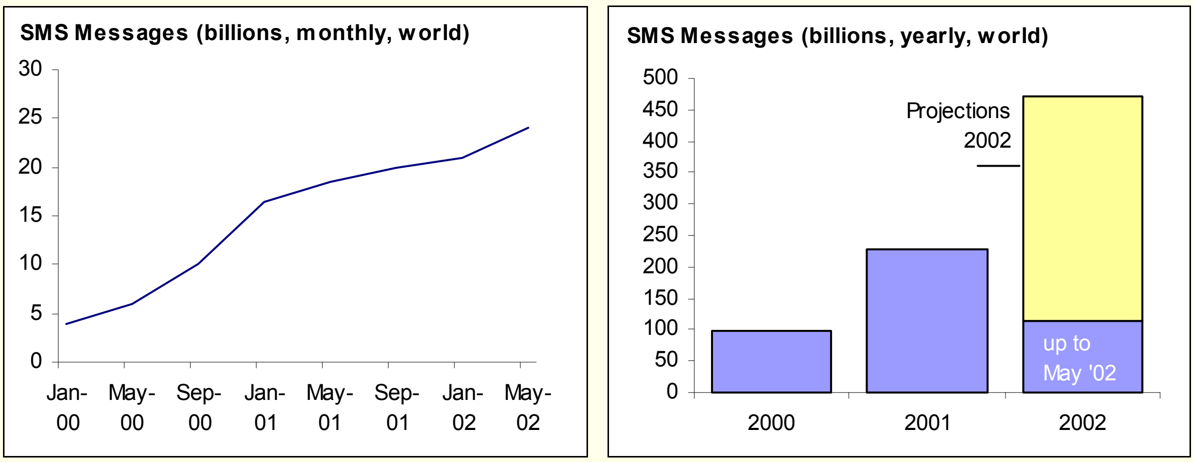
Note: In right chart, RoE stands for Rest of Europe.
Source: MPHPT (left chart); Dr Carl H. Marcussen (Centre for Regional Tourism and Research, Denmark, at http://www.crt.dk/), ITU World Telecommunication Indicators Database (right chart).

There are a number of different applications currently available on mobile handsets, some of them already widely used, while others are still developing their full potential. The success of **mobile messaging** has been phenomenal and a surprise to both operators and users (see Chapter two). Clearly the most widely used mobile messaging service is SMS, which allows users to send messages up to 160 characters long via their mobile phone. In May 2002 alone, SMS users worldwide sent a total of 24 billion messages[4] (see Figure 3.5).

The tremendous success of the service can be attributed to two main reasons. First, for brief communications, SMS is less expensive than mobile voice calls. Second, SMS is a less intrusive form of communication than real-time voice and lends itself better to many situations where voice calls would be inappropriate—an SMS user can send a message during a meeting, on the bus, or anywhere else simply by typing on the keypad of the phone. The demand for SMS has been particularly strong among younger people, especially those with a limited budget for voice calls. It has also had great success in developing countries, such as the Philippines (see Chapter five).

Not only have operators been able to profit from person-to-person SMS, but they have also found ways to charge for information broadcasted to a large number of users via SMS. During the 2002 football World Cup

Figure 3.5: Worldwide SMS growth



Source: GSM Association.

for example, many sites offered SMS updates for every goal or final score. This enabled people at work or away from televisions or PCs to keep up to date on the scores. Users were even willing to pay upwards of 50 US cents for every broadcast SMS received. Germany's eight goals against Saudi Arabia proved profitable for those countries' mobile operators.

As mentioned in Chapter two, several countries have already introduced multimedia messaging (MMS) -type services, the successor to SMS. In June 2002, Japan's J-Phone had 5 million camera-equipped "sha-mail" handsets in use on its network.[5] Another first mover in the field of MMS is Korea, which launched its mobile picture and video messaging services in April 2002. Korea's largest mobile operator, SK Telecom, doubled the number of its users whose phones have high-speed Internet access from 6.96 million in 2001 to 12.97 million in 2002.[6]

E-mail was the most popular Internet application until the arrival of the World Wide Web, and it continues to be popular, with one forecast putting the total number of users with e-mail mailboxes at 1.2 billion by the year 2005.[7] As mobile services become more sophisticated, more e-mail services will be made available on mobile phones. It is interesting to note that even though the estimates for the number of e-mail boxes are quite high, there will probably still be more mobile phones than PCs. This highlights the significant impact of making e-mail available on standard mobile phones. Research in Motion (RIM) developed a stand-alone mobile device that lets users send and read e-mail. RIM's "Blackberry" was originally meant only for e-mail but has now been enhanced with voice capabilities, making it a mobile phone and e-mail client in-one. New 2.5G and 3G phones have much of the same functionality, but have evolved in the opposite order. Mobile phones started with voice services but are incorporating e-mail clients, or programmes, into their devices for use on data networks, allowing users to download and send mail messages from standard accounts via their phone. If the past is a good indicator of future development, mobile e-mail may well become one of the most popular data services on offer—a trend that has been confirmed by a number of user surveys.

SMS already illustrates how simple data transfers function well over mobile connections. However, when the data becomes more complex, such as Web pages, the results have been mixed. The two most popular methods for browsing Web pages on the Internet using a mobile device, WAP and i-mode, differ fundamentally, but aim to deliver the same type of Web-browsing experience.

As mentioned in Chapter two, **WAP** had difficulty catching on with consumers because users expected a PC-type browsing experience, only to be disappointed by the lack of content available, slow download speeds, and expensive tariffs. Even when they are equipped with WAP-enabled handsets therefore, some users are choosing not to use the services offered, particularly because of the high cost (see Figure 3.4, right chart). The same phenomenon is being seen with GPRS handsets. Despite the lack of initial enthusiasm however, the number of WAP users is slowly increasing (there were 284 million users in Western Europe in 2001), as is the available content.

While WAP portals have had a difficult time attracting users, in Japan, DoCoMo's i-mode and similar services offered by KDDI and J-Phone have had phenomenal success (see Figure 3.6, left chart). Since its inception in February 1999, DoCoMo has built a subscription base of over 33 million users, bringing the total number of mobile Internet users in Japan to over 54 million. In addition, i-mode is no longer limited to the Japanese market. KPN has 50'000 subscribers on their new i-mode network, including 10'000 in the Netherlands[8] and 40'000 in Germany.[9] Other economies, such as Taiwan, China, are also developing services and hope to meet with similar success.

Although the digital content market for mobile has had some success, it has been much harder for the mobile world to work out a viable plan for **m-commerce** (mobile commerce). The Internet version, e-commerce (electronic commerce), has had mixed reviews, but overall transactions are on the rise. On the mobile side, the European Information Technology Observatory estimates that Europeans alone had m-commerce transactions totaling €247 million (US$ 223 million) in 2001, with a predicted €488 million (US$ 440 million) for 2002.[10] The Japanese MPHPT foresees dramatic growth in m-commerce, which is set to reach an estimated US$ 14.8 billion, representing 21.6 per cent of total e- and m-commerce transactions, by 2005.[11]

Handsets

The advent of the mobile Internet could serve to revitalize the mobile handset market. Handset manufacturers enjoyed a period of strong growth up until 2001 when, for the first time, mobile handset sales actually fell from one year to the next. This followed a 60 per cent compound annual growth rate from 1996 to 2000.[12] The drop in sales is certainly not due to lack of demand for mobile communications: on the contrary, people are using mobile services more than ever. Rather, the problem for handset manufacturers lies in the fact that certain markets, namely Western Europe and parts of Asia, are nearing saturation levels. This leaves manufacturers and operators with the conundrum of how to stimulate demand for new handsets when most users already have a mobile phone. The answer is two-fold. First, they must find ways to increase revenues from existing users. Second, they need to offer new services that require phones with enhanced functionality and colour screens.

While the solution may sound simple, it has been much more difficult to implement in practice. Operators have been able to raise revenues by offering newer services such as SMS to existing users. However, equipment manufacturers have found it a difficult task to convince users to upgrade to newer phones with additional features. Even with the promise of Internet services over GPRS networks in Europe, manufacturers have not been able to produce large numbers of phones to capture the initial demand. In addition, as with PCs, many users wait until the very last moment to purchase handsets in order to obtain the most features and value for their money.

Handset manufacturers are also feeling pressure from personal digital assistant (PDA) manufacturers that have built wireless connections into their devices. While the PDAs are not yet in wide circulation, they may serve to stimulate take-up of high-speed services such as GPRS and 3G, because their larger colour screens are better suited for multimedia viewing and delivery. Also, in the mobile market as a whole, enhanced data services are fast becoming a lucrative source of revenue. Furthermore, mobile phones have the potential to provide wider access to the big Internet portals, due to their high penetration levels.

3.1.3 User adoption of high-speed mobile services

While simple data services have been the most successful aspect of the mobile Internet thus far, the introduction of 2.5G and 3G[13] mobile services could significantly increase the demand for mobile content. With a larger "pipe" through which to send and receive data, mobile users will be able to take advantage of MMS, use streaming audio and video, engage in interactive gaming, and have an always-on mobile connection at their disposal. While it may be tempting to compare 2.5G and 3G connections with the wired world's "broadband" connections, the two serve different purposes. The physical limitations of small, mobile devices and the slower overall speeds make 2.5G and 3G connections particularly suited to more targeted uses.

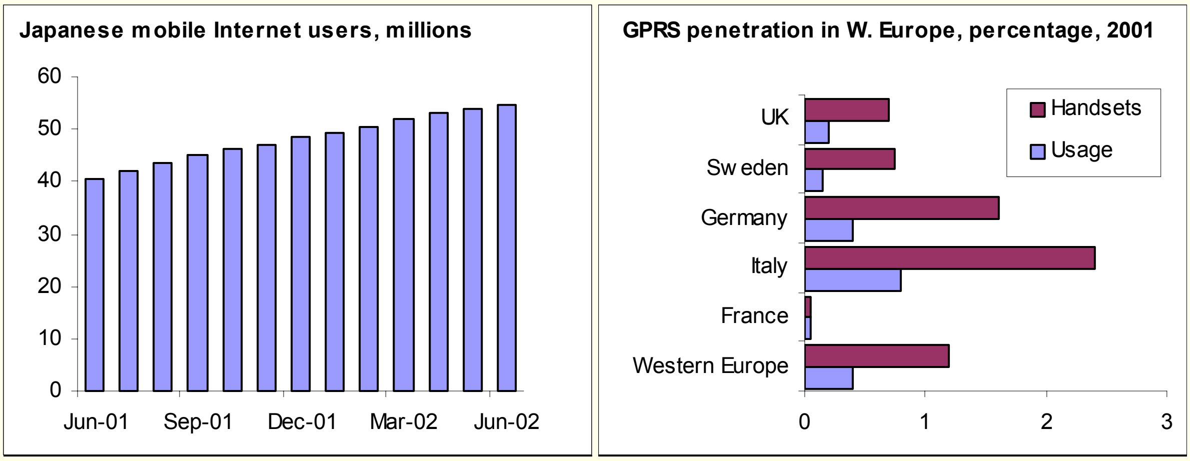
In 2001 and 2002, **GPRS** (2.5G) networks were launched in 49 economies, but their growth has been slower than expected by many operators. As of July 2002, 121 GPRS networks had been commercially deployed and a further 60 networks were in testing and implementation phases.[14] In the United States, GPRS has been launched by AT&T wireless and Cingular Wireless, which began providing the service in Seattle and are planning to extend it to other cities later in 2002.[15] In Western Europe, it is estimated that about 1.2 per cent of cellular users have a GPRS-enabled handset, but that only 30-35 per cent of those users make actual use of GPRS services (see Figure 3.6, right chart). The result is that the total number of GPRS users at the end of 2001 barely reached 1 million. This rather disappointing start is probably due to several factors, including the lack of handset availability, the high price of services and the lack of content and attractive applications.[16]

The other 2.5G standard in operation, **cdmaOne IS-95B,** has been successfully launched in Hong Kong, Israel, Japan, Korea and Peru. At the end of the first quarter of 2002, there were 43.2 million cdmaOne subscribers worldwide.[17]

3G **CDMA2000 1x** networks have been deployed in a number of countries, with Korea being the first to launch services. In Korea, the total number of CDMA2000 1x handsets sold has been growing at an cumulative average monthly growth rate of 16.8 per cent, to reach over 10 million in June 2002 (see Figure 3.7, left chart). In Japan, the number of CDMA2000 1x users on KDDI's networks has reached over 1 million. In fact, KDDI has terminated its sales of 2G handsets. Other countries that have launched commercial CDMA 2000 1x services include Canada (Telus and Bell Mobility), the United States (Metro

Figure 3.6: Mobile Internet users

In Japan (millions) and in selected Western European economies (as a percentage of all mobile users)



Note: Japanese mobile Internet user data includes DoCoMo's i-mode, J-Phone's J-Sky and KDDI's EZweb.
Source: Telecommunications Carrier Association, Japan (left chart), Analysys Research, 2002 (right chart).

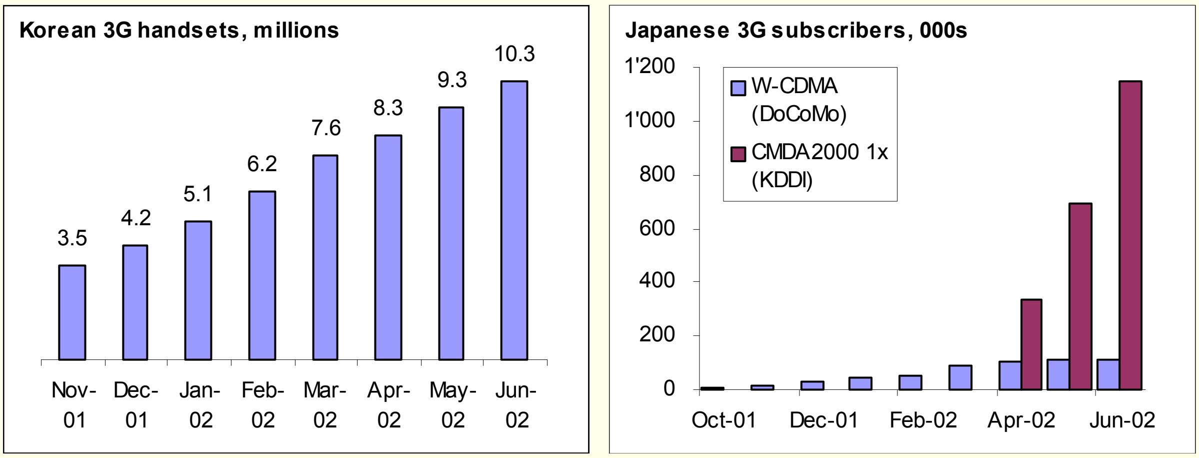
PCS), and Brazil (Telefonica), all in the Americas region. As of December 2001, there were 3.65 million CDMA2000 1x subscribers worldwide and, as of June 2002, that number had leaped to 11.5 million.[18]

The only 3G **W-CDMA** network in operation is DoCoMo's "FOMA" in Japan. In June 2002, DoCoMo's 3G subscribers reached almost 120'000 (see Figure 3.7, right chart). Europe will probably not see its 3G W-CDMA networks deployed until at least 2003.

Although Japan has unveiled fast 3G networks and is still reeling from the success of i-mode, there has not been a repeat of the overly-optimistic subscriber predictions that were made during the initial frenzy for 3G licences. In fact, DoCoMo, which launched **W-CDMA** 3G services in October 2001, issued conservative estimates in September 2001, forecasting 6 million subscribers on its network by 2004.[19] KDDI is slightly more optimistic and predicts 7 million subscribers by March 2003.[20] This is due to the fact that KDDI was able to upgrade its cdmaOne network to CDMA2000 1x more directly, whereas DoCoMo has had to build its W-CDMA networks from scratch, leading to more modest subscriber estimates.

Figure 3.7: 3G in Korea and Japan

Korean sales of CDMA2000 1x handsets (thousands) and Japanese 3G subscribers (000s)



Note: The left chart includes CDMA2000 1x handsets sold. These numbers do not refer to the actual number of subscribers of CDMA2000 1x services.
Source: Ministry of Information and Communication, Korea (left chart), Telecommunications Carrier Association (TCA), Japan (right chart).

On a global scale, the UMTS Forum has issued optimistic projections with a projected 170.3 million 3G users in the world by 2006 and 629.9 million by 2010[21], and 3G revenue growth from US$ 1 million in 2002 to over US$ 320 million in 2010 (see Figure 3.8). The UMTS Forum predicts that majority of 3G users will be in the Asia-Pacific region. This may not seem surprising, given that the first users of 3G were located in the Asia-Pacific region, where much of the success of digital content for mobile has been seen. Needless to say, it remains unclear just how successful 3G services will be on a global level. Much of their success depends on the availability and affordability of handsets, attractive billing plans and compelling content.

Although 2.5G and 3G connections are still in their infancy, they have the potential to provide a great boost to the mobile Internet, given the right blend of content and pricing. While predictions and estimates run the gamut, it is clear that users will soon have access to a much richer and faster multimedia experience through their mobile phones.

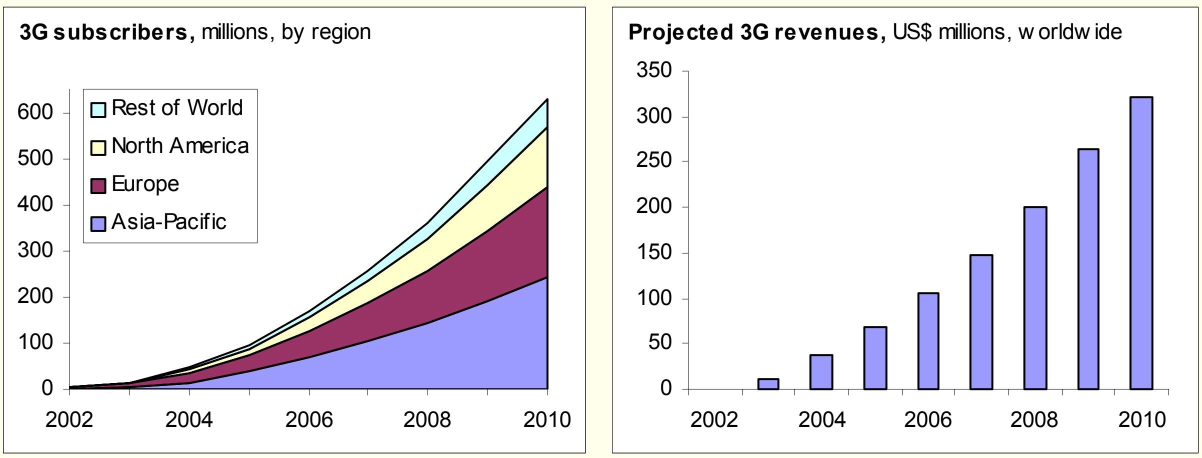
3.1.4 User expectations

Now that 3G is already a reality in many countries, and is on the verge of being deployed in others, the main question operators are now facing concerns the expectations of customers, i.e. what do future or actual users expect from their mobile phone? From a survey conducted by the Japanese Telecommunications Carrier Association (TCA)[22], it seems that mobile users would like to enjoy higher data transmission speeds, and the ability to exchange high-quality video clips and pictures.

The list of most popular mobile Internet services currently accessed by users confirm the result of the survey. In Korea, for example, online games, broadcasting and sport news represent 35.7 per cent of mobile Internet use, followed by e-mail (33 per cent) and news/stock information (16.3 per cent). This corresponds to a higher access of websites providing news, sport or e-mail browsing.[23] The pattern is no different in other parts of the world, such as Europe, where less technologically advanced applications (SMS, EMS etc) are used mainly to send and receive simple text messages[24] and to download ring tones and games.

However, 3G services are not only surrounded by expectations, but also by many doubts and obstacles, which prevent potential users from taking up new services. The above-mentioned survey by the Japanese TCA, confirms that the factors slowing the diffusion of the mobile Internet include the high cost of mobile services and handsets, the limited coverage area of new services and the lack of suitable content. Combined with technical problems, these hurdles are familiar as having been a major cause of the limited development of WAP services in Europe.

Figure 3.8: World 3G subscribers and revenues, predictions



Note: The left chart represents estimates.
Source: UMTS Forum.

3.2 Corporate strategies

The advent of the mobile Internet is likely to transform current mobile market structure and dramatically change the underlying logic for business strategy and development. This section examines the changing landscape in a converging world and the main barriers to entry for new players and established ones. It continues with a discussion of the evolving mobile Internet value chain. The necessary evolution of billing models for mobile data services is also considered. Finally, the section concludes with a summary of the determining factors for the success of the mobile Internet market.

3.2.1 New players, new roles

The transition from circuit-switched networks and voice-only services, to IP-based networks and the introduction of multimedia services will provoke a corresponding shift of value from transport to content. This will stimulate the creation of a number of new players looking to capture this emerging business opportunity as well as encouraging established players to consider non-traditional roles. In a voice-only environment, the two principal players are network operators and device manufacturers. In a voice only world, operators typically concentrate their efforts on the transport layer and add value through quality of service and network coverage. For their part, device manufacturers focus on innovations for the performance and functionality of the handset.[25]

With the advent of mobile data transmission, new roles have evolved around value-added services, such as application development, content creation, delivery and aggregation. New players making inroads in the mobile Internet market include media companies such as Vivendi, content developers such as Yahoo!, and financial service providers, such as Reuters. It can be said that new players and roles fall into four main groups: mobile or multi-access portals, mobile voice portals[26], mobile application service providers (MASP), and mobile virtual network operators (MVNO).[27] MASPs[28] are part of a growing industry sector resulting from the convergence of wireless technologies and service outsourcing. MASPs provide the same service to wireless clients as regular application service providers (ASP) provide to fixed-line clients, that is to say Web-based access to applications and services that would otherwise have to be stored locally. The main difference is that MASPs enable access to these services through a variety of mobile devices, such as mobile phones or PDAs. For their part, MVNOs[29] have been defined in a variety of ways. ITU defines an MVNO as an operator that offers mobile services but does not own its own radio frequency.[30] An MVNO can be a mobile service provider or a value-added service provider. It may carry its own network code and, in many cases, issues its own SIM card.[31] The regulatory landscape for the introduction of MVNOs is discussed further in Chapter four.

In an attempt to create direct relationships with end-users, while taking account of the increasing importance of value-added services, device manufacturers have begun to adapt their businesses towards a service provision model. One of the most popular mechanisms for this is the manufacturer’s “club”, whereby users can download ring tones, screensavers, and games. For example, Club Nokia[32] is a wireless Internet portal that allows owners of Nokia phones to access proprietary entertainment and information content. The manufacturer’s strategy involves bypassing its distribution customers (operators) by securing loyalty with its customers’ customer (the mobile phone user). As such, however, the manufacturer is not in direct competition with mobile operators, as it does not provide an Internet access service. In addition, access to the Club service is far from automatic: users have to purchase prepaid access cards through Nokia service shops. While the “Club” portal may give the manufacturer the edge over operators and content developers in the short term, this advantage is likely to erode over time. In the meantime however, it will have served to spur content development for the mobile industry as a whole.[33]

Device manufacturers are also contemplating entry into the MVNO space, as is the case of the PDA manufacturer, Palm. In this respect, manufacturers have an additional advantage over mobile operators, in that they have direct access to information regarding the timing and development of new features and capabilities on handsets. Their main aim is to decrease device replacement rates and thwart customer churn. However, in entering the content market, they are positioning themselves in direct competition with their key customers, mobile operators.

By taking on new roles, established mobile operators are entering the market through partnerships with new companies or the establishment of separate operations. They are striving to move beyond a business model of network provision to one of content provision. In Europe alone, more than 200 mobile portals have been launched, of which many are led by operators, including, Zed (Telecom Finland), T-Motion (Deutsche Telekom's T-Mobile), Vizzavi[34] (Vivendi/Vodafone) and Genie (BT, now O_2).[35] Despite some clear advantages over other players, such as control over connectivity, customer information, support and billing, many operators are concerned that they will become nothing more than a transport "pipe" through which other players will transmit and sell content. This concern is partially justified, given the general decline in average revenue per user (ARPU) for voice services and the wide array of new players entering the market. Operators are aiming to maintain and enhance their direct relationship with end-users, thus avoiding a scenario in which customer allegiance is directed increasingly towards content developers.

3.2.2 The balance of power

As mentioned above, there are a number of key roles in the mobile Internet arena, for which new and established players can compete. These roles include: content provision, content aggregation, service provision, device supply, payment processing and billing. The most important aspect will be the ability to own the relationship with the customer, which to a large extent determines a player's bargaining power. In this respect, mobile operators have a distinct advantage over content providers. However, a small number of successful wireline Internet content businesses, such as Yahoo! and AOL are able to leverage their expertise to create economies of scale in the mobile Internet. New players without a strong wireline presence, such as iTouch UK[36] and i3 Mobile[37] (MASPs), are positioning themselves between mobile operators and content providers, offering both content aggregation and content distribution services. These players, however, rely heavily on mobile operators for distribution. In terms of application development, mobile operators tend once again to retain the most bargaining power. Application developer companies or mobile game providers are generally small and are often under exclusive distribution agreements with operators.

Mobile commerce services offer one exception to the apparent dominance of mobile operators. Companies offering m-commerce or facilitating financial services are limited in number and subject to national banking legislation. Generally, therefore, mobile operators find themselves in a position of limited power vis-à-vis the banking world. This is also due to the fact that banks have been early adopters of information and communication technologies, and leaders in secure digital transactions.[38]

A 2002 European Commission report, prepared in conjunction with Accenture, analyses the bargaining power of the major players in the mobile value map, based on market share and company revenues. Their findings in four different geographical areas (Europe, Germany, Japan and the United States) are summarized below and set out in Table 3.1.[39]

In Japan, mobile operator DoCoMo holds the greatest bargaining power by virtue of its market share and close cooperation with device manufacturers. For example, its market position, and close partnership with handset makers such as Matsushita and NEC helped to make the i-mode service such a success. The introduction of value-added services also contributed to increasing DoCoMo's subscriber base. On the manufacturers' side, the new data services being offered were seen as a way to encourage users to upgrade their handsets. The Japanese content market was also stimulated with the introduction of i-mode, prior to which it had been highly fragmented, and Internet penetration had been surprisingly low.[40] The strategy adopted by DoCoMo ensured that content providers were given incentives for content development through revenue-sharing. In turn, DoCoMo exploited its market power to impose proprietary technical specifications and standards on content providers (such as mark-up languages) and device manufacturers (such as direct access buttons and larger colour screens).

The United States market, by contrast, is dominated by content providers and fixed Internet portals, such as AOL, Yahoo!, and MSN, which hold most of the bargaining power, together with 10 other companies. These top 14 companies controlled 60 per cent of user minutes as of March 2001, down from 110 companies in March 1999.[41] The shrinking number of firms that dominate the online content world makes it increasingly difficult for new entrants to compete. Handset manufacturers may actually see their market power decrease as PDAs and Pocket PCs become the devices of choice for mobile Internet access. In sum, bargaining power in the United States seems to be squarely in the hands of content providers, notably powerful media groups.[42]

Table 3.1: The bargaining power of industry players in the mobile value map

	Germany	Europe	United States	Japan
Portal provider	Unique visitors* 1 T-Online 7.3 mill 2 Lycos 5.7 mill 3 AOL 5.6 mill 4 Yahoo! 4.6 mill 5 Microsoft 4.2 mill 6 MSN 4.1 mill Source: Nielsen Ratings 06/01	Unique visitors* **1 MSN 20.8 mill** 2 Yahoo! 18.2 mill 3 Lycos 17.6 mill 4 Microsoft 16.8 mill 5 AOL 13.0 mill 6 T-Online 7.3 mill Source: Nielsen Ratings 06/01**	Unique visitors* **1 AOL 63.5 mill** 2 Yahoo! 54.5 mill 3 MSN 48.4 mill 4 Microsoft 25.7 mill 5 Lycos 22.0 mill 6 Excite 19.9 mill Source: Nielsen Ratings 06/01	Unique visitors* **1 Yahoo! 8.8 mill** 2 NIFTY 4.7 mill 3 MSN 4.2 mill 4 NEC 3.5 mill 5 Sony Group 2.6 mill 6 Microsoft 2.5 mill Source: Nielsen Ratings 06/01
Network operator	1 T-Mobil 40% 2 Vodafone 40% 3 E-Plus 14% 4 Viag 7% Source: GSM Standard 07/01 + company information	**1 Vodafone ca. 24%** 2 Orange ca. 13% 3 T-Mobile ca. 12% 4 TIM ca. 10% 5 BT ca. 7% Source: GSM Standard 03/01 + company information	**1 Verizon 25%** 2 Cingular W. 18% 3 AT&T W. 14% 4 Sprint PCS 9% 5 Nextel Dom. 6% 6 VoiceStream 5% 7 Others 23% Source: All standards 03/01+ company	**1 DoCoMo ca. 61%** 2 DDI ca. 20% 3 J-Phone ca. 19% Source: All Standards 06/01 + company information
Handset provider	1 Nokia 47% 2 Siemens 21% 3 Motorola 13% 4 Mitsubishi 5% 5 Philips 3% 6 Alcatel 3% 7 Others 8% Source: Expertenschätzungen/ Firmenangaben 07/01	**1 Nokia 49.2%** 2 Siemens 13% 3 Motorola 11'7% 4 Ericsson 10'5% Source: GFK, 06/01, 07/01	**1 Nokia 32%** 2 Motorola 24% 3 Ericsson 6% 4 Audiovox 6% 5 Kyocera 6% 6 Samsung 2% 7 Others 11% Source: The Yankee Group (2001)	**1 NEC 28.3%** 2 Matsushita 17.9% 3 Sanyo 9.7% 4 Mitsubishi 8.9% 5 Sharp 7.4% 6 Others 27.8% Source: Gartner (2001)

Notes: * Unique visitors: Number of visitors that visited a specific website, category, channel or application at least once during the course of the reporting period.

** Tendencies, based on figures from Denmark, Finland, France, Germany, Italy, Norway, Spain, Sweden, Switzerland, UK.

Source: Adapted from European Commission Directorate-General Information Society and Accenture, Final Report, "Digital Content for Global Mobile Services", February 2002, available at http://europa.eu.int/information_society/index_en.htm.

The European content market tells yet a different story. This is mostly due to the fact that Europe has a larger and more diverse market, comprising a number of economies and languages. In Europe as a whole, handset manufacturers such as Nokia and operators such as Vodafone seem to be operating on an equal footing in terms of market share and revenues. However, on a country-by-country basis, this may not always be so. In Germany, for instance, most of the bargaining power rests with the dominant mobile operator, T-Mobile. The content industry in Europe is also still highly fragmented. This essentially stems from Europe's cultural and linguistic diversity, and has made the creation of pan-European media companies difficult. The availability of content remains limited, driving costs upward. Consequently, revenue sharing arrangements between content providers and operators are not easily reached. In the future, however, the bargaining power of device manufacturers is likely to decrease, as the manufacturing market expands to include a larger number of foreign firms (such as Japanese NEC and Matshushita), as well as PDA and Pocket PC makers. The media industry is also likely to see more attempts at the creation of regional or pan-European media groups. The European mobile content market will nonetheless remain fragmented for some time to come, while mobile operators seek to gain bargaining power through partnerships and increased consolidation.

3.2.3 Getting together: partnerships in a converged world

The development and licensing of high-speed third-generation services, in some cases at high costs[43], triggered a wave of consolidation and partnerships agreements between mobile operators not wishing to miss out on the "trillion dollar opportunity".[44] In Switzerland's race for 3G licenses, for instance, the TeleDanmark[45] merger of diAX and Sunrise[46] led to the withdrawal of one bidder and the temporary postponement of the auction. In Korea, the two of the consortia established to bid for 3G licenses have more than 500 members and the third has more than 1'000. Moreover, many mobile operators are looking beyond their borders to acquire new customers. In Europe, Vodafone[47] has been investing in a number of European operators and has major investments in Verizon (United States), Iusacell (Mexico) and Japan Telecom (Japan).[48] Germany's T-Mobile[49] (Deutsche Telekom) now owns US-based VoiceStream, UK's One 2 One, MaxMobil in Austria, RadioMobil[50] in the Czech Republic and also has majority stakes in other Eastern Europe and South-East Asian wireless carriers. Deutsche Telekom is rebranding its companies to prepare for a public offering of T-Mobile shares in 2002.[51] Similarly, France Telecom[52] is expanding with its purchase of UK's Orange[53] and Germany's MobilCom.[54] Norway's Telenor and Finnish operator Sonera also have a number of international investments.[55] In Asia, NTT DoCoMo[56] is one of the few operators to have significant investments in non-Asian markets, with a stake in AT&T Wireless (US) and KPN (Netherlands).[57] In the United States, most international investments have occurred primarily in other North American markets. For example, Verizon has invested in Mexico's Iusacell and Canada's Telus[58], Sprint has invested in Mexico's Pegaso and Rogers Canada[59], and VoiceStream owns a stake in Canada's MicroCell.[60]

The various facets of the mobile Internet value chain will present significant opportunities for increased cooperation. In fact, collaboration and consolidation are said to be key in a increasingly digital economy and companies can clearly longer afford to operate in isolation. The expansion of mobile data communications requires added functionality such as content aggregation, transactions management and security services, and no one player can satisfy all of these roles.

Companies have been coming to terms with the dynamics of this new environment and are joining forces. Partnership agreements are being struck between companies in complementary but also competing industries.[61] Yahoo! and AOL are pursuing partnerships with handset manufacturers. AOL Time Warner and AT&T have signed joint agreements to market and sell products. In Japan, manufacturers NEC and Matsushita together with KDDI and Japan Telecom have created an ISP consortium, launched in June 2002, with the aim of cutting costs and developing more compelling content.[62] In the world of operating systems, Symbian, the developer of the popular operating system for Psion PDAs is now collaborating with 3Com, the owner of the Palm Operating system.[63] Industry experts predict that this collaboration may eventually set the standard for mobile operating systems.[64] In June 2002, some 200 mobile operators, device and network suppliers, information technology companies and content providers formed a new global organization for the development of mobile services, known as the OMA or Open Mobile Alliance.[65]

As far as service development is concerned, mobile retailing (or m-tailing, as it is sometimes called), is a key area that will require a number of partnerships. Mobile operators cannot function independently in a world that will be progressively dominated by the distribution and delivery of goods, content aggregation and credit risks. This means that operators, banks and portal service providers need to tailor systems and solutions in cooperation with system integrators. Moreover, for the inclusion of adequate security features and user-friendly interfaces, the cooperation of device manufacturers and software houses is also indispensable.

In order to encourage the adoption of mobile financial services, banks have formed consortia among themselves and with handset manufacturers. It may not be long before banks and telecom companies overcome the distance between them to similarly join forces.[66] Mobile phones may eventually become the tool of choice for cashless payments and this for three compelling reasons: almost everyone has one, they are all connected to a network and they all provide the possibility of secure authentication. One banking consortium, the "Mobey Forum"[67] is working to facilitate the open provisioning of mobile financial services and obtain interoperability of technical and security requirements for the mobile finance industry. Mobey brings together the online banking experience of leading banks with the expertise of technology companies focusing on the mobile Internet. The Forum plays the active role of intermediary between the various standards committees of the mobile industry and financial sector. Handset manufacturers have also joined forces to create the Mobile Electronic Transaction Initiative (MeT).[68]

In another initiative, credit card companies teamed up with mobile operators to form the Mobile Payment Forum[69] in March 2001. The objective of this Forum is seen to complement the work that is already being done by other industry initiatives such as Mobey and MeT. Thus far, however, developments in mobile payment and transaction services have primarily been led by banks. Banks have not had much incentive to partner with mobile operators for a number of reasons: they already have an individual relationship with customers, their customer base is large, and they have a number of long-standing security considerations. Moreover, they do not feel the urgent need to implement a micro-payment system. Thus, although operators are playing an enabling role in mobile financial services, banks are leading the market. Whereas operators can be active in the m-tailing market, they will have to "become" regulated banks in order to be significant players in the mobile commerce and banking world. By contrast though, it seems that credit card companies are keener to partner with operators, for example through initiatives such as the Mobile Payment Forum.

3.3 Barriers to entry and market development

There are a number of barriers to the development of the mobile Internet market. The first of these is the need for partnerships. As mentioned above, for the mobile market to develop, players must move away from an isolated service provision model. However, some partnerships have had a poor success rate due to the lack of trust between partners and mismatched expectations.[70] Partnerships or acquisition strategies can often result in prolonged discussions with partners, and diluted revenue expectations, leading to delays in service deployment. Another barrier is, in some cases, the high 3G licence and network infrastructure costs operators must incur. This has forced carriers to cut corners at the expense of investing in key technology enablers such as user localization and billing systems. These investments are pivotal to the creation of compelling content services. Other factors hindering development include the lack of handset availability, open access and revenue sharing. Each of these factors is considered below.

3.3.1 Availability of handsets

There has been much concern in the industry over the limited availability of handsets. In many cases, although mobile Internet services had been commercially deployed, users could not avail themselves of them due to the lack of suitable products on the market. The deployment of GPRS services in Europe was plagued with handset delays. Moreover, handset availability was cited as one of the reasons for delays in the NTT DoCoMo and Manx Telecom[71] 3G launches.[72] Moreover, the absence of economies of scale means that when handsets become available, they are typically expensive. High handset costs mean lower service take-up. This will eventually impact operator revenues and in turn decrease their ability to subsidise handsets. Not only are handsets expensive, but those handsets on the market are often incapable of providing optimum service delivery. As the number of handsets with the requisite functionality for capturing and viewing content in an attractive manner is limited, there is an underlying justification for key players to adopt a "wait and see" attitude.[73] This inhibits market growth.

Another barrier to the adoption of mobile Internet technologies is the general decline in handset subsidies. In Europe, GSM handsets were usually subsidized for first-time users, that is to say offered in a "bundled" service package. Such subsidies have since been declining and are typically unavailable for replacement handsets. Moreover, GPRS handsets are not seeing the same level of subsidies as GSM handsets. This is due to three main reasons: the mobile market is reaching saturation, there is increased competition, and operators are trying to recoup the high prices they have had to pay for 3G licenses. In Korea, the Government has banned handset subsidies altogether and, in April 2002, imposed fines on operators that still provided subsidies to their end-users.[74] One of the few places where subsidies seem to be on the rise is Japan, at least where CDMA2000 1x services are concerned. KDDI has been heavily subsidizing handsets for its 3G users, offering them at a wholesale price of US$ 74.64, instead of the retail price of US$ 381.49.[75]

3.3.2 Open architectures and open access

In the early days, mobile operators made several attempts to develop their own content and applications, restricting users to "walled garden" portals. Efforts are now under way to develop open service platforms, and to provide open access to networks (see Box 3.1). Associated regulatory developments are further discussed in Chapter four.

Box 3.1: Opening up the networks in Japan

At the moment, i-mode users can only access the Internet through DoCoMo's gateway. DoCoMo plans to open up its networks for i-mode to other ISPs in November 2002, while KDDI already opened up its portal for EZweb in October 2001. As at mid-2002, mobile Internet services are provided through closed networks owned and operated by carriers. The 3'000 plus i-mode official sites provide a wide array of services through DoCoMo's servers and networks. The operator came under serious scrutiny in 2001 regarding its closed content policy. It had planned to open its networks in March 2003, but brought the deadline forward to November 2002 after pressure from various industry players and Government. Soon, DoCoMo users will be able to use their own ISP to gain access to the Internet via their mobiles. The largest ISP in Japan, Nifty, is now preparing to launch its services through DoCoMo's gateway.

The Government is now taking this a step further. A body for the telecommunications ministry, MPHPT[76], compiled a report last June 2001, recommending that content providers and ISPs jointly set up an organization to decide the criteria for selection of mobile sites. This would replace the current system whereby mobile operators unilaterally decide which sites are "official" based on their own criteria, and bill users for access to these sites on the part of content providers. For instance, carriers will release customer identifications only for official sites, and in return, will collect content fees for content providers. Content providers claim that screening standards are non-transparent and that the treatment of official sites is discriminatory. The second recommendation is to encourage operators to collect charges for unofficial and well as official sites.

In December 2001, the MPHPT proposed a government-industry initiative for the evaluation of mobile content development. However, the Ministry and Japanese operators could not reach an agreement. The MPHPT has stated that it is hopeful that operators will follow the lead of others such as KDDI in loosening approval criteria for offical sites.[77]

Source: MPHPT, Japan.

Operators are no longer creating applications and content in solo, but are increasingly adopting a role of facilitator and aggregator. It is evident that both industry players and end-users will benefit from an open business environment—a kind of "ecosystem" for the mobile Internet. As stated by Nokia in a press backgrounder:

> "*In order to prevent the fragmentation of services, control of the mobile Internet must not be conceded to any one company. On the contrary, the only way to ensure that the concept of personalized communications works universally for one billion plus users in any network environment and with any type of access, is to have open standards and seamless interoperability in the industry*."[78]

In November 2001, Nokia and NTT DoCoMo headed a joint action plan to accelerate the development of the mobile Internet based on the "open mobile architecture" initiative.[79] The initiative brings together the major handset makers and the world's largest mobile operators, including AT&T, Vodafone, Symbian and Sony Ericsson.[80] The industry is hoping to avoid a situation in which a number of different standards exist, thus preventing economies of scale and global service availability. Member companies will develop software in compliance with the technical specifications of bodies such as the WAP Forum and 3GPP.[81] Nokia stresses that "middleware" software, which enables connectivity, is a crucial element that should be licensed as source code[82], openly and on equal terms to all companies. This may serve in part to address the problem of lack of compatibility and interoperability between handsets and services.

3.3.3 Sharing the revenues

One of the key requirements for the development of the mobile Internet is the availability of digital content on mobile devices. For this reason, it is important to create a framework that encourages content providers to develop content. In a world in which mobile operators keep all revenues from traffic and have a direct billing relationship with end-users, content providers have few incentives to invest in content development. In most markets, this has been a bottleneck for the development of the mobile Internet. Most operators have yet to develop revenue-sharing schemes or business models that incite content developers to partner with them. Alternatively, cost-cutting policies, in some cases due to high 3G license costs, have made operators increasingly demanding when negotiating revenue sharing agreements. One notable exception is the business model adopted by DoCoMo for its i-mode service, in which the operator bills for official sites and keeps only 9 per cent of the revenues from the content service, the rest being passed on regularly to the service provider.

In Korea, operators are offering a "walled garden" content model, with revenues split between content provider and service providers in a ratio of 90:10. KTF Mobile has more than 130 content providers and SK Telecom more than 250. In theory, therefore, content providers should get 90 per cent of any revenue raised from the sale of content. In practice, however, the majority of revenues (around 70 per cent) come from airtime (per-minute) charges for using the mobile phone and are wholly retained by the operator.

3.4 Creating value and charging for it

3.4.1 The mobile Internet value chain

While the value chain in a voice-only mobile world is fairly straightforward, it becomes much more complex in a converged mobile Internet environment. The new environment will be multi-faceted, with revenues being shared between mobile operators, third party application developers, content and media providers with which they form partnerships and alliances.[83] As mentioned earlier in this chapter, it is an environment in which no single player can have all the necessary capabilities to offer a comprehensive service. In an attempt to keep up with constantly evolving market conditions, players are re-positioning themselves along the value chain. The European Information Technology Observatory (EITO) categorizes the mobile Internet value "web" into three main market areas: technology, applications and services. The technology area refers to network equipment vendors, manufacturers, and companies providing enabling technologies. The application area includes application providers, content providers and application developers. The services area includes mobile network operators, virtual operators and portals. Figure 3.9 outlines these various players and their interdependency.

Although voice will continue to dominate mobile services for some time, premium content revenues will be significant in the longer term and crucial to brand building. With the growth of digital content and applications, it is important for all players in the market to extract the maximum value from the evolving value chain. The digital content space remains an area of uncertainty at the moment, as players struggle to meet user requirements and manage expectations. What is clear is that the mobile portal will be an important catalyst for the development of a healthy mobile Internet market: it is not surprising that mobile operators have tried to move into this space.

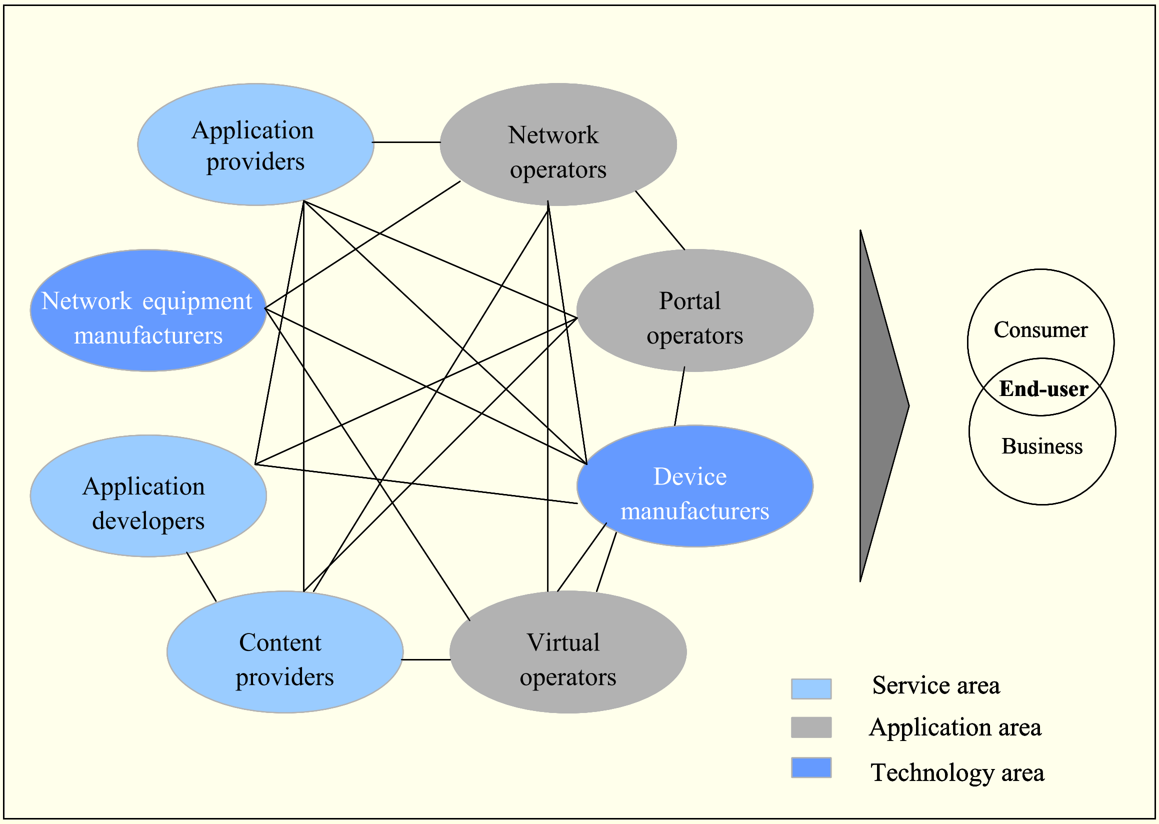
Operators are now shifting their business models towards other value-added elements, rather than focusing on the transport layer. The battleground, as shown in Figure 3.9, revolves primarily around gaining access to the customer. In this respect, operators are currently in an advantageous position due to their existing billing relationship with customers. It would seem that in Europe and the United States, handset manufacturers also have an added advantage in that there is a chronic lack of handsets on the market. This factor, which has caused delays in the deployment of GPRS and 3G services, allows manufacturers to command higher retail prices for handsets. However, manufacturers lack the established and direct relationship with the end-user. As mentioned in section 3.2.1, attempts to establish a relationship through initiatives such as "Club Nokia" are proving partly successful. In Japan, there is a unique rapport between operators and manufacturers—one of collaboration, rather than competition. There, the brand rests firmly in the hands of the operator, as handsets are manufactured and labelled according to the operators' dictates.

3.4.2 The evolution of billing models

Billing parameters

With the advent of high-speed mobile data services, the traditional elements used by operators for billing purposes are gradually losing their relevance. The notion of "time" on a network is fading as network connections move towards an "always on" platform. The idea of "distance" is also on the way out, particularly in a world where IP addresses are ubiquitous and always "local". Billing strategies are therefore migrating towards concepts such as "volume-based", "data type" and "flat-rate".

Figure 3.9: Main players in the mobile data value web



Source: European Information Technology Observatory 2002, 10th edition.

In a 2002 report, the UMTS Forum identifies a number of parameters that can be used to determine the price of a given 3G or mobile Internet service: subscription, duration, destination, location, volume, network, device capabilities, quality of service, service termination indicator, event, transaction type, transaction value and content.[84] These parameters are defined as follows:

- **Subscription:** A great number of services will be based on a monthly subscription (or a recurring charge) giving unlimited access to a specific service. In some cases, a cap may be imposed on usage, with additional charges payable by high-volume users.

- **Duration:** Services can be billed in terms of the length of time (minutes) associated with the delivery of a service. This is a fairly transparent billing mechanism for users and has been used in traditional circuit-switched networks for voice billing as well as data billing. This may continue to be used in future data networks for low-bandwidth applications.

- **Destination:** In some cases, billing may be related to the termination of access. This is the traditional charging method for long-distance and international telephony. This type of charging will be rare for accessing digital content over high-speed mobile networks. The Internet, for instance, has no distance-dependent tariffs.

- **Location:** The location, from which the user is accessing the network, can also play a role in user billing. For instance, it can be used to impose preferential or premium rates for access in certain congested areas, e.g. urban areas, airports.

- **Volume:** Volume will become one of the most crucial parameters for mobile data billing. Services requiring the delivery of large amounts of data could be charged according to the volume of data requested by the user, e.g. video streaming, gaming. The exact measure of volume to be used can vary (e.g. in Japan, "packets" are used and early GPRS services bill per megabyte). This is a much less transparent billing system for users, who may find it rather difficult to evaluate or predict the volume of data transferred in any given event.

- **Network:** Like in the case of GSM, high-speed mobile data providers plan to offer global roaming. This will no doubt come at a premium price, depending on which network is being accessed.
- **Device capabilities:** According to the UMTS Forum, billing systems should be developed in order to allow service providers to bill users based on the capabilities of devices, notably in terms of the amount of data a given terminal is equipped to download.
- **Quality of service (QoS):** In simple terms, quality of service can include five elements: peak bandwidth, average bandwidth, delay or latency, reliability or error rate, priority or precedence. Certain services require higher or lower quality of service. Service providers may be able to charge according to the quality of service required for a particular service, or give rebates when that quality of service was not achieved.
- **Service termination indicator:** If a service is terminated abnormally, users could be compensated through a reduction in charges.
- **Event:** An "event" is one of the newer concepts for data service billing. An event can consist of an e-mail or a short message resulting in a product or service being ordered. Events can be charged either in terms of quantity, or in terms of value or quality (e.g. transaction type and value, content type—see below)
- **Transaction type:** This type of charging focuses more on the value of the service. Some transaction types, for instance the secure and timely purchase of shares, are of more value than others.
- **Transaction value:** Another parameter that can be used in billing is the value of the transaction, particularly in cases where the network operators is billing on behalf of a third-party content provider.
- **Content type:** Billing according the actual content being accessed is perhaps one of the most complex billing methods. Examples include artist-dependent MP3 downloading, and timely stock pricing.

Since always-on 2.5G and 3G services are not yet widely available on the market, billing models for a converged environment have not been fully developed. Current mobile Internet pricing schemes tend to take the four following elements into account: subscription cost (typically per month), airtime cost (per minute), data volume cost (typically per packet) and the cost of specific content (per-content or per-month). In the transition from low-speed to high-speed data services, service providers tread a fine line between pricing a new service too cheaply (and risk undercutting older and established low-speed data services) and pricing it at too high a level (thus stifling the market). In order to address this, operators have been attempting to differentiate their prices according to service type. In Korea for example, where such differentiated pricing is applied, US$ 1.00 will buy 91 kb of text messaging, 236 kb of multimedia messaging, or 0.45 Mb of audio/video on demand. Other examples of billing models and tariff plans for the mobile Internet are discussed below.

Billing for connectivity

In the 2G GSM world, billing for data has not been significantly different than billing for voice: users have been charged for WAP services according the amount of time spent online. This meant that users were punished for the slow downloads imposed upon them by the 9.6 kbit/s transmission speed of the circuit-switched network. This was one of the main reasons for low user adoption.

The best examples of evolved data billing in the 2G world are i-mode and similar services in Japan, such as EZweb. The i-mode billing model is straightforward and fairly equitable. Because i-mode uses a packet-based network for data transmission, mobile phone users are billed according to the volume of data they download: each packet, or 128 bytes, costs JPY 0.3 (0.2 US cents). In addition, they are charged a subscription fee of JPY 300 (US$ 2.41) per month for access to official sites. Some content providers charge an additional fee of JPY 200-300 per month. In the case of official sites, DoCoMo bills the user directly and keeps a 9 per cent commission fee, while forwarding the rest to content and application developers. As mentioned earlier, this has helped spur the content market.

With the arrival of higher-speed always-on networks, operators in other parts of the world are beginning to re-evaluate their billing strategies. Upon launch, 2.5G services such as GPRS were billed according to the total volume of data downloaded, rather than the time spent online (unlike WAP over GSM which was typically billed in the same manner as a per-minute voice call). However, tariffs differ significantly from operator to operator and from country to country. In Western Europe, the average GPRS consumer tariff is US$ 6.37 for monthly access and US$ 3.60 per Mb. But users can pay up to US$ 100 on E-Plus (Germany), Swisscom Mobile (Switzerland) and Omnitel Vodafone (Italy) networks (see Table 3.2). One megabyte is roughly equivalent to downloading 800 WAP pages, but only 20 standard HTML pages on a mobile device.

It is not surprising, therefore, that service providers have looked towards flat-rate pricing in an effort to render service costs less prohibitive and tariff plans more transparent, particularly in North America. In Europe, Austria seems to have the most favourable flat-rate tariff plan, and is one of the larger markets for GPRS, reporting a total of 35'000 GPRS subscribed users out of 60'000 GPRS device owners.[85] In India, BPL Mobile is imposing a flat fee of Rs 750 per month (US$ 15.40) for unlimited use (plus an activation fee of US$ 24.6). More recently, in May 2002, Orange launched a flat-rate mobile Internet service in France.

The service will cost US$ 5.68 on launch and should be available in other European countries by the end of the third quarter of 2002. The flat rate will be available to customers with either GPRS or WAP-enabled 2G handsets. For an introductory period (until September 2002), users will have unlimited access to websites. After that date, a cap of 10 Mb per month will be imposed.[86]

Table 3.3 sets out the tariffs for 3G services in Japan. It is important to note that there are a number of differentiated pricing plans on offer by Japanese operators. For example, DoCoMo offers five different "Packet Pack" discount plans for its 3G service, depending on user preferences. The retail price for data transmission over 3G networks is either less than or equal to 2G networks. A user adopting the 3G "Packet Pack 20" charging plan, would spend about US$ 22 for 5Mb of data, whereas they would spend about US$ 102 for the same amount of data over a 2G network. In reality, the cost could be even lower depending on the amount of data downloaded. The billing model in Korea is fairly similar to the Japanese model, but does not include a monthly subscription price for data services. In Korea, the approximate charge for a 1Mb transmission would be US$ 4.22. In countries like Japan and Korea, at least, the notion that 3G services come at a premium is a myth.

Table 3.2: Examples of GPRS tariffs in selected countries, 2002

Country	Operator	Monthly Tariff (US$)	Number of Mb included	Cost per additional Mb (US$)
Austria	tele.ring	14.45	20 Mb	1.38
Canada	Microcell	47.7	25 Mb	1.9
Croatia	Hrvatski Telekom	3.49	0.1 Mb	1.8
Hungary	Pannon GSM	16.56	3.9 Mb	2.29
Italy	Omnitel Vodafone	0	0	22.45
Singapore	MobileOne	0	0	2.8
Switzerland	Swisscom	0	0	13.0
United States	AT&T Wireless	29.99	5 Mb	7.17

Note: The above are representative tariffs only. Bundled (discounted) mobile Internet packages may also be on offer.
Source: Operator data, Cellular News.

Table 3.3: Billing for 3G services in Japan

Operator (service)	NTTDoCoMo (W-CDMA:i-mode)			
Transmitted data size	**1Mb**	**5Mb**	**20Mb**	**100Mb**
Discount service	–	PP20	PP40	PP80
Basic monthly charge (US$)	0.85	0.85	0.85	0.85
Charge per packet (US$)	0.0017	0.0009	0.0004	0.0002
Additional basic monthly charge of discount service		17.06	34.12	68.24
Charge per packet over the basic monthly charge		0.0009	0.0004	0.0002
Monthly charge (US$)	14.18	34.17	67.49	134.13

Operator (service)	KDDI (CDMA2000 1x:EZweb)			
Transmitted data size	**1Mb**	**5Mb**	**20Mb**	**100Mb**
Discount service	–	PacketOne Middle Pack	PacketOne Middle Pack	PacketOne Super Pack
Basic monthly charge (US$)	2.56	2.56	2.56	2.56
*Charge per packet (US$)	0.0009	0.0009	0.0009	0.0009
Additional basic monthly charge of discount service		20.47	20.47	72.50
Charge per packet over the basic monthly charge		0.0003	0.0003	0.0002
Monthly charge (US$)	9.22	23.03	37.42	131.57

**Note:* This charge is applied for each transmission (sent or received) of over 100 packets between 0100 hours and 1700 hours.
Source: Operator data from DoCoMo (top table) at www.nttdocomo.co.jp, and from KDDI (bottom table) at www.kddi.com.

Billing for messaging services

At present, incoming SMS messages are free and the average charge for sending an SMS message in Europe is around US$ 0.19, providing the mobile phone user is on the home network. Nearly all GSM handsets on the market today are SMS-enabled. In Asia, the cost is typically lower due to the availability of bundled messaging offerings. Web-based SMS (sending a text message from the Internet to a mobile phone) is typically free of charge and service providers earn revenues through advertising.[87] Industry observers argue that compared to the low-cost of SMS[88], the retail charge per message is in some cases excessive. In fact, European operators have been seen to increase their charges for the low-cost technology since they became aware of its success with users.[89] In addition, the non-transparency of mobile roaming charges in Europe has been carried over to this early data service: it remains unclear to the average user what the cost of receiving or sending a message to and within a foreign network will be.

In the UK, the four carrier network operators, O_2, Orange, T-Mobile and Vodafone all plan to launch MMS message services by December 2002—a move which is likely to provoke a price war. T-Mobile revealed that it plans to charge US$ 30 per month for its MMS services and also plans to subsidize the Sony T68i (the handset comes with a snap-on camera) by half. The cost of the handset will still be US$ 298, but will compare favourably to Nokia's 7650, priced at US$ 600 prior to its launch in July 2002. The Portuguese market, which already has two competing operators, also provides a good indication of pricing for MMS services. Both TMN and Vodafone Telecel charge US$ 0.41 per multimedia message. To encourage early adopters, TMN is offering twenty free MMS per month until 31 October 2002, but will not be offering the service to prepaid users. Unlike T-Mobile, the operator does not plan to subsidize the T68i handset, which will cost around US$ 756. TMN's handset and Telecel's handset are priced at US$ 434.69 and US$ 470.72 respectively. In the UK, T-mobile is offering MMS on a flat fee basis, charging US$ 29.00 per month in addition to the monthly subscription tariff, allowing users to send a maximum of 10 Megabytes of MMS messages per month. In The UK, the T68i handset with camera is priced at US$ 290.21. Nokia has favoured a per-message billing system, rather than a flat rate, charging 47 US cents per message. Though initial billing methods may differ, outcries from user groups regarding the cost-orientation and transparency of messaging rates, combined with the high take-up of messaging services, will probably drive operators to resort to flat-rate billing.

Billing for portal and content services

Since the early Internet days, there has been significant debate about whether users will be willing to pay for content. In terms of connectivity and messaging, the precedent has already been set with SMS, WAP and i-mode, while its predecessor in the content market, the fixed Internet, is based on a predominantly free content model. The digital content market for mobiles is, however, much more complex.

Today, a very small percentage of mobile revenues stems from paid content. However, many service providers believe that it is critical to charge for content and that the free content model is not a sustainable one. Others argue that charging for content will bear little fruit, given that most of it is seen as generic and low in value. Mobility, location and time-sensitivity are seen as critical factors in adding value to mobile content. Most industry observers do agree that in the mid to long term, charging for mobile content will become commonplace. An important development in the billing of portal services is that operators are increasingly considering the establishment of reverse billing arrangements with independent content providers. These arrangements allow the operator to bill the customer directly for content, and passes on a proportion to the content provider (as is the case of i-mode, for example). Moreover, mobile transactions will eventually provide additional revenues for operators, particularly where a fee is imposed for each transaction.

In the case of mobile entertainment services, the UMTS Forum has recommended direct user billing, with advertisement-based services being free of charge. In the case of multimedia messaging services offered by portal operators however, mobile operators may be involved in third-party billing depending on whether or not the portal operator has secured a direct relationship with the end-user. In the case of mobile Internet browsing, operators typically provide Internet access and bill the end-user.

In either case, it remains clear that as bandwidth increases and newer applications appear on the market, the method by which service providers charge for services must evolve. With mobile content becoming more plentiful and diversified, service providers will tend to gravitate first towards volume-based billing, and eventually towards billing systems that take into account the "value" of the content to the user. This will apply particularly to bandwidth-hungry applications such as video-conferencing.

The potential of advertising

A number of new possibilities emerge for targeted advertising through mobile devices. There are three principal advertising methods in the online world: banner advertising, content advertising and sponsorship. Banner advertising is ubiquitous on the fixed-line Internet, and advertising companies are now evaluating its relevance for mobile networks. Banners facilitate the analysis of user click-through rates (CTR), thus providing valuable insight into usage patterns. Content advertising refers to the development of websites that inform users about the products or services of other companies. This service, which users can access free of charge, is typically financed by the companies that are listed on the site. Finally, sponsorship opportunities allow companies to sponsor different content packages in exchange for visibility on content sites.

The main barriers to successful advertising on the mobile Internet are screen size and user interest. Traditional Internet banner advertising may be too disruptive and insufficiently personalized to entice the mobile user. Content advertising however, could provide an incentive for users to use the services and for companies to enlist. Other initiatives that may bear fruit include the exchange of prizes or credits for advertising. One Japanese website, "Kenshou", provides a good illustration of this kind of promotional advertising.[90]

3.5 Conclusions: the economics of success

Both Internet and mobile phone usage have grown faster than anyone had initially predicted, bearing witness to the insatiable human appetite for communication. Mobile phones have the potential to extend Internet access to the world's near one billion mobile users and will fulfil an increasingly prominent role in information delivery. But experience has shown that the recipe needs to be right: while some data services, like SMS and i-mode, have been extremely successful, others such as WAP have failed to find wide acceptance. It is clear therefore, that future data services will need to be cost-effective and easy to use if they are to have any success with users.

Fascinating developments in the mobile industry have transformed the nature of services on offer. These in turn have brought about a changed market structure: Data networks are converging with traditional voice-only networks, new players are appearing, and established players are expanding and innovating their services. Meanwhile, customer loyalty continues to be sought by all players. To this end, operators are struggling to retain and exploit their billing relationship with end-users, while content providers and manufacturers are seeking to establish theirs. It is also beginning to dawn on companies that they can ill afford to act alone. The high cost of network development, installation and exploitation force this realization. So competition between players is being tempered by increasing cooperation and collaboration.

The rapid development and deployment of mobile Internet services is dependent on a number of conditions. Most important of all is the deployment of high-speed 2.5 and 3G networks. This will be crucial to the creation of new multimedia applications. Next, and just as important a requirement, is the availability, adequacy and affordability of handsets, without which data services cannot spread. Furthermore, players should be discouraged from imposing commercial restrictions on content providers or establishing "walled gardens" of content—users will typically expect some cost-free access to non-proprietary mobile Internet content. Finally, billing models should be simple and transparent, with distinctions between voice services, data services and access to content. Overall, the mobile Internet should not be considered a substitute for the fixed-line Internet, as usage patterns and requirements for Internet browsing via mobile devices differ significantly from those of the traditional Internet.

It goes without saying that in a free market, billing schemes have a direct bearing on the availability of services and their variety. The evolution of the fixed-line Internet, particularly during its early stages, furnishes a good example. To begin with, surfing the Internet attracted per-minute usage-based charges. Thereafter, in most countries, operators adopted billing systems based on subscriptions plus a reduced per-minute charge. In countries where local calls are billed on an unlimited basis, like the United States and Canada, flat-rate plans became available in 1997. Countries in Europe and Asia soon followed suit. The development of the mobile Internet appears to be following a similar course. In the early days of WAP over GSM, users were billed for every minute they spent online. Subsequently, i-mode combined monthly subscription with volume or packet-based billing, and always-on GPRS has brought with it billing using volume-based charges. With high-bandwidth applications and increased spectrum efficiency, will flat rates become the norm for mobile data, as they have done for fixed data? Although flat-rate schemes for data services are already being considered by a number of mobile operators, users will have to wait some time before these become widely available.

Unlike the fixed-line Internet, access to mobile communications has always come at a premium. Small wonder then, that content on the mobile Internet is similarly priced. The fixed-line Internet established a tradition of largely free and non-proprietary access to all manner of data and information. Accordingly, Internet users have started to expect content services and unlimited messaging (e-mail) free of charge. Mobile users, by contrast, seem quite willing to pay per message for SMS, per packet for i-mode content and high rates for voice calls while roaming. Moreover, a direct relationship exists between the mobile user and operator, facilitating billing for a variety of add-on services. This was not typically the case with fixed Internet access. On the whole, this bodes well for the future of paid digital content services on mobile devices. Combined with high worldwide mobile penetration and short-range technologies, it may eventually mean greater success for mobile business-to-consumer commerce than has hitherto been seen over the fixed-line Internet.

[1] For the purpose of clarity, Hong Kong, China is hereinafter referred to as “Hong Kong”.

[2] ITU Data: Predicted relationship between GDP per capita and Internet users given by: Users = 3.68147 + 0.00112 * GDP per capita with an R^2 of 0.45.

[3] ITU World Telecommunication Development Report: Reinventing Telecoms – World Telecommunication Indicators 2002.

[4] See “GSM Statistics”, June 25, 2002, GSM World at http://www.gsmworld.com/news/statistics/index.shtml.

[5] See “Over Five Million “Sha-Mail” Handset Devices Now in Use”, 7 June 2002, J-Phone, at http://www.j-phone.com/h-e/index.html.

[6] See “Price Cuts Spur Korea’s Mobile Net Use and Revenues”, 17 July 2002, eMarketer, at http://www.emarketer.com. See also “Wireless MMS- Global Growth Analysis”, 13 May 2002, at http://www.3g.co.uk/PR/May2002/3360.htm.

[7] See “E-mail mailboxes to increase to 1.2 billion worldwide by 2005”, 19 September 2002, CNN.com at http://www.cnn.com/2001/TECH/internet/09/19/e-mail.usage.idg/.

[8] See “85% of users express satisfaction with i-mode tm”, 17 June 2002, KPN Press Release at http://www.kpn-corporate.com/eng/pers/index.php?id=2.01&taal=eng.

[9] See “Mobiles Internet ist für die Kunden eine neue Welt”, 17 June 2002, E-Plus Press Release, http://www.eplus-imode.de/1/de/html/pub/presse/index_presse_home.html?presseinformationen/imode_pi_de_japan_reise.html.

[10] European Information Technology Observatory 2002, p. 232.

[11] See MPHPT White Paper (2001), Japan.

[12] See “Gartner Dataquest Says Worldwide Mobile Phone Sales in 2001 Declined for First Time in Industry’s History”, 11 March 2002, Gartner Dataquest at http://www4.gartner.com/5_about/press_releases/2002_03/pr20020311a.jsp.

[13] For a description of the difference between 2.5G and 3G networks see Chapter two.

[14] Data provided by the GSM Association.

[15] “Cell phone carrier technology chart”, 2 April 2002, CNET Wireless at http://www.cnet.com/wireless/0-1923403-8-7093240-1.html?tag=st.wr.1923403-8-7093240-4.subdir.1923403-8-7093240-1.

[16] See M. Minzlaff K. Bond, “The reality of GPRS in Europe: subscribers and revenue” (2002), Analysys; and European Information Technology Observatory 2002, p. 194 and p. 234.

[17] Data provided by the CDMA Development Group (CDG) at http://www.cdg.org.

[18] Ibid.

[19] See “NTT DoCoMo’s Deployment Strategies of Third-Generation Mobile – Slide 24”, 21 September 2001, ITU 3G Licensing Workshop at http://www.itu.int/osg/spu/ni/3G/workshop/presentations/Satoh%20DoCoMo.pdf.

[20] Speech given by KDDI President Onodera in March 2002 at the launch of CDMA 2000 1X service.

[21] See “The UMTS Third Generation Market Study Update”, August 2001, UMTS Forum.

[22] See the Japanese Telecommunications Carrier Association (TCA), MPHPT, Japan.

[23] See “Korea Internet White Paper 2001”, National Computerization Agency, Ministry of Information and Communication.

[24] See section 3.1.2 and Chapter two on short message service. SMS is offered by telecom operators in Europe to send information regarding sport scores, news, horoscopes, etc.

[25] “Changing Dynamics in the mobile landscape”, Industry Comment, Analysys Consultancy.

[26] Voice portals are a special case of mobile portals, relying on voice for information input and output, rather than cumbersome keypads of touch-sensitive screens. See Chapter two for more on portals.

[27] "Roam: Making Sense of the Wireless Internet", B. Guissani, Random House, 2001.

[28] Examples of MASPs include i3Mobile and iTouch UK: see http://www.i3mobile.com/ and http://www.itouch.co.uk/ respectively.

[29] Examples of MVNOs include Tele 2, at http://www.tele2.com/, and Virgin Mobile, at http://www.virginmobile.com/mobile/.

[30] "Licensing of Third Generation (3G) Mobile: Briefing Paper", International Telecommunication Union, 2001, available at http://www.itu.int/osg/spu/ni/3G/workshop/.

[31] SIM stands for Subscriber Identity Module. The SIM card is a secure "smart card" device for the authentication of both mobile subscription and subscriber, primarily used on the GSM platform. The card contains security related data, subscription data as well as user data (e.g. telephone numbers). Its use facilitates number portability, since the user can in most cases insert the SIM card into another compatible telephone. Many 3G operators are looking to incorporate a smart card like the SIM card for their services. USIM (Universal SIM) or UIM (User Identity Module) cards are enhanced versions of the SIM card adapted for 3G networks. NTT DoCoMo's 3G handsets, for instance, use a UIM card.

[32] See the Club Nokia website http://www.club.nokia.com/.

[33] "Handset Loyalty Programs: Nokia Inside?", 6 May 2002, Perspective, Pyramid Research.

[34] The Vodafone/Vivendi portal "Vizzavi" is both a mobile portal and a cable TV portal. See http://www.vizzavi.com/.

[35] See http://www.zed.com/ (Sonera), http://www.t-motion.com/index.shtml (T-Mobile), http://www.vizzavi.com/ (Vodafone) and http://www.o2.co.uk/ (BT), respectively.

[36] See http://www.itouch.co.uk/.

[37] See http://www.i3mobile.com/.

[38] See "Electronic Cash and the Innovation Process: A User's Paradigm", L. Srivastava and R. Mansell, ACTS/FAIR Working Paper No. 35, Brighton: SPRU, 1998.

[39] The report is entitled "Digital Content for Global Mobile Services", European Commission Directorate-General Information Society, Accenture, February 2002. As stated in the report, although subscriber base or company revenues are not necessarily the only relevant measures of bargaining power (which ideally should be determined on a case-by-case basis), the measures set out in Table 3.1 can be considered as key indicators of a company's bargaining power.

[40] See "3G Mobile Policy: The Case of Japan", L. Srivastava, INFO, Vol. 3, No. 6, December 2001.

[41] According to a report by Jupiter Media Metrix released in June 2001, AOL Time Warner, Microsoft, Yahoo! and Napster control half the minutes spent online. In descending order of market share, the other ten companies are: Juno, eBay, Electronic Arts, ExciteAtHome, iWon, Walt Disney, Terra Lycos, The Human Internet, Flipside Sites and CNET Networks. See "4 Firms Control Half of Net Usage". 5 June 2001, The Standard, at http://www.thestandard.com/article/0,1902,26904,00.html.

[42] "Digital Content for Global Mobile Services", European Commission Directorate-General Information Society, Accenture, February 2002.

[43] In Europe alone, mobile operators have spent over € 100 billion (US$ 98 billion) on the purchase of 3G licences.

[44] "3G – How to exploit a trillion dollar opportunity", UMTS Forum, Position Paper 1, August 2001.

[45] Tele Danmark increased its share in Sunrise from 44 per cent to 89 per cent, purchased from BT, and also agreed to buy 70 per cent of diAx. See "Swiss call halt to auction", 13 November 2000, 3G newsroom, at http://www.3gnewsroom.com/3g_news/nov_00/news_0018.shtml.

[46] The Sunrise website is at http://mobile.sunrise.ch/.

[47] Vodafone's website is at http://www.vodafone.com/.

[48] Verizon was created by the merger of Bell Atlantic and GTE in 2000. Verizon's website is at http://www.verizon.com/. Iusacell and Japan Telecom websites are at http://www.iusacell.com.mx/ and http://www.japan-telecom.co.jp/english/ respectively.

[49] The T-Mobile website is at http://www.t-mobile.com/.

[50] See http://www.voicestream.com , http://www.one2one.com/ , http://www.t-mobile.at/_startpage/, and http://www.radiomobil.cz respectively.

[51] "Call it VoiceStream now and T-Mobile very soon", 13 February 2002, Seattle Times, http://seattletimes.nwsource.com/html/businesstechnology/134403958_voicestream13.html . In July 2002, however, Deutsche Telekom announced its intention to sell Voicestream.

[52] France Telecom's website is at http://www.francetelecom.fr/vanglais/home/homev4.html.

[53] "France Telecom to acquire Orange creating a leading global wirefree business", 30 May 2000, Press Release—France Telecom, at http://www.francetelecom.com/vanglais/actualite/commdosp/actu300500.htm. See also the Orange website at http://www.orange.com/english/default.asp?bhcp=1.

[54] As of 28 May 2002, discussion between the two companies were still ongoing. See "France Telecom poised to buy MobilCom" , 28 May 2002, Network News, available at http://www.networknews.co.uk/. For more information, see MobilCom's website at http://www.mobilcom.de/e_index.html?shop_id=&vp_nummer=&w_code=.

[55] See http://www.telenor.com/ and http://www.sonera.com/ respectively.

[56] DoCoMo's website is at http://www.nttdocomo.co.jp/english/. The AT&T Wireless and KPN websites are http://www.attws.com/ and http://www.kpn.com/ respectively.

[57] SK Global (Korea) is an example of an Asian operator with investments in other Asian economies, including Mongolia (SkyTel) and Uzbekistan. Most recently, they have won a CDMA licence to operate in Viet Nam and in Cambodia.

[58] Iusacell's website is at http://www.iusacell.com.mx/. Telus's website is at http://www.telus.com/.

[59] See http://www.sprint.com/, http://www.pegasopcs.com.mx/, and http://www.rogers.ca/ respectively.

[60] See Microcell's website at http://www.microcell.ca/.

[61] "The Mobile Commerce Value Chain: Analysis and Future Developments" (2002), S.J. Barnes, International Journal of Information Management, Vol. 22.

[62] This "Megaconsortium", as it is dubbed, would bring together the greatest number of Internet users in Japan. See "NEC, KDDI, two others ally on Internet consortium", 22 April 2002, Total Telecom.

[63] See the Symbian website at http://www.symbian.com/ and the 3Com website at http://www.3com.com/.

[64] "Recent Advances in Wireless Networking" (2000), U. Varshney, IEEE Computer, Vol. 33.

[65] See OMA's website at http://www.openmobilealliance.org/.

[66] "Digital cash - The telephone is the tool", 27 April 2002, The Economist.

[67] See http://www.mobeyforum.org/.

[68] MeT was founded in April 2000 by Nokia, Ericsson and Motorola and aims to establish a framework for secure mobile transactions. See http://www.mobiletransaction.org/.

[69] Board Members include Visa, Mastercard, American Express, Vodafone, Hutchinson 3G, Telecom Italia Mobile, and NTT DoCoMo. See http://www.mobilepaymentforum.org/.

[70] "Value, content, partnerships and revenues in the Mobile-Internet Era", B. Nordström, Mobile Commerce, GSM Association.

[71] Manx Telecom is an mmO2 (ex-British Telecom) subsidiary operating on the Isle of Man. See http://www.manx-telecom.com/.

[72] "NTT DoCoMo delays 3G launch and looks for new opportunities", 31 July 2001, Ovum Featured Article, available at http://www.ovum.com/.

[73] "Digital Content for Global Mobile Services", European Commission Directorate-General Information Society, Accenture, February 2002.

[74] See "South Korea fines mobile firms over handset subsidies", 9 April 2002, Yahoo! Asia News, at http://asia.news.yahoo.com/020409/reuters/asia-98936.html.

[75] "KDDI subsidizes 1x to tune of US$ 355 million", 10 July 2002, 3G mobile.

[76] MPHPT stands for Ministry of Public Management, Home Affairs, Post and Telecommunications. See their website at http://www.soumu.go.jp/english/index.html.

[77] MPHPT, "Report on Broadband competition policy in Telecommunication business field".

[78] "Open Mobile Architecture", Nokia, Press Backgrounder, November 2001.

[79] See "Comdex: Nokia pushes Open Mobile Architecture", 12 November 2001, Info World, at http://www.infoworld.com/articles/hn/xml/01/11/12/011112hnnokiatwo.xml.
See also "Industry Leaders Announce Commitment to Open Mobile Architecture", 13 November 2001, 3G Newsroom, at http://www.3gnewsroom.com/3g_news/nov_01/news_1455.shtml.

[80] The initiative was launched by the following companies: AT&T Wireless, Cingular Wireless, MM02, NTT DoCoMo, Telefonica Moviles, Vodafone, Fujitsu, Matsushita, Mitsubishi Electric, Motorola, NEC, Nokia, Samsung, Sharp, Siemens, Sony Ericsson, Toshiba and Symbian.

[81] The WAP Forum website is at http://www.wapforum.org. The 3GPP website is at http://www.3gpp.org.

[82] Source code refers to the "before" and "after" versions of a computer program that is compiled before it is ready to run in a computer.

[83] "3G – How to exploit a trillion dollar opportunity", UMTS Forum, Position Paper 1, August 2001.

[84] "Support of Third Generation Services using UMTS in a Converging Network Environment", UMTS Forum, Report 14, 2002.

[85] "The reality of GPRS in Europe: subscribers and revenue" (2002), M. Minzlaff & K. Bond, Analysys.

[86] See "Orange to launch flat rate GPRS mobile Internet access", 27 May 2002, The Register, at http://www.theregister.co.uk/content/6/25460.html.

[87] The Lycos service is a good example of a free web-based SMS service at http://sms.lycos.co.uk/mobile/

[88] SMS is carried over the signaling channel. This should mean that transmission and interconnection costs are minimal.

[89] See "Submission to Study Group 3 of the ITU-T", International Telecommunication Users Group (INTUG), June 2002, at http://www.intug.net/submissions/ITU-T-SG3_roaming.html.

For an example of an SMS price increase in Europe, see also "Orange to increase SMS charges", 25 March 2002, The Register, at http://www.theregister.co.uk/content/archive/24570.html, which notes the increase in the price of SMS messages on Orange's UK network from US$ 0.09-0.10 to US$ 0.15 from April 2002.

[90] "Mobile Internet Content Providers and their Business Models: What can Sweden learn from the Japanese experience?", A. Devine and S. Holmqvist, Master's Thesis, Royal Institute of Technology, Stockholm, 2001.

4 CHAPTER FOUR: REGULATORY AND POLICY ASPECTS

This chapter has three main areas of focus. The first of these is competition policy, the purpose of which is to ensure fair access and stimulate innovation in the market. This covers licensing and post-licensing policies (also explored in the context of individual country cases in Chapter five). The second is international cooperation in such areas as global roaming and the circulation of terminals. The third focus is an increasingly important one for policy-makers, namely the guarantee of user rights, including consumer protection and access to information regarding the development and use of new technologies.

4.1 The importance of effective regulation

4.1.1 Regulatory reform

Since the early 1980s, telecommunication market reform has been implemented in many corners of the globe. Although the reform process has varied from country to country, at least three factors seem essential for its success: market liberalization, the establishment of an independent regulator, and effective competition policy. Along these lines, ITU's World Telecommunication Development Report 2002[1] draws the following conclusions from reform in action:

- Privatization without competition is good, but privatization with competition is much better.
- Introducing private sector players is good, but allowing them the freedom to compete is better.
- Creating regulators is good, but giving them adequate powers and independence is better.
- Creating a duopoly is good, but allowing open competition is better.
- Introducing competition is good, but introducing it at an early stage of market development is better.

There are a number of differences between the mobile and the fixed telecommunication markets that have implications for regulatory reform. The mobile market has, for instance, been developing at a phenomenal rate, especially during the late 1990s. This means that, in contrast to the public switched telephone network (PSTN) world, no incumbent operator has been able to develop a longstanding national history of dominance. The 1990s saw the establishment of an independent telecommunication regulator in a number of countries. The challenge these new bodies faced was, *inter alia*, to ensure that competition was maintained in a sector that was subject to less stringent regulation (see Figure 4.1). Another challenge was that new services and technologies began appearing every day, effecting rapid changes in market conditions and requiring special attention to competitive forces.

A second important difference between the mobile and fixed-line worlds is that, in the case of mobile, there is a need for radio spectrum, which is a limited resource. Because of this, compared with the fixed telecommunication market, only a limited number of facilities-based mobile operators can be permitted to enter the market in a given area. Nevertheless, the generally competitive environment and the lack of significant regulatory constraints has meant that there had been a large increase in the number of companies: whereas there were less than 200 operators worldwide in 1992, by the end of 2001 they numbered over 600. Of course, some 100 countries did not even have a mobile network in 1992, whereas less than a dozen were without one at the end of 2001. It is also noteworthy that more than a third of countries around the world had three or more competing mobile operators by the end of 2001 (see Figure 4.1).

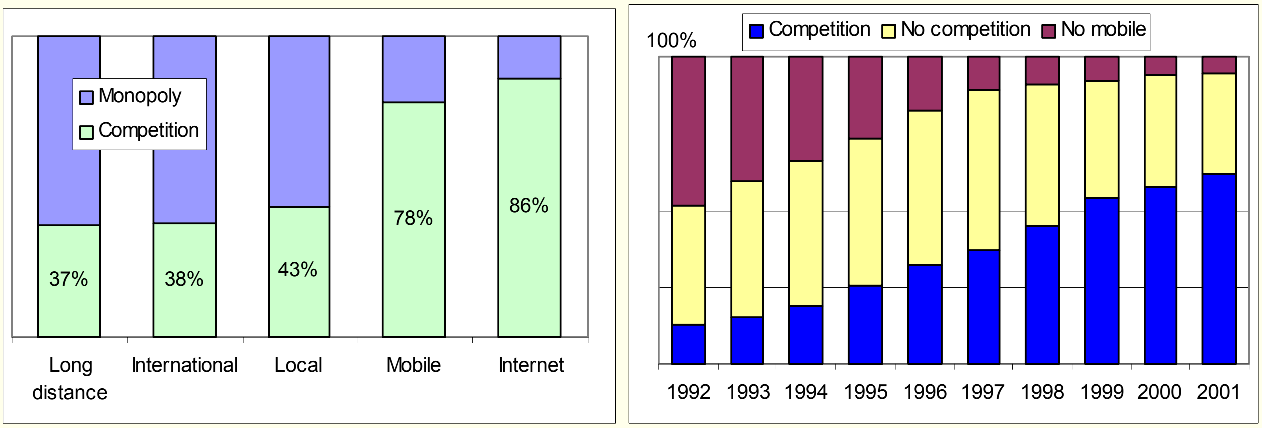
4.1.2 New trends and new policy challenges

Who stands to gain the most from a competitive telecommunication market? Ostensibly, users reap the benefits of competition, which include, *inter alia,* lower prices, new services and accelerated technological innovation. The mobile market is a case in point: mobile call charges have been decreasing, GSM operators now offer roaming services in over one hundred countries and new multimedia handsets and services are appearing on the market.

In the case of fixed Internet access, various technologies have already emerged that enhance the user experience (such as ADSL[2]) and the number of users is increasing dramatically on a global scale. Networks are shifting from circuit-switched to packet-based, from narrowband dial-up connections to broadband

Figure 4.1: Competition status

Legal status of competition in telecom market segments, 2001 and Economies with competitive mobile markets, per cent



Note: Left chart: Status refers to legal rather than actual situation. "Long distance" refers to domestic while "International" refers to international long distance. "Mobile" refers to digital cellular mobile networks. Percentages show countries that have adopted a degree of competition. Right chart: Status refers to actual, rather than legal status.
Source: ITU World Telecommunication Development Report 2002: Reinventing Telecoms.

always-on connections, and from voice calls to data transmission. And the tide of change has not yet tarried, with numerous new mobile Internet access technologies constantly being introduced. Reviewing fixed-line technological trends can give an indication of how future mobile technology trends might look. Recent major trends in the fixed line technologies can be summarized as follows:

- Shift to all-IP networks:

  As the Internet expands, hitherto independent telecommunication networks are gradually being integrated with IP technology. For example, international IP telephony traffic, which represented just 3 per cent of total traffic in 2000, is forecast to attain 40 per cent in 2004.[3] An IP telephony network has the advantage of being a "cheap network", avoiding the need for expensive circuit switches and thereby enabling operators to establish and operate IP telephony networks at much lower cost than circuit-based networks.

- Broadband services:

  Until the late 1990s, ISDN offered the broadest bandwidth available. Since then, new broadband technologies such as ADSL and cable modem have emerged, offering increasingly generous capacities. With the technological evolution of Internet content, taking applications from simple text and small pictures to full motion video, broadband offers the capacities required for such services. However, in the absence of sufficient broadband availability, even as it begins to diffuse into the market, broadband still lacks "killer content". Nevertheless, within a few years, broadband networks are likely to become a requirement, not only for entertainment purposes, but also for business-to-consumer and business-to-business e-commerce.

- Flat-rate charges:

  In most cases, voice call charges are calculated according to distance, duration and time of day or week. The same applies to dial-up Internet access utilizing existing telephone networks. With the growth of services using broadband content (e.g. full motion video) over the Internet however, this per-minute billing method is a deterrent to users, who are wary of clocking up charges owing to longer connection times. Even where the per-minute charge is reduced, users may still not feel at their leisure to browse and download content. For this reason, some major broadband service providers, such as ADSL and CATV[4], have already introduced flat-rate charge systems.

These transformations of the fixed-line market are concurrent with the nascent growth of data services in the mobile market, although the majority of mobile communications is still voice-based. Thus, similar trends can already be identified. 3G mobile and WLAN services, which may eventually be suitable for broadband Internet access, have already been introduced in several countries, although it will require some time before they reach the mass market. As described in Chapter two, future technological trends in mobile markets may be summarized in similar terms to those in the fixed-line world:

- Shift to all-IP networks:

  In the future, the introduction of the new Internet Protocol version, IPv6, enabling virtually unlimited IP addresses, will open the door to pervasive (ubiquitous) computing, i.e. the means to access information networks anytime, anywhere. Not only will PCs and mobile handsets be connected to a network, but so will other electrical items that will have IP addresses for communication with users and each other, such as refrigerators, car navigation systems and vending machines (discussed further in Chapter six).

- High-speed services:

  In the 2G era, many mobile operators have offered Internet access services. But the transmission speed has generally been less than 15 kbit/s. The amount of data transmitted has been limited, and most content has been text-based only. With the introduction of 2.5G, 3G and WLAN onto the mobile market, high-speed data transmission will become increasingly possible, bringing with it new data services including the kinds of multimedia offerings that are now beginning to appear.

- Flat-rate charges:

  In the early days of the mobile Internet, users were billed in the same way as for voice calls, e.g. per-minute billing for WAP over GSM. With the evolution of packet-based networks however, volume-based charges have increasingly been introduced. In the future, with the growing popularity of multimedia content, huge amounts of data will need to be processed, and the per-minute billing system may be driven into obsoletion for such services. For mobile Internet access then, flat-rate systems may become the norm. Flat-rate schemes for data services are already being considered by a number of mobile operators.

The mobile Internet has the potential to open up exciting new possibilities in the information society, but this potential needs to be harnessed effectively. Patterns of demand and supply entail strong interaction between policy and regulation, and market dynamics. Just as competition policy influenced the rapid growth of mobile market in 1990s, new market trends call for the development of new competition policies if regulators and policy-makers are to create a favourable environment for the development of these networks. In other words, the success of the mobile Internet will not be down to market forces alone, but will require conscious and informed decision-making on the part of regulators and policy-makers in order to guide operators and influence market development.

The convergence of Internet access and mobile services has brought with it additional factors, such as the creation of new mobile Internet platforms (e.g. portals). Due to their ownership of network infrastructure and their direct relationship with the customer, mobile operators will no doubt have a strong influence on the market for mobile Internet platforms. It is therefore important for regulators and policy-makers to work with industry to ensure that these platforms are as open to competition as possible.

Moreover, due to the inherently global nature of high-speed 3G networks facilitating the mobile Internet, international roaming and terminal circulation issues will have to be considered. Thus, a harmonized approach to regulation, through the guiding influence of regional and international organizations, is pivotal to the success of the market. Another important role for policy-makers is the guaranteeing of consumer rights, including consumer protection and access to information regarding the development and use of new technologies.

4.2 Towards an appropriate licensing framework

Licensing policy governs the structure of markets, procedures for market entry, the number and type of operators, the degree of competition between players, revenues generated for governments, as well as the efficient supply of services to the public. Licensing plays a particularly important role in the mobile market because, as mentioned previously, the market is based on a limited resource, the radio spectrum. In this regard, the costs and procedures for licensing may facilitate business development, but may also be the source of substantial barriers to entry.

In the first half of 2000, overblown expectations for 3G services resulted in high auction prices for these licences in countries such as the United Kingdom and Germany. Since then, due to the declining value of telecommunication stocks around the world and investor caution over balance sheets, 3G auction prices have been dropping steadily (see Figure 4.2). Moreover, some countries have postponed their licensing process, while others have changed their licensing methods in order to reduce the burden on 3G operators.

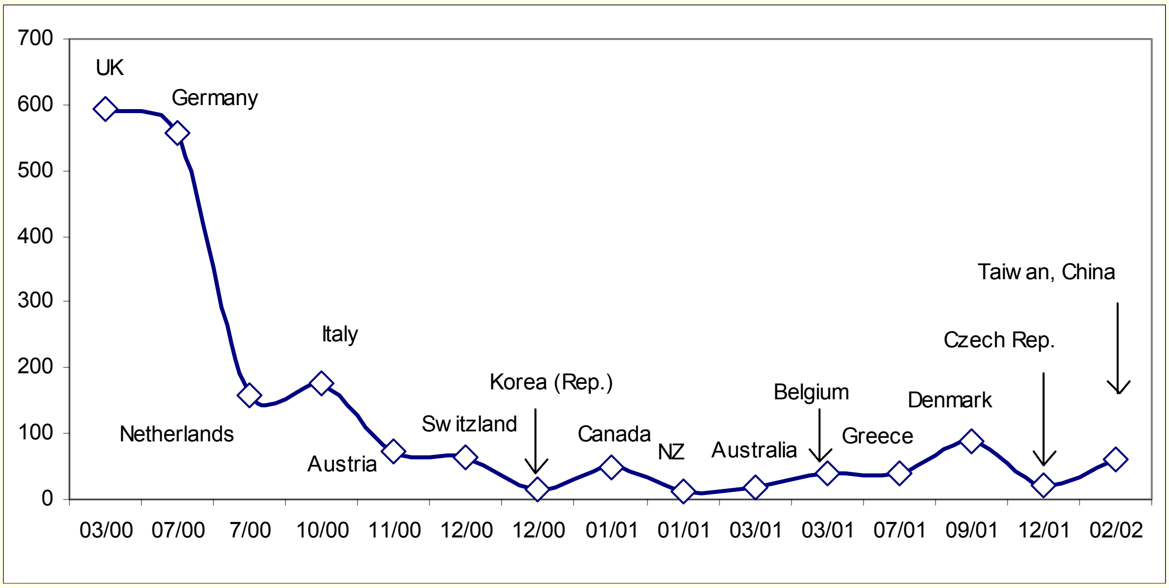
Providers of WLAN services, by contrast, are not placed under such heavy burdens in respect of financial or other licence conditions, allowing them greater flexibility, and encouraging smaller players onto the scene. This is because WLAN technologies make use of unlicensed bands reserved for low radio power equipment and typically reserved for public use. This may create the risk of interference between services, but allows considerable flexibility and versatility for entities wanting to enter the WLAN market—from covering many locations, to covering just one location (such as hotels and restaurants offering WLAN access in a single building), and from charging for services to offering them free of charge. Given the low initial costs for WLAN base stations, and the absence of licence fees, providers can set up their Internet access services quickly and cost-effectively. Some exceptions to the unrestricted provision of WLAN services do nonetheless exist. Regulation and licensing conditions for these cases are examined in section 4.2.2 below.

4.2.1 Licensing policy for 3G mobile services

The most important policy issue for 3G licence allocation is the licensing process. Three basic allocation methods, or minor variants of them, have typically been applied: auction, "beauty contest" and hybrid, each with its particular merits and demerits. Ideally, regulators should select the most profitable and suitable method for their domestic market, in the light of these considerations. Regulators must also decide on the number of licences to be awarded; what proportion of these should be allocated to existing 2G licensees, and what proportion to new entrants. Finally, the fees and conditions that are imposed on successful bidders as part of the licence agreement are a key element in licensing policy.

Figure 4.2: The 3G rollercoaster

Trends in 3G licence prices obtained through auction, in US$ per inhabitant



Note: Excludes comparative selection ("beauty contests") and mixed "hybrid" licensing processes. Horizontal axis is not linear.
Source: ITU research.

The auction method for licence allocation

A spectrum auction is a market-based method for awarding licences. Supporters of this method argue that it is a transparent and objective process, which is easy to understand and frees administrators from the pressures of reconciling numerous objectives, including regional employment policy and the support of "national technology champions". As shown in Table 4.1, Germany, New Zealand and the United Kingdom are examples of countries that have auctioned 3G spectrum.

However, this approach raises other challenges for policy-makers, particularly in terms of efficient auction design and timing. One concern is that high auction prices make it more difficult for winning bidders to fund network roll-out and service development. Another risk is that the operator with the greatest capacity for monopolization could bid for all mobile licences up for auction, thereby acquiring or maintaining its monopoly status.

Those who criticize auctions argue that 3G bidders may impose higher retail prices on their subscribers in order to recover losses due to licensing costs. This may mean that 3G operators are handicapped in their competition with other broadband media. Another concern expressed by critics relates to cross-subsidization. If 3G operators with other licences (in domestic or foreign markets) impose high retail prices for these other business services, but adopt relatively low prices for 3G services in order to gain 3G market share, this prevents fair market competition.

The comparative selection process ("beauty contest")

When adopting a comparative selection approach, the regulator allocates licences to operators who best meet stated pre-set criteria. Typically, governments rate applications according to those criteria and licences are allocated to those whom the government believes best meet the stated requirements. China, Japan and Sweden are examples of countries that have applied this "beauty contest" approach.

One of the disadvantages of this approach is that it puts a much greater burden on policy-makers than an auction, as it requires them to decide between bidders according to a complex scoring system. While some factors can be quantified, other criteria are more difficult to assess. Moreover, the qualitative aspect of the decision-making may leave administrators open to accusations of non-transparency and bias.

The "hybrid" selection processes

Some countries have adopted a hybrid method to allocate licences. In order to be eligible to bid, applicants have to pre-qualify in terms of criteria similar to those established for straight-out "beauty contests". Licences are then allocated on the basis of an auction. By their nature, such pre-qualification processes can potentially be complex, time-consuming and contentious, and the scope for subjective interpretation of the rules and requirements increases the risk of litigation and delay in introduction of the new service. Nevertheless, such processes can be used to help ensure that potential holders of 3G licences have the expertise, capability and will to meet social and policy objectives required by government. Box 4.2 describes the 3G licensing process in Hong Kong, China[5], where the number of bidders was initially whittled down in the beauty contest component, and a final selection was subsequently made by auction.

Number of licences

When determining how many 3G licences to issue, it is important to take into account the current market environment, expectations about future demand for services, and supply side considerations such as necessary frequency bands for each operator's network business. In many high-income countries, what is called the "n+1" model has been adopted for licensing. Under this model, the number of 3G licences allocated equals the number of existing 2G licences, plus one additional licence.[6] Typically, the amount of spectrum available for IMT-2000 services should allow for between three and six new 3G mobile telephony licences in a given market. Taking into account licences awarded to date, the average number of 3G licences awarded is four per country (see Table 4.1).

Table 4.1: Allocation of 3G mobile licences in selected countries worldwide

Country	No of licences	Mobile incumbents	Method	Date awarded	Amount bid, US$ million
Australia	6	3	Regional auction	March 2001	610
Austria	6	4	Auction	November 2000	618
Belgium	4	3	Auction	March 2001	421.2
Czech Republic	2	2	Auction	December 2001	200
Denmark	4	3	Sealed bid auction	September 2001	472
Finland	4	3	Beauty contest	March 1999	Nominal
France	4 (2 awarded, 2 still on offer)	3	Beauty contest + fee (Auction for two outstanding licences closed in May 2002)	July 2001 (Results of revived auction due in September 2002)	4.52 billion (subsequently reduced to 553 million each, plus 1% of revenue)
Germany	6	4	Auction	August 2000	46'140
Greece	3	3	Hybrid	July 2001	414
Hong Kong, China	4	6	Hybrid	September 2001	Minimum 170 each plus royalties
Israel	3	3	Beauty contest + fee	December 2001	157.1
Italy	5	4	Hybrid	October 2000	10'180
Japan	3	3	Beauty contest	June 2000	Free
Korea (Rep.)	3	2	Beauty contest + fee	August 2001	2'886
Malaysia	3	3	Beauty contest	December 2001	Nominal
Netherlands	5	5	Auction	July 2000	2'500
New Zealand	4	2	Auction	January 2001	59.9
Norway	4	2	Beauty contest + fee	November 2000	88
Singapore	3 (+1?)	3	Cancelled auction	April 2001	165.8
Slovenia	1	2	Cancelled auction	December 2001	82.2
Spain	4	3	Beauty contest + fee	March 2000	480
Sweden	4	3	Beauty contest	December 2000	Nominal
Switzerland	4	2	Auction	December 2000	119.8
Taiwan, China	5	4	Auction	February 2002	1'400
UK	5	4	Auction	April 2000	35'400
Total (25)	99 +	79	13 auctions 9 beauty contests 3 hybrid		105'286 +

Source: ITU Briefing Paper on the "Licensing of 3G Mobile" available at: http://www.itu.int/osg/spu/ni/3G/index.html, Comparative Assessment of the Licensing Regimes for 3G Mobile Communications in the European Union and their Impact on the Mobile Communications Sector, European Commission, Directorate-General Information Society, Final Report, 25 June, 2002, and 3GNewsroom.com at: http://www.3gnewsroom.com/index.htm.

Box 4.1: 3G licence prices in France: "times they are-a-changing"

ART reduces 3G licence fees

In August 2000, the French regulator, the *Autorité de Régulation des Télécommunications* (ART), announced the allocation of four licences for 3G services using a comparative selection ("beauty contest") method, with payment of an initial up-front fee. In January 2001, only two incumbent operators applied for the four 3G licences on offer, after two other candidates dropped out of the race, primarily due to inability to pay the fee of € 4.95 billion (US$ 4.52 billion). The winners, France Telecom (parent company of mobile operator Orange) and SFR, were awarded 3G licences in July 2001. It was initially decided that the licensees should pay half the entire fee in the first two years: in September and December 2001, 1/8 of the total per month; in March, June, September, December 2002, 1/16 of the total per month. The other half was to be paid over the following 13 years, in yearly instalments. When the first payment was due however, SFR displayed reluctance to hand over its payment. In November 2001, ART amended the licensing conditions, reducing the licence price to € 619 million (US$ 553 million). This amount is equivalent to the first payment owed by licensees under the earlier conditions. It also added a fixed one per cent charge on revenue and extended the term of the licence from 15 to 20 years.

ART accepted applications for the other two licences up until May 2002, with the final outcome to be announced in September 2002. One of the drop-outs from the earlier process and the third largest GSM operator in France, Bouygues Telecom, has already submitted a bid in the revived auction—observers expect it may be the only application. Bouygues forecasts the cost of the new network to be € 4 billion over seven years (in addition to the licence fee).

Source: Autorité de Régulation des Télécommunications (ART); Total Telecom News, 15 May 2002; Public Network Europe, May 2002.

Box 4.2: Hong Kong's licensing process, or how to do it well

Hong Kong's hybrid method based on royalties

Hong Kong not only has one of the highest teledensities in Asia, but it also has one of the highest mobile densities in the world with 5'701'700 subscribers in 2001, representing over 59 per cent of total telephone subscribers. It is not surprising that it is ranked first in ITU's Mobile/Internet Index (see Table 10 in the Statistical Tables section in the Annex).

The promising environment that now exists for 3G is largely due to the balanced and successful management of Hong Kong's third-generation licensing process. The regulator, OFTA, opted for a hybrid process consisting in a pre-qualification process followed by spectrum auctioning. The process took place in several stages, with applications invited from operators using any of the family of IMT-2000 standards, subject to compatibility with existing standards. Furthermore, OFTA decided to allow existing 2G operators, whether successful or not in obtaining 3G spectrum, to use any IMT-2000 standard within their assigned 2G frequency bands for 3G services, when equipment becomes commercially available. Rather than a purely fee-paying system, royalty payments, with a schedule of minimum payments, were introduced by OFTA, in order to minimize the financial burden on operators.

The results of the process were announced in September 2001, with 3G licences awarded to four successful bidders, namely: Hong Kong CSL Limited (joint-owned by Telstra Corporation and Pacific Century CyberWorks); Hutchison 3G HK (joint-owned by Hutchison Whampoa and NTT DoCoMo); SmarTone 3G and Sunday 3G (Hong Kong). Under the regulatory framework of open network access, the 3G licensees are required to open up at least 30 per cent of their capacity for use by mobile virtual network operators (MVNOs) and/or content and service providers. Also in October 2001, OFTA published its guidelines for the application of Public Non-Exclusive Telecommunications Service (PNETS) licences and invited applications from potential MVNOs. OFTA has thus sought to ensure that competition be enhanced and the market be kept as vibrant and balanced as possible.

By the end of May 2002, six companies had obtained MVNO licences in Hong Kong. They are currently using 2G technology for service provision, with plans to migrate to 3G technology once the networks are ready.

Source: ITU case study on third-generation licensing in Hong Kong SAR and China, available at http://www.itu.int/osg/spu/casestudies/index.html.

3G Licence conditions

Regulators have imposed specific obligations on licensees, such as duration of the licence, date of commencement of operations and the coverage of a certain percentage of the territory or population. These obligations are often secured by the threat of sanctions. Table 4.2 shows various examples of how 3G licence conditions can affect the market after licensing.

Despite the promise of 3G mobile services, the payment of high licence fees will only be warranted for a licensee if the market lives up to expectations. This may seem like common sense. But experience has shown that estimating the growth potential of the market is not always easy, with many early licensing processes having involved exorbitantly high fees, with the result that operators were knocked flat when the telecoms bubble finally burst. Figure 4.2 shows the trends in 3G licence prices per inhabitant obtained through auction, in selected economies. In the first group—the United Kingdom, Germany, Netherlands and Italy—bidders paid a high sum per capita, making it potentially difficult for them to recover licence costs. Subsequently, in the light of dashed market hopes, 3G licence prices dropped dramatically. In early 2002, over 20 countries had already allocated 3G licences using a range of fees, methods and conditions (see Table 4.1), offering useful lessons for 3G licensing policy in the future.

The European 3G bidders, notably in Germany and the United Kingdom, are suffering from very high 3G licence fees. They have appealed to regulators to alleviate the burdens placed on them. The European Union has looked into this issue, and announced that, in principle, 3G licensing conditions should not be changed, in order to ensure a predictable environment and legal certainty favourable to long-term investments.[7] It is, however, encouraging increased infrastructure sharing for cost efficiency.

Some countries have chosen to adopt licensing methods that charge licence fees in proportion to the number of users, such as Sweden (annual levy of 0.15 per cent income yearly, in proportion to operators' income) and Japan (annual licence fee per handset, in proportion to the number of handsets in circulation). This method reduces the initial payments owed by licensees, even though there is a risk that operators may lose incentives to use the spectrum more efficiently. Overall, this method imposes a lesser financial burden on operators, as did the unique royalty scheme introduced in Hong Kong (see Box 4.2).

Licensing principles

In addition to the licensing methods and conditions, the overall principles guiding the licensing process also need to be established by regulators. In the selection process, regardless of the method chosen, regulators should try to develop quick, efficient, transparent and objective criteria. As underlined by ITU's workshop on 3G licensing held in September 2001, *"For credibility reasons, licence award processes should be transparent and open to full public scrutiny. This is why objectivity and stability in the licensing process are essential, in order to ensure that regulatory risk is minimized. The fast-moving world of telecoms also means that award processes should be designed to happen as quickly as is feasible."*[8]

As regards licence fees, these are typically used to fund governmental activities. Ideally, however, these funds should be re-invested in the same sector, for instance to assist with spectrum clearance, or to help bridge the digital divide, rather than being used for unrelated purposes.[9]

Efforts to harmonize policy within the European Union have not yet made much headway. In the licensing process for European Union countries, some operator groups (consortia) applied for 3G licences in several different countries, and some were licensed with totally different licensing conditions applying each time. Based on the analysis and experiences of 3G licensing policy in European Union countries, a report assessing the various 3G licensing regimes was released by the European Commission in June 2002.[10] This report lists the following five principles for spectrum assignment exercises and regulation of spectrum-based services for policy-makers and regulators:

- Build spectrum assignment on the notion of a "sustainable market";
- Allow for the gradual introduction of a new technology and/or new capacity;
- Design the process for spectrum assignment so as to minimize distortions;
- Align licence conditions and other regulatory levers to allow for financial stability;
- Support the take-up of market demand.

Table 4.2: Matching 3G licence conditions with key areas of regulatory focus

	Possible key areas of regulatory focus					✓✓Primary focus ✓Secondary focus
Key 3G licence conditions and circumstances	*Industry structure*	*Pricing*	*Interconnection*	*Customer access*	*Quality of Service*	*Comments*
Number of licences	✓✓					On average, 3G licensing allowed for one additional mobile operator per market; Number of 3G licences equals the number of networks built.
Award method	✓✓	✓				Highest bidding operators were awarded a 3G licence.
Relative timing of the award	✓✓					Number of interested candidates for 3G awards went down after mid-2001, in line with market expectations.
More spectrum for 3G new entrant	✓✓				✓	Aimed at allowing for a level playing field for new entrant versus existing 2G operators with a 3G licence.
Payment modalities	✓	✓				Modalities did not substantially affect industry structure.
Licence duration	✓✓					Defines duration of 3G services provisioning on the mobile market.
Spectrum size	✓✓				✓✓	Given scarcity of 3G spectrum, increased spectrum size per operator implies fewer licences
Roaming rights / obligations	✓✓		✓✓		✓✓	Defines use of networks by other operators; improves overall service availability.
Access obligations	✓✓		✓✓	✓✓		Defines potential for service providers in a market.

Source: "Comparative assessment of the licensing regimes for 3G mobile communications in the European Union and their impact on the mobile communications sector", European Commission Directorate-General Information Society.

Para-national, international and inter-regional bodies have an important role to play in defining such principles and in establishing guidelines and, given their fundamentally neutral status, may provide the best framework for policy harmonization.

4.2.2 Licensing policy for WLAN[11] services

Regulation and licensing policy for WLAN services are likely to become a hot topic owing to a number of reasons. First, interference between household and other appliances and WLAN services is likely to be an increasing problem. Second, the "open" nature of the bands in question can be an irresistible invitation to users to sidestep charges.

As outlined in Chapter two, the WLAN systems that hold the most promise are IEEE 802.11b (Wi-Fi) and 802.11g, both operating in the 2.4 Ghz band, and 802.11a, operating in the 5.2 GHz band. In most countries, the two frequency bands, 2.4GHz and 5.2GHz, do not require a licence for use and were originally allocated for low-power applications.[12] One upshot of this is that operators can start WLAN operations more quickly than mobile phone operations, because they need not go through a licensing procedure or pay for licences. In some countries however, commercial exploitation of these unlicensed bands is prohibited (see Box 4.3). One difficulty however, is that these bands were first set aside for low-power applications, meaning that the average radio power, and coverage (maximum 300 metres) of each base station is limited, and that there is a high risk of interference.

Box 4.3: Reconsidering unlicensed spectrum

WLAN Regulation in the UK

In April 2002, the British Telecom Group (BT) announced its plan to offer WLAN services. The network will use the IEEE 802.11b standard, which operates in the 2.4 GHz spectrum used by unregulated devices, such as microwave ovens, garage door remote controls and Bluetooth wireless technologies (see Chapter two for details about these technologies). However, unless BT plans to offer WLAN access free of charge (which it does not), the UK's Radiocommunication Agency (RA) must first approve proposals to open the unregulated spectrum for commercial services.

To this effect, the RA completed a consultation process on the issue of the commercial use of the 2.4 GHz band. In June 2002, the e-Commerce Minister announced changes to regulations that will permit parts of the radio spectrum to be used for commercial telecommunication services from 31 July 2002 onwards, and without the need for a Wireless Telegraphy Act licence. Operators will still, however, have to obtain a licence under the Telecommunications Act.

BT plans to install IEEE 802.11b WLAN base stations at 400 sites across the country in 2002, offering 11Mbit/s broadband Internet access for laptop users in "hot spots", such as airports and shopping precincts.

Source: "Timms opens way for wireless possibilities", 10 June 2002, Department of Trade and Industry, United Kingdom. See http://www.nds.coi.gov.uk/.

As mentioned above, due to low initial costs, WLAN providers may set up almost any kind of service, with as many WLAN business models in existence as there are technological possibilities. One problem with such an open and unregulated system, is that individual users can open "hot spots" for others. If they offer their WLAN access to others free of charge, the services of incumbent ISPs offering exclusive Internet access services to their users are effectively available to "free-riders". In the United States, some cable operators have pointed out that some of their customers open their accounts for WLAN access redistribution to anyone who can catch the "spill over" radio. These operators have resorted to issuing letters, urging such users to cease this redistribution.[13] The problem with such redistribution is that, if it spreads, it may undermine ISP business models and have consequences for future content development and expansion. Regulators may therefore decide to impose regulation banning the redistribution of bandwidth.

4.3 Ensuring fair competition in the marketplace

Licensing may provide fundamental groundwork for successful 3G deployment, but it is not the end of the story. "Life after licensing" is also a tricky business, and to ensure fair competition, effective policy-making and regulation are required. Open markets are an important, but not indispensable, means to realize fair competition when market forces dominate. For instance, in a "*laissez-faire*" market, dominant operators may impose high interconnection charges on other operators, and high service charges on their users. Although this may maximize their profit, it has harmful effects on the market as a whole and curtails the benefits to users. Almost all countries have imposed general regulations prohibiting business activities that stifle competition, such as anti-trust legislation. Telecommunication networks and services are regarded as important socio-economic infrastructure, for which governments generally seek to ensure a level playing field. The most important competition policy mechanisms relate to market structure, specifically to market power regulations (e.g. "significant market power", or SMP, described in section 4.3.1 below) and merger controls.

Resource sharing and interconnection are good ways for operators to seek economic efficiency of networks. They may enable operators to provide cheaper services to consumers. On the other hand, if operators having strong bargaining power leverage that power for their increased benefit, payments charged by them for sharing or interconnection would be higher, for which consumers would have to bear the final cost.

In each case, simple criteria do not suffice. This is due to the fact that the telecommunication market and competition levels differ from country to country, and because technologies are evolving at a rapid pace. Because regulations may impose restrictions on business plans, those operators that are subject to regulation need to be identified clearly. Flexible regulatory mechanisms, such as the possibility of removing regulatory restrictions from target operators in the case of increased competition, should also be considered.

4.3.1 The evolving definition of market power and dominance

Competitive markets, or those in the process of transition to an open market, facilitate the development of cheaper and innovative services and technologies, but in the fixed-line telecoms world, certain market players—frequently the incumbent, or oldest provider—tend to dominate. In order to give smaller players a fair chance, regulators in many developed countries have designated certain operators as having "market power". These operators are then subject to asymmetric regulation vis-à-vis other players in the market, including interconnection requirements, the prohibition of cross-subsidization and unfair discrimination, and accounting separation. Recently, regulators are coming to the realization that mobile operators, traditionally subject to lighter regulation, should also be evaluated according to these criteria.

The concept of market power can be defined as follows: *the ability of a firm to independently raise prices above market levels for a non-transitory period without losing sales to such a degree as to make this behaviour unprofitable*.[14] The European Commission employs the term "significant market power" (SMP) to describe this kind of market position. However, the definition does not necessarily imply that the operator actually has market power or dominance.

In targeting operators with SMP, defining the relevant market is the first crucial step. Market definition involves two main criteria: the characteristics of products and services, and geographic network coverage. If regulators choose to set wide parameters in defining these criteria, the "market" becomes wider and the relative weight of each candidate for SMP becomes smaller, and vice versa. The European Commission has issued draft recommendations defining different product and services markets.[15] One such market definition pertains to "call termination on individual mobile networks". According to this definition, all mobile operators are dominant as regards the termination of calls on their networks.[16] Mobile operators are of the view that the Commission is going too far by introducing market definitions that will lead to over-regulation. Naturally, service providers, who pay mobile operators for terminating calls, are happy with the draft definitions. Despite fears of over-regulation, it is certainly a positive sign that the European Union is concerned about high charges for mobile call termination.

As an example of a relatively clear-cut SMP market definition, in the Japanese mobile market, all PDC (personal digital communications) and CDMA mobile phone operators are designated as one relevant market. The introduction of WLAN services will, however, complicate this definition. In the Republic of Korea, only the dominant mobile operator, SK Telecom, is designated as an SMP operator in the mobile service market (see Box 4.5). Here too, if the WLAN market grows, defining the market may become more complex.

In addition to defining the market, criteria need to be established for measuring market power. In essence, market power is measured by assessing how it affects price increases owing to restricted output, and the extent to which it would constitute a barrier to market entry. Most countries define SMP by measuring market share. In Japan, the threshold for market share is set at 25 per cent (see Table 4.3). The European Union has recently introduced a more qualitative definition, based on the concept of collective dominance by joint alliances of operators.[17] It sets out the market share threshold as follows: "dominance concerns normally arise only in the case of undertakings with market shares of over 40 per cent". Also in the European context, the Swedish regulator, PTS, recently attempted to apply a qualitative SMP definition to collective operators, but failed to have this recognized in a recent court case (see Box 4.4).

The new European Union Regulatory Framework obliges its Member States to review effective competition regularly, requiring them to assess the existence of effective competition in each market and to impose sector-specific regulatory obligations where such effective competition does not exist.[18]

The designation of SMP is likely to become more complex still in the mobile Internet era of convergence, as mobile operators increasingly run networks, platforms and content businesses. In some cases, they would qualify as having SMP in their platform or content business, because they have SMP in the network market. In designating SMP operators, regulators will thus be able to assess the overall dominance of a given company under its various different market "hats".

Table 4.3: Regulation of significant market power in the mobile market

Thresholds for SMP regulation in the European Union, Japan and the Republic of Korea

	European Union (previous)	European Union (revised)	Japan	Korea
Authority	National Regulatory Authorities (NRAs)		MPHPT	MIC
Definition	Over 25 per cent market share, plus qualitative definition(*1)	Qualitative definition(*1), based on a number of additional criteria. Elimination of quantitative measure.	Over 25 per cent market share (*2)	Over 50 per cent market share
Designated mobile operators	NRAs designate operators based on harmonized national telecommunication regulation		All nine companies of NTT DoCoMo Group	SK Telecom

Note: (*1) As stated in Article 13 of the European Union's Framework Directive, the definition is as follows: "an undertaking shall be deemed to have significant market power if, either individually or jointly with others, it enjoys a position of economic strength affording it the power to behave to an appreciable extent independently of competitors customers and ultimately consumers". A number of criteria are added to this definition, such as the overall size of the undertaking, control of infrastructure not easily duplicated, technological advantages or superiority, absence of countervailing buying power, easy or privileged access to capital markets/financial resources, product/services diversification (e.g. bundled products or services), economies of scale, economies of scope, vertical integration, a highly developed distribution and sales network, absence of potential competition.

(*2) Designated by the Minister of MPHPT, (1) where the market share of the number of subscribers to the cellular phone services provided by Type 1 telecommunications exceeds 25 per cent, (2) where the market share of the previous year's profit surpasses 25 per cent, and (3) when the Minister deems it necessary to ensure proper competition with other telecommunications carriers in consideration of the trend of the market share mentioned in (2) and other conditions.

Source: European Union, MPHPT (Japan), MIC (Republic of Korea).[19]

Box 4.4: Significant market power (SMP) in Sweden

Swedish regulator's designation and court decision

Since 1999, Sweden's Telia, which has a 31.4 per cent share of the national mobile market), has been designated as an SMP operator. In February, the Swedish regulator, Post- och telestyrelsen (the National Post and Telecom Agency, PTS), insisted that Tele2 (which had a 16.6 per cent share of the market) and Europolitan Vodafone (13.4 per cent) had sufficient share in the interconnection market to be similarly designated, and announced a review of whether their interconnection charges were cost-orientated. The rationale behind this decision was based on the fact that, together, these three operators controlled 90 per cent of the market for interconnection, including both fixed-line and mobile networks. Both Tele2 and Europolitan appealed the decision, claiming that it deviated "radically" from European Union regulation, and from the National Telecommunications Act, both of which stipulate the 25 per cent market share requirement. In April 2002, the Stockholm County Administrative Court granted their appeal, invalidating the PTS decision until further notice.

Source: Tele2 Statement, "Swedish watchdog eyes Europolitan, Tele2", 21 February 2002; "Europolitan Vodafone appeals SMP ruling", 13 March 2002, "Court blocks Swedish watchdog ruling on Tele2", 17 April 2002, Total Telecom News; PTS. See: http://www.pts.se/index_eng.asp.

Another aspect of market power is market dominance, the definition of which varies significantly in the laws and jurisprudence of different countries. According to the World Bank's *Telecommunications Regulation Handbook*[20] two key factors in the determination of market dominance are highlighted. First, there should be a relatively high market share. Second, there must typically be significant barriers to entry to the relevant markets occupied by the dominant firm. For example, in early 2002, the European Commission challenged the Dutch mobile operator, KPN Mobile and fixed operator, KPN Telecom, on grounds of violation of EC competition rules, alleging that it has abused its dominant position regarding the termination of telephone calls on KPN's mobile network, with which it has an exclusive agreement. The complaint stems from the United States operator, MCI WorldCom, a new entrant on the European mobile scene.[21] In the United States, the regulator, the FCC, applies a similar a dominant carrier regulation, although no mobile operator currently has a high enough market share to meet the threshold criteria.

4.3.2 Merger control

Corporate mergers are not unusual in the business world. In many cases the impact of a merger on competition is not so great, and by merging, companies can realize economies of scale, enrichment of their finances and more effective management. But if a merger creates dominant power in a market, there is a greater potential for excessive market power and abuse of dominance, potentially undermining consumer and social benefits. This is why governments often regulate mergers.

Despite the ubiquity of mergers, telecommunication regulators (and sector ministries) are responsible for approving mergers in the industry in around half the countries of the world. This is mainly because the telecommunication infrastructure is heavily dependent on, and affected by, technological conditions.

As in the case of SMP regulation, when the authority examines a possible merger, it clearly defines the relevant market and then evaluates the operator's market share and barriers to market entry following the merger. An example of this assessment process can be found in the *Horizontal Merger Guidelines*, published by the United States Department of Justice and the Federal Trade Commission (FTC).[22] These guidelines set out a five-stage assessment process:

- Market definition, measurement and concentration;
- The potential adverse competitive effects of mergers;
- Entry analysis;
- Efficiencies;
- Failure and existing assets.

After evaluation, regulators decide whether or not to approve the merger. If it is approved, the regulator sometimes attaches conditions or modifications in order to prevent or reduce anti-competitive effects, or require the companies in question to divest assets or operations in order to eliminate potential anti-competitive effects.

In the mobile market, the number of operators has been on the rise since the 1990s and until recently merger cases have been quite a rare occurrence. However, the increasing business costs for launching 3G have meant that some operators are opting for mergers or taking the opportunity to acquire assets at bargain prices. For example, in the Republic of Korea, where three 3G licences were awarded, the original five 2G mobile operators merged into three as of 2000 (see Box 4.5).

4.3.3 Resource sharing

The advantages of sharing resources include the promotion of the economic efficiency of existing networks and realization of efficient competitive conditions for new operators. Operators that share networks are also able to get services up and running in less time than would otherwise be the case.

Box 4.5: Policy on mergers in Korea

Mergers of 3G mobile operators

In the Korean mobile telecommunication market, competition was first introduced in 1996 when Shinsegi Telecom joined the market incumbent, Korea Mobile Telecom (renamed SK Telecom in 1997). In October 1997, KT Freetel (KTF), LG Telecom and Hansol PCS (later renamed to Korea Telecom M.com—KTM) launched their PCS services, bringing the total competing mobile companies to five. At the end of 2000, the breakdown of subscribers in the Korean mobile telecommunication market was as follows: SK Telecom: 41.4 per cent, KTF: 20.1 per cent, LGT: 15.0 per cent, KTM: 11.9 per cent, and Shinsegi: 11.6 per cent.

In December 1999, the largest market operator, SK Telecom, proposed a merger with Shinsegi Telecom by acquiring a controlling share of stakes in Shinsegi Telecom. Under the Telecommunication Business Law in Korea, the merger of mobile operators is subject to approval by the Ministry of Information and Communication (MIC), in consultation with Korea Fair Trade Commission (KFTC), Korea's anti-trust body. This proposal was approved in April 2000 by the KFTC, under the condition that the total market share be reduced to below 50 per cent by June 2001.

Meanwhile, KTF proposed a merger with KTM in 2000. This merger was not regarded as breaching anti-trust laws because it did not result in the accumulation of significant market power. In May 2001, the merger of KTF and KTM gave birth to a unified company under KTF.

As of the end of June 2001, SK Telecom (Shinsegi Telecom included) satisfied the KFTC's conditions by reducing its share of subscribers—partly accomplishing this by not engaging in active marketing in what is a fast-growing market—to 49.7 per cent at the end of June 2001, enabling its merger and acquisition (M&A) with Shinsegi Telecom. On 14 January 2002, the Ministry of Information and Communication gave its final approval of the merger with 13 attached conditions including the opening of the company's wireless Internet network to competitors, and equal network access rights to content providers and ISPs. Subsequently, the combined company has gained market share rapidly.

Source: White Paper 2000, Ministry of Information and Communication, Korea, December 2000; IT industry Outlook of Korea 2002, Korea Information Society Development Institute, at: http://www.mic.go.kr/.

Network sharing: Mobile virtual network operators (MVNO)

In the fixed-line market, it has become common for value-added service providers to lease circuits from other players. In the mobile market, because of the limited availability of frequency bands, there are fewer such providers than in the fixed market.

Mobile virtual network operators (MVNOs) are mobile or value-added service providers that buy access to networks on a resale basis and offer services in much the same way as a full network operator.[23] They are also sometimes referred to as "enhanced service providers". There are considerable disparities in policies governing MVNOs, in that some countries allow such resale of services, but have established no regulatory framework, while others explicitly prohibit this practice, and others still both permit and regulate it.

In many countries, the issue of regulatory intervention in the case of MVNOs has still to be resolved. One point of view is that regulation (for example, of access price and conditions) has the advantages of widening the choices available to mobile users, making more efficient use of spectrum, and stimulating competition, resulting in new and innovative services and lower prices. In Ireland and Hong Kong for instance, offering some portion of lines to MVNOs is a mandatory condition for 3G operators, while Malaysia does not explicitly impose this requirement on MVNOs, although there is some expectation that bidders offering to do so voluntarily will win good marks in the licensing process.

While it is often held that MVNOs are a good thing for competition, the opposing view is that the mobile environment is sufficiently competitive, and that the arrival of 3G operators (many high-income countries adopted the "n+1" approach) will further increase competition. The stance taken by some is one of "wait and see", leaving time for the 3G market situation to become clearer.

In any event, policy-makers need to be clear about their objectives if they do decide to establish regulatory provisions for MVNOs. In view of the current market climate however, and given the innovative potential of 3G, regulatory prudence is advisable.

Infrastructure sharing

Among mobile operators, site and tower sharing has been commonplace for several years. This practice is generally considered to promote new entrants' ability to compete against incumbent operators that already have facilities available and have occupied the best available sites. Such site and facility sharing has also prevented wasteful facility duplication, and from an environmental perspective has had a positive impact (e.g. fewer masts being built). In the early stages of 3G service deployment, network sharing is effective to cope with high initial costs and low income from a small number of subscribers. The concept of infrastructure sharing includes various models that are categorized according to the types of equipment operators share (see Table 4.4). Although infrastructure sharing benefits operators, discrepancies in operators' bargaining power can make it difficult to reach an agreement on sharing, and authorities may be requested to mediate (see Box 5.8 in Chapter five).

In order to ensure a predictable environment and legal certainty that is favourable for long-term investment, instead of permitting initial licensing conditions to be modified to reduce the financial burden on 3G licence holders, the European Union is encouraging infrastructure sharing.[24] However, for operators concerned with maintaining some autonomy, infrastructure sharing can present some difficulties with regard to cost reduction. Some operators maintain that the network needs to be kept under internal control, and that network sharing is therefore simply not an option.[25]

4.3.4 Pricing regulation

As discussed in Chapter two, the principal technical difference between 2G services, and higher-speed 2.5G and 3G services, is their Internet access method. A notable exception to this in the 2G era, was NTT DoCoMo, which actually introduced a packet-switched mobile network for data transmission. In the GSM world however, WAP services operate over circuit-switched networks and are not distinguished from voice calls, so are typically subject to per-minute-based billing. In contrast, 2.5G GPRS services use packet networks, and 3G technologies such as W-CDMA and CDMA2000 separate voice call and data transmission. Added to the complex landscape of billing and service types are SMS and MMS (see Chapter two). In the example described in Box 4.6, the Danish regulator, the National Telecom Agency, regards SMS as distinct from voice calls, and raises the possible need for adjustment of existing regulations.

This separation of voice and data calls can give rise to disputes where price regulation for mobile services exists. This stems from the fact that, in assessing operators' pricing, regulators review their operating and financing costs, and determine the rate of return. In this process, Internet access charges may be subject to different pricing according to whether data transmission is calculated as an independent service or as a merged service with voice calls. In particular, this distinction may influence price cap regulation, which gives operators a free hand in setting prices under a given price cap. Under this regulation, services are usually grouped into one or more service baskets, with different service baskets typically subject to different price cap indices.

Interconnection between operators also requires come calculation of cost. Interconnection principles, such as those set out in the Reference Paper for WTO's Agreement on Basic Telecommunications and the European Union's Interconnection Directive, require interconnection charges to be "cost-orientated"[26]—interconnection charges should approximate costs to prevent operators with market power demanding a high price for terminating calls. In respect of SMS services, however, interconnection agreements do not exist in many countries, meaning that it may fall to regulators to take the initiative in harmonizing operators' interests (see Box 4.7 on SMS interconnection in Chile and Venezuela).

Table 4.4: Infrastructure-sharing models

Models	Benefits	Prerequisites / drawbacks
Common network RAN + CN	Cost sharing for capital investment (capex) and operations expenditure (opex)	Extra Public Land Mobile Network identity and special organization
	Possibly better control over QoS than with geographical split	Coordination between common network and operators
		Clear definition required of when / what is the end of the common network
Site sharing	Reduction of the overall number of sites	Agreements on sites and antennas that can be shared; agreements on access to sites
	Preserves independence of each operator	Agreements between operators for supplier selection; access to equipment; site intervention
Antenna sharing	Mainly if there are restrictions for addition of antenna on site	Permanent solution as the migration cost is high
		Identical coverage- no differentiation possible
Shared cabinet Node B	Reduced hardware; footprint and site requirements	Agreements between operators for supplier selection; access to equipment and hardware management
Full RAN sharing	RNC sharing beneficial for both operators' low-level traffic	Tighter agreements and cooperation between operators than for shared cabinets or site sharing
		Loss of independence through common software management
		Specific development necessary for separate QoS handling

Note: RAN: radio access network; CN: core network; RNC: radio network controller; QoS: Quality of Service.

Source: European Commission Strives to Promote Network Sharing, 12 June 2002, 3G Mobile.

4.4 Promoting open mobile Internet platforms

A mobile Internet platform can be defined as a system that enables various Internet content or applications over a common infrastructure (such as content distribution, user authorization and billing). This platform can help harmonize mobile Internet market growth by offering a common and integrated service platform for users. With the emergence of 3G, bringing the fast data speeds that are necessary to enrich content and applications, opening up mobile Internet platforms to a wide range of entities will be important for accelerating market growth. As described in Chapters two and three, private companies and industrial bodies have usually taken the leading role in the development and standardization of mobile Internet platforms, while the role of governments has been relatively small. This is because the incentive for open platforms has usually been driven by market imperatives, at a juncture when operators have found them to be in their interest.

Under the Japanese business model for the mobile Internet, mobile operators offered all services—Internet access, portals and billing services—single-handedly. During the height of the 2G growth period, this model proved successful in stimulating new and attractive services speedily and efficiently. As described below, the three operators are planning to open their platforms to other ISPs. When a mobile Internet market reaches saturation, an open platform becomes ever more crucial for the expansion and success of future services.[27] One of the ways in which an open platform policy will benefit such markets, is by allowing new players onto the scene and providing a basis for the development of mobile virtual network operators and alternative information providers.

Box 4.6: Pricing SMS messages: The Danish regulator's response

In March 2001, a meeting was held between the Danish regulator and the Telecommunication Industries Association of Denmark to discuss the legal framework for premium rate services via SMS, e.g. ring tones, sport news or similar services.

The legislative provision in question was section 27(3) of the *Act on Competitive Conditions and Consumer Interests in the Telecommunications Market,* which states that telecommunication companies may not, as an integral part of charging calls to subscriber numbers, collect non-traffic-related payments from the calling end-user on behalf of third parties, unless the payment relates to information and content services. At a follow-up meeting in August 2001, technical conditions in connection with the transmission and charging of a premium rate SMS message were further reviewed. The regulator noted at that meeting, that since the transmission, reception and charging of premium rate SMS messages differ greatly from traditional voice telephony, which served as a framework for designing the legislation in question, premium rate SMS messages could not be considered to fall under the above-stated rules on information and content services.

The Agency has nonetheless asked the industry to ensure a high degree of consumer protection. For instance, it has asked the industry to ensure that the consumer will always be able to check and limit his usage of premium rate SMS, in particular:

- to inform the individual customer actively about the possibility of barring premium rate SMS messages;
- to give adequate price information.

Following the August 2001 meeting, and in light of the very rapid development in the area, the National Telecom Agency has also suggested to the Ministry of Information Technology and Research that it should consider, at the first opportunity, whether the existing legislation needs to be adjusted so as to ensure that the future framework will remain sufficiently flexible to support the development of data services for the benefit of the consumers.

In summary, the outcome of the case means that the present legislation will still allow telecommunications providers to offer premium rate SMS messages. However, that legislation may be revisited in the near future.

Source: Telestyrelsen, National Telecom Agency (Denmark), at: http://www2.tst.dk/uk/index_uk.htm.

Box 4.7: SMS interconnection in Chile and Venezuela

In Venezuela, the lack of price harmonization in SMS interconnection agreements has resulted in new policies being developed in what may serve as a useful precedent for other Latin American countries. In February 2002, the Venezuelan regulator CONATEL intervened in a dispute concerning interconnection of SMS platforms between Movilnet (which transported 120 million SMS per month, collecting US$ 0.025 per message) and Digitel (which transported 100 million SMS per month, collecting US$ 0.05 per message). Pressured by considerations about the early introduction of 2.5G systems, the regulator set out the general, technical and financial conditions and ordered the two companies to reach an agreement within 75 days. With this intervention, CONATEL established a new type of regulatory initiative, which is now being studied by other Latin American regulators that are facing similar problems of SMS interconnection in their markets.

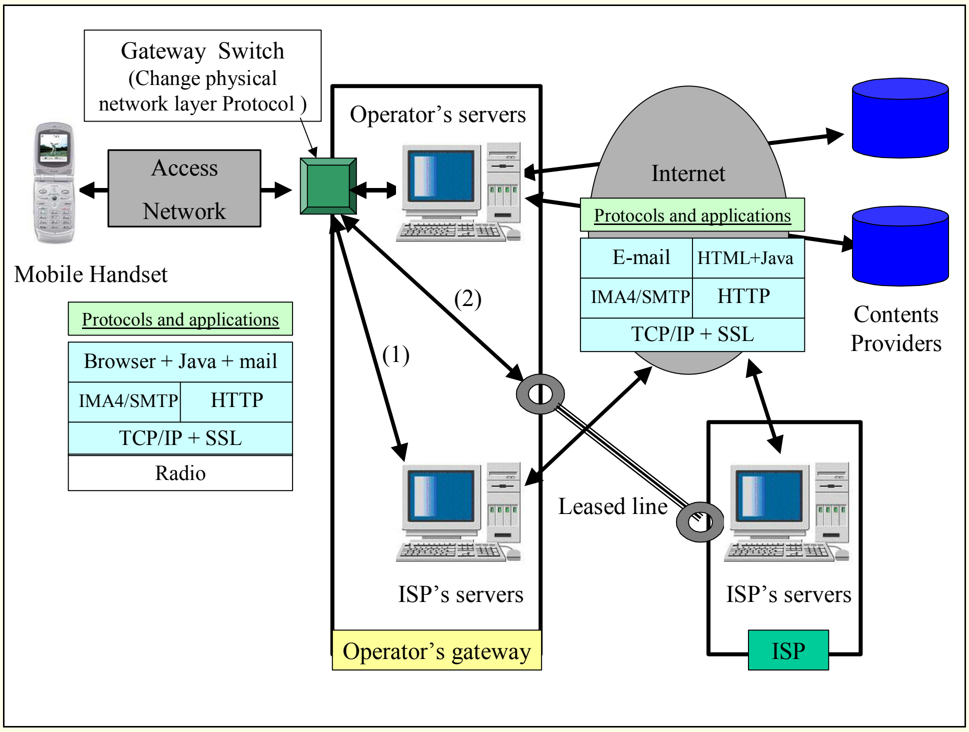
In the case of Chile, until mid-2002, Chilean mobile operators didn't have SMS interoperability, and users could send SMS only to other subscribers of the same operator. This slowed SMS penetration in Chile. By the initiative of mobile operator, ENTEL PCS, in June 2002, all Chile mobile operators signed an agreement that would allow for inter-carrier SMS interconnection. This is expected to expand SMS use in Chile.

Source: "Chile SMS agreement create a new competitive environment", 17 July 2002, Pyramid Research.

4.4.1 Gateways

In the case of WAP, users can decide which ISPs or content providers to access. By contrast, for i-mode, which runs over a packet network, the operator's gateway is the only Internet access route (see Figure 4.3). In this model, users access the Internet via the mobile operator's gateway only. Compared with the fixed Internet, this system may still place the other ISPs at a disadvantage because only the network operators have users' access details.

Figure 4.3: Open mobile Internet access for 3G (W-CDMA)



Note: There are two access methods for other ISPs:
(1) Location of ISP's servers in the operator's building;
(2) Connection of the ISP's servers outside operator's building via leased lines.
Source: "Report on business models for next generation mobile systems", 26 June 2001, MPHPT, Japan.

In Japan, the MPHPT set up a study group on business models for next-generation mobile phones, and released a report in June 2001.[28] In the report, the three incumbent mobile operators revealed that they were planning to open their gateways to other ISPs: NTT DoCoMo announced that it would establish an environment that would make it possible for its mobile users to access other ISPs within two years. KDDI also revealed its intention to open a gateway but did not specify the timing. J-Phone said that is was considering similar measures. Even when the gateways are open to other ISPs (see Figure 4.3), the regulator may check the status of this open gateway policy[29] (e.g. if other ISP's interconnection costs are high, in reality no ISP would connect its gateway to the mobile operator's network). In a similar move, a forum of industrial bodies and regulators was established in Korea, and has decided to open gateways to other ISPs (see Box 4.8).

Box 4.8: The Korean approach to open gateways and portals

In the past, Korean mobile operators have maintained an exclusive network which excluded other ISPs from connecting directly to their networks, so that data transmission between mobile users and other ISPs or content providers has had to pass through the operators' own servers. In June 2001 however, the Korean Mobile Internet Forum, which comprises all stakeholders in the Korean mobile Internet market, agreed that mobile operators would open their networks to other operators, ISPs, and content providers by allowing access to their gateways and InterWorking Function (IWF), a function unique to the CDMA2000 network.

The process is composed of three stages. The first stage involves the opening of operator portals to other content providers. During this stage, users are able to access other portals via the operators' servers. Three Korean mobile operators offer this service. In 2002-2003, during the second stage, the gateway will be opened to other ISPs directly, so that users can access them directly via the operator's gateways without requiring access to the operator's servers. While the content providers can provide their content independently, they still depend on the operator's network for billing. In the third stage, the IWF will be opened to other operators, ISPs and content providers directly, so that they may compete with mobile operators.

Source: MIC Report on "Open Mobile Internet Networks", 2002, at: http://www.mic.go.kr/.

4.4.2 Portal access

Even where other ISPs can access mobile networks directly, another platform that potentially needs to be opened is the portal site. A portal offers links to other selected websites at one click, by entering the relevant URL, and is typically the first Web page that users access.

Open platform portals raise two important issues. The first is how to secure transparency in the selection of portal content. In China, the "Monternet" programme of China Mobile has opened portals to content providers (see Chapter five). Under the model used by i-mode, the mobile operator selects "official sites", with the advantage that the operator collects the content charge. In all cases, the selection process for "official sites" should be transparent in order to avoid unfair selection by operators. For instance, operators might release customer identification only for official sites, and in return collect content fees for content providers. Content providers claim that screening standards are not transparent and that the treatment of official sites is in fact discriminatory. Japan took a step further: The MPHPT commissioned a report in June 2001, which recommended that the concerned parties—comprising operators, content providers and ISPs—jointly set up an organization to determine the criteria for selecting sites for which operators would collect subscription fees. Under the new, expanded system, operators would collect fees not only for their "official sites", but also for other sites which satisfied the criteria of the organization. In December 2001, the MPHPT proposed a government-industry initiative for the evaluation of mobile content development (see Box 3.1 in Chapter three). Korean operators, meanwhile, have opened portals to other ISPs in the first part of a three-stage opening process (see Box 4.8).

The second issue is ensuring equal portal selection. If a mobile operator offers its own portal site exclusively (a "walled garden"), despite opening its platform to other ISPs, it would have strong advantages over these and other content providers. Japanese operators have now adopted this model, and some WAP operators have also tried to keep their Internet access users within their own portal sites. From the viewpoint of fair competition, users should have freedom and autonomy in selecting a portal site, just as they do when accessing the Internet from a PC, or the operator should add links to other ISPs' portal sites where the mobile operator offers its own portal site. The role of regulators then, should be to secure such autonomy for users (see Box 4.9), as well as mediating between operators and ISPs or content providers, where necessary.

4.4.3 Billing platforms

As discussed in Chapter three, mobile commerce (m-commerce) is set to expand in the future, and will not only cover the low-cost goods and content of the 2G era, but will begin to expand to cover more expensive items. In many countries, m-commerce alliances have been established and have started to operate. But the lack of a single billing platform is the most significant obstacle to ensuring that such operators can realize the potential revenues to be reaped from m-commerce.

The problem is that, if each content provider establishes its own billing system, independently from others, users have to repeat the registration process with each individual provider, and will be billed separately by each one. For the user, this can seem as onerous as having to go to a different supermarket checkout for each item in their shopping trolley. The other problem is security—not all providers offer a high-security data transaction system, or protect user information sufficiently. To avoid these problems, it is expected that a common billing platform will be developed. As things stand, there are three common billing platforms for

Box 4.9: The case of France Telecom's locked portal

In April 2000, France Telecom announced that users of its mobile handset packs would be locked into its own WAP portal. A French Internet and WAP portal company, Wappup.com, took France Telecom to the Commercial Court in Paris. It complained that France Telecom's product was anti-competitive, and therefore a threat to the fledgling French wireless application protocol market. On 23 May 2000, the court granted an injunction blocking the company from selling its WAP-enabled mobile phones that lock users into its own WAP portal. The impact of the court decision was not without effect, as France Telecom decided to enable its WAP phones to allow user access to alternative servers with adequate performance, as from 13 June 2000.

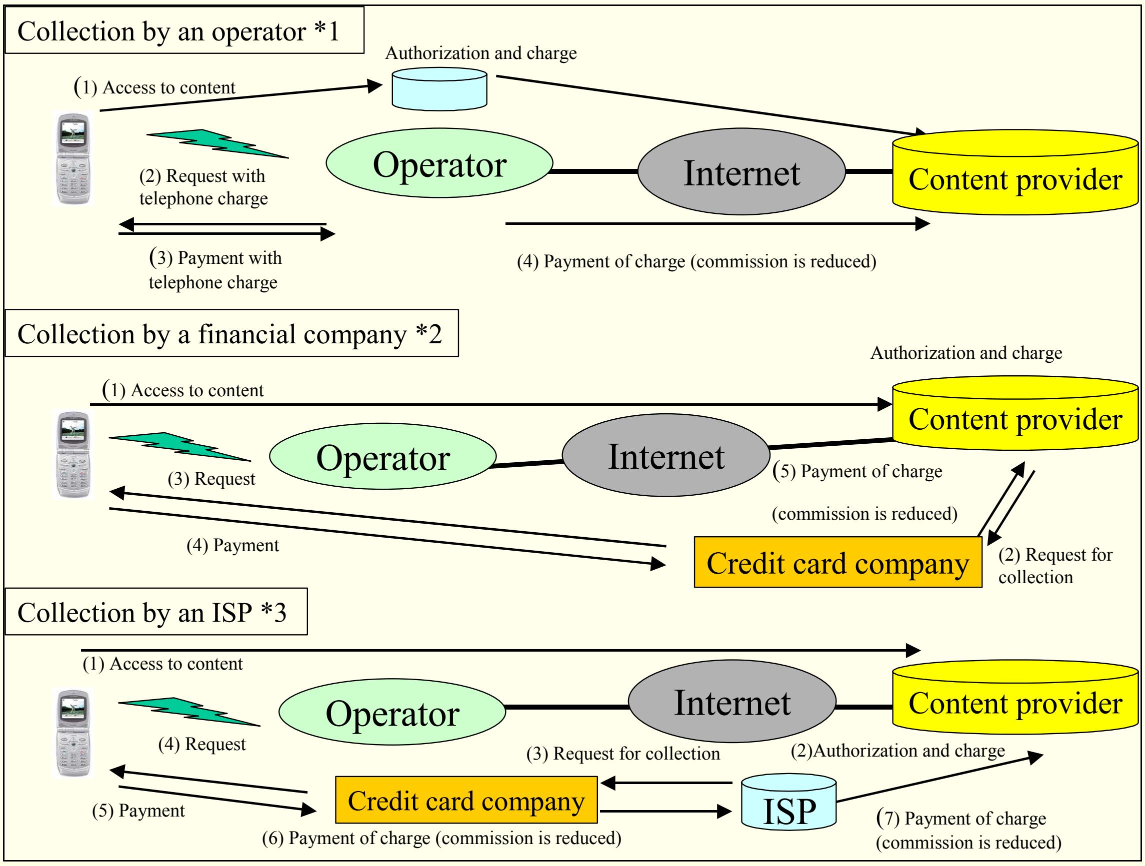
Source: Total Telecom, "Court rules against France Telecom in WAP case", 1 June 2000.

mobile services. The first of these is the i-mode model, whereby mobile operators authorize their subscribers, and collect bills for their "official content" that are stored in their servers, instead of with content providers. The second is collection by financial institutions such as credit card companies or banks. These institutions authorize and collect charges on behalf of the content providers. The third method is collection by ISPs. In this case, ISPs authorize the user and charge for content, while financial companies such as credit companies or banks collect the charges from the user at the same time as other ISP charges (see Figure 4.4).

A number of initiatives for establishing common billing platforms already exist, including the Mobey Forum, in which European and United States banks participate. But despite such international efforts at cooperation, common billing platforms are typically developed by a single operator with or without a single banking partner, and few have yet been tested outside the originator's home market.[30] Here, there is potentially an important mediating role to be played by regulators. One such example comes from Spain, where the three incumbents, the new 3G entrant Xfera, and banks with at least an 80 per cent share of the Spanish banking market have formed the "MobiPay" consortium billing platform. This was in conjunction with intervention from the Spanish regulator, the *Dirección General de Telecomunicaciones*, to ensure fair competition. The original plan to establish a common m-commerce platform was hatched by two of the incumbent operators—a move that was found to be anti-competitve by the regulator, which, in 2001, stepped in and forced them to adopt a single platform.[31]

Figure 4.4: The payment chain: models for common billing

Content billing platforms for common billing



Note: *1: adopted typically by i-mode business model. This shows when a user accesses its 'official content'.
*2: in this case, a user inputs ID given by a credit card company, when he/she buys content.
*3: in this case, a user inputs ID given by an ISP, when he/she buys content.
In cases *2 and *3, not only credit card companies, but other financial institutions, such as banks, may be involved.

Source: Adapted from "Report on business models for next generation mobile systems", 26 June 2001, MPHPT, Japan.

Generally speaking, a common billing platform is favourable for the development of m-commerce, but it could also be argued that a single billing platform has the potential to create closed "clubs", preventing fair competition between participants and outsiders. Regulators therefore need to continually evaluate whether a particular billing platform is open to new entrants in the interest of fair competition.

4.4.4 Handset peculiarities

In the 3G era, mobile handsets will not be the only mobile Internet access devices. Each user is likely to own a number of devices with a telecommunication function for specific purposes. For this reason, smooth transition between devices is set to become a *sine qua non*. One example of technology enabling this kind of transition is the adoption of SIM cards by GSM operators, which enable information, including user identity, to be stored and retrieved when changing handsets. Along similar lines, W-CDMA has adopted the Universal Subscriber Identity Module[32] (USIM) that can store much more information and has strong security functions compared with SIMs. USIMs can also function as electronic wallets or credit cards.[33] Some operators using another 3G standard, CDMA2000, are also adopting the same kind of card.[34] With the freedom it offers, and also because it can store a lot of information and offer various functions, USIM has the potential to realize "ubiquitous" computing for the mobile Internet era. Given the relative harmonization of 3G standards compared to 2G ones, it also stands to be a more "roamable" asset. A USIM is, however, not without disadvantages, including the lack of easy switching of terminals due to USIM locks and the lack of number portability. These two features are described below.

USIM locking

In many countries, mobile handsets are obtainable at a particularly cheap price when a contract is simultaneously concluded with a mobile operator. This is because retail shops often receive subsidies from mobile operators. The mobile operator pays the initial costs for its new subscribers, aiming to recoup these costs later through fees.[35] Obviously, this arrangement is only attractive to operators insofar as their users stay under contract at least until all the initial costs have been recouped. One way of ensuring this is for operators to impose a long-term contract using the so-called "SIM-lock" system, by which user information on the SIM cannot be changed. The handset cannot be used on any network other than that of the original operator. The danger for users is that the SIM card remains locked for an extended period, even once the initial costs have been recouped by the operator, effectively leaving the user out of pocket. To address this problem, the United Kingdom regulator, OFTEL, considers 12 months to be sufficient for initial costs to be reimbursed and requires that operators "unlock" after 12 months.[36]

Although the future USIM card has higher performance and stronger security functions than current SIM cards, if operators apply USIM locking in the same way as some have applied SIM locking, any advantages of USIM over SIM are effectively negated. However, once unlocked, USIM cards regain all of their advantages, including the possibility of number portability.

Number portability

Even though voice calls will be just one of several mobile functions in the 3G era, mobile phone numbers will go on being an important piece of information for users. When a user changes mobile operator, keeping the same number (number portability), will be a high priority. For example, with number portability, it will be possible for a user to change mobile operator without changing their mobile handset once the USIM lock is no longer in place.

Many major economies have introduced number portability over fixed lines, but the mobile market paints a different picture, although some European countries have introduced mobile number portability, such as the United Kingdom (January 1999) and the Netherlands (April 1999).[37] The United States had also planned to introduce mobile number portability in November 2002, but has postponed this for one year. This is mainly in order to resolve implementation issues such as training personnel, and other non-technical tasks, and to reduce the burden of simultaneous implementation of number portability.[38] Japan is also recognizing the importance of introducing number portability for competition.[39]

4.5 Fostering cooperation at a global level

The world is becoming more mobile, and not just in technological terms: users too, travel increasingly between countries. Seamless global roaming has thus become an essential requirement for operators. Global roaming will require the resolution of a number of technical, as well as commercial and regulatory issues. Accompanying this trend is the emergence of cooperation in developing new technologies for roaming.

4.5.1 Roaming issues

Roaming essentially refers to the possibility for users to communicate when moving between different countries or regions (different frequency bands and billing systems), or to communicate between devices based on different technologies (interoperability). For the success of 3G, it will be essential to ensure seamless and affordable international roaming, as well as roaming between 2G and 3G, during the transition phase. With three different technologies and five frequency bands approved for 3G, and with different systems operating between countries, a number of interface and "frequency bridging" issues need to be resolved for 3G services to guarantee full interoperability.

A number of technical solutions have been found to accommodate international roaming. For example, international roaming using GSM was originally impossible owing to incompatibility of the GSM standard with standards used in the Americas and some parts of Asia, notably Japan and South Korea. However, since the widespread adoption of GSM in the 1990s, GSM handsets have been developed which support the PCS-1900 standard used in the Americas, and others have been developed which support both GSM and the PHS standard used in Japan. For 2.5G networks, international roaming services are already being offered on the GPRS network, GRX, and by the cdmaOne group.[40]

The IMT-2000 (International Mobile Communications) standard, developed under the auspices of ITU, gives technical specifications for 3G systems that have been approved by all the main players in the market. However, a single standard could not be agreed on, with the result that IMT-2000 actually covers several different interfaces and access technologies (see Chapter two).

As regards affordability, considerable concern has been expressed at the very high costs of international mobile roaming. While telecommunication charges have generally declined, roaming bills have increased, and such high and unpredictable costs have been inhibiting the use of mobile telephones during international travel. One possible way forward is to stimulate more price competition. Promoting greater price transparency and simplified tariffs, introducing prepaid roaming, or encouraging substitutability between services may achieve this. In Europe, where GSM international roaming is very common, sensitivity to international roaming charges is increasing, both in terms of competition and market structure.[41] There is no regulation of international roaming charges and mobile operators have considerable bargaining power. Hence, the charges are up to five times higher than for national mobile calls to the same destination within the European Union.[42] The European Union is therefore carrying out an inquiry on international roaming, the purpose of which is to investigate the conditions and pricing of mobile roaming by collecting comparative information on prices and cost levels for all European Union mobile operators.[43] In the GSM world, international SMS roaming charges are also under debate, with the International Telecommunications Users Group (INTUG) calling on national regulators to examine carefully the behaviour of mobile operators in charging for SMS, and to reduce the costs of SMS for international roaming customers.[44]

With increased international travel, and as the Internet becomes a necessary part of daily life, the need for anywhere, anytime Internet access is increasing. International mobile data roaming is therefore also a growing necessity. But, as we have seen, as international roaming agreements are concluded between operators, without any involvement of regulators, roaming charges tend to be high. If the international roaming charge is dramatically more expensive than national interconnection charge, and there is no provision for cost-orientated charges, users lose out, market growth is hampered. Regulators therefore have an important role to play in establishing appropriate cost-orientated roaming charges.

4.5.2 Global circulation of terminals

Global circulation relates to the right of users to carry their IMT-2000 terminals from their home country to another, and the ability to use these terminals when accepted and connected by a network operator.[45]

There are two requirements for global circulation. The first relates to the *temporary* entry of pre-established terminals into a foreign country, and their exemption from regulation. In practical terms, this pertains to a subscriber's right to carry a personal handset into foreign countries and to use it, subject to network coverage and commercial roaming arrangements between operators. This issue is currently being considered by ITU's Radiocommunication Sector (ITU-R), as described below.

The second requirement concerns restrictions imposed on foreign manufacturers for the *import* of handsets in a given country. This will most likely be dealt with through Mutual Recognition Agreements (MRAs), which are negotiated bilaterally and are measures for the mutual certification of radio equipment imported or exported for the purpose of conventional and permanent use.

Mechanisms to facilitate global circulation

Working Party 8F of the ITU Radiocommunication Bureau (ITU-R WP8F)[46] identified the following three principles to facilitate global circulation of IMT-2000 terminals:

- Regulators are not to require any licence for visiting terminals;
- Regulators are not to require an additional terminal certification or type approval for visiting terminals;
- IMT-2000 terminals should be included under the terms of an arrangement between customs' administrations in order to facilitate customs clearance for users intending to carry and use their personal equipment in the visited country or transiting to another country, such as the Istanbul Convention.[47]

An important requirement for global circulation is that the network should be able to detect and identify a terminal causing harmful interference and deny service to the identified terminal. Under ITU-R Recommendations, IMT-2000 terminals would have to meet a "uniqueness" test, which requires each terminal to have a unique identity or number. When a terminal malfunctions, regulators in the visiting country or a network operator would have the ability to trace the terminal. Some interested parties are working on an industry initiative to give access to the electronic equipment identity information of each terminal. Others have proposed that access to the information should be provided through a neutral body, like ITU. Some Administrations remain uncertain about how the technical requirements of ITU-R Recommendations fit into the overall regulatory approach. Meanwhile, the IMT-2000 Forum of the Asia-Pacific Telecommunity (APT IMT-2000 Forum) has taken the initiative of implementing a mechanism to trace and identify terminals at the regional level. Above all, international discussions have revealed the areas that require further work in order to establish internationally recognized criteria (see Box 4.10).

4.6 Protecting the consumer

Ubiquitous mobile Internet using broadband access will be soon be a widespread reality, involving many service providers, and many users. Compared with ordinary human-to-human interfaces, these online data transactions can treat a lot of data quickly and accurately, and service providers can respond to the needs of individual customers, for instance by creating databases. However, unless users have readily available information on these various and enhanced services, they may not be able to use them effectively, may not find the services they need, and could thus run into difficulties.

One example of consumer protection rules is the OECD's *Consumer Protection Guidelines*, issued in December 1999 (see Box 4.11). Its recommendations create a framework for good practice and are designed for inclusion in possible legislation. It recommends that governments, business communities and consumer groups should work together nationally and internationally to implement the guidelines and make companies and the general public more aware of consumer protection laws. In many countries, various entities have developed similar guidelines to protect consumers in e-commerce.

It is also important to bear in mind that there are a number of differences between m-commerce and e-commerce using PCs. One such difference relates to users. The speed of mobile handsets is generally faster than PCs. There will be a large number of users who have limited experience and insufficient technical and legal knowledge about m-commerce. Another difference relates to the limited screen capacity of mobile terminals to display items such as forms or contracts, as well as limited keypad functions for entering data (e.g. the absence of specific "delete" or "enter" keys). This affects the way in which personal information might be solicited or captured. For these reasons, special regulations for mobile Internet consumers may be required.

Box 4.10: The potential role of ITU in the global circulation of terminals

Some ITU Member States participating in the work of ITU-R WP8F have raised regulatory concerns related to the principles established by the Working Party. The main concern expressed is that *without any regulatory arrangements*, it might not be possible to ensure that visiting IMT-2000 terminals are in compliance with the laws and policies of the visited country. Thus developing a regulatory framework for the efficient global circulation of handsets has become a priority for both industry and governments.

ITU requested comments from its Member States about the three regulatory principles established by the Working Group in January 2001, through a request for comments (RFC). Each Administration was invited to comment by indicating 1) whether it already applies the three principles (see section 4.5.2); 2) whether it intends to apply them at a future date; or 3) whether any of them will not be applied. The aim was to open a dialogue for building an interface between facilitating global circulation and the rights of Administrations to regulate their telecommunications. The results showed some disparity among type approval authorities and procedures, with a significant majority of respondents not recognizing technical tests, conformance tests, or type approvals carried out by foreign authorities or test laboratories. In the majority of cases, type approval is mandatory for all radio terminal equipment. One-half of the respondents required the same type approval process for visiting terminals and terminals that are to be placed on the market. The respondents are equally divided about whether international standards, mostly ITU Recommendations, are mandatory for radio terminal equipment to circulate in their country. This demonstrated the need to build an internationally recognized framework, to give Administrations the confidence that visiting terminals would not cause harmful interference in case of malfunction. In the light of these priorities, ITU-R WP8F is in the process of approving the basic technical requirements that would be applied globally to prevent terminals from causing harmful interference in the visited country.[48]

The overall consensus to emerge from discussions, whether within ITU or elsewhere, is that, whatever the global circulation mechanism, it should be developed on a globally agreed technical basis.

Box 4.11: Consumer protection guidelines

Main points of OECD guidelines on the protection of consumers using e-commerce (December 1999)

- Businesses should not act, or make any representation or omission that might be deceptive, misleading, fraudulent or unfair. Information about companies, products or services should be "clear, conspicuous, accurate and easily accessible". Businesses should comply with policy/practice statements made, clearly identify advertising and marketing, and be aware of global e-commerce regulations.
- Consumer requests to stop unsolicited commercial e-mail messages (spamming) should be respected.
- Information on transaction terms, conditions, delivery and costs should be sufficient for the customer to make an "informed choice" about whether to proceed with a purchase.
- The consumer should be able to check precisely the goods/services they are buying, before completing the transaction and be able to cancel should they later change their minds.
- Companies should provide secure payment methods and give information on security levels these provide.
- Consumers with a complaint should have access to 'fair and timely' redress and not face 'undue cost or burdens'. Governments should assess current legal frameworks to see if e-commerce consumers are given the same protection as other consumers

Source: OECD Guidelines For E-Consumers. See OECD website at http://www.oecd.org/EN/home/0,,EN-home-29-nodirectorate-no-no--29,00.html.

4.6.1 Privacy protection

When mobile handsets were used only for voice calls, private user information was known only to mobile operators. With the mobile Internet, many entities, such as ISPs and content providers, also process and keep user information, creating databases of this information and using it to advertise according to the preferences of each user. This is useful to content providers and, in most cases, also to users. With more detailed personal information at their disposal, content providers can more efficiently target consumers according to their specific areas of interest. However, as databases contain increasingly detailed information on users, and the number of entities holding such personal data increases, the risk of abuse or intrusion upon privacy is significantly raised. Personal information could potentially be revealed to any curious Internet "snooper", and perhaps modified, or used for illegal purposes.

Regulation of consumer privacy exists on two levels: legal regulation, and self-regulation by industry players. In the United States, various Acts concerning privacy protection exist, such as the Privacy Act and Children's Online Privacy Protection Act. The Department of Commerce has also issued "safe harbour" guidelines on privacy protection. The Federal Trade Commission (FTC) supervises companies and groups participating in these guidelines based on the FTC Act. Self-regulation also plays an important role in the United States. Private sector privacy protection groups, such as the "Better Business Bureau OnLine" (BBB) and TRUSTe, are recognized as "safe harbour" supervisory organizations. The "safe harbour" guideline principles are as follows[49]: (1) notice: obligation of informing individuals about the purpose etc., (2) choice: securing individuals' opportunity of choice, (3) safe harbour sensitive information principle: sensitive information must be given affirmative or explicit (opt-in) choice (4) onward transfer: applying (1) and (2), when organizations disclose information to a third party, (5) security: obligation of taking reasonable precautions to protect information, (6) Data integrity: personal information must be relevant for the purposes for which it is to be used, (7) access: Individual must have access to personal information about them and (8) enforcement: enforcement of Principles. BBBOnLine has been implementing a "privacy seal" programme since March 1999. Under the programme, it gives authority to websites or online services that satisfy conditions to protect privacy by granting them a "privacy seal", a symbol of privacy protection that the providers can display on their homepages as a mark of quality. Consumers can then rely on such "marked" network operators and service providers. TRUSTe has a similar "privacy mark" programme.

Clearly, such protective measures for privacy and security of information on individual users also need to be extended to the mobile Internet, and regulators and industry players need to be working towards that goal as part and parcel of the services and applications offered.

4.6.2 Secure mobile data transactions

Data protection for mobile transactions is also an important security issue. Data in digital form are particularly vulnerable to being copied or modified by a third party, and there is the added complication that such data can be produced anonymously, making it difficult to identify malicious intruders or "spoofers". The issue of security is a very important one, as concerns in recent years about viruses, cyberterrorism, hackers, and so forth, have shown.[50]

Security

Although, wireless networks allow increased freedom of movement, their proliferation means that security features, such as corporate firewalls built around LANs and WANs, may no longer suffice. Data stores and transmissions are becoming increasingly vulnerable to interception, hacking and viruses. In addition, with wireless becoming the network of choice, issues such as access to emergency services and the role of location-based services are being examined. The main vulnerabilities occur at the translation point between the wireless protocols and the wireline (fixed) protocols. Others exist once the transmission arrives at the wired Internet and becomes subject to the vulnerabilities of that network. Table 4.5 shows a number of different possible types of threat against 3G systems.

Table 4.5: Predicted threats against 3G systems

Category	Examples of threats
Threat to network facilities	Congestion (impossible or difficult connection) Spoofing (call charges billed to another user)
Threat to terminal	Programming bugs in terminal operating system (delete address data, freeze) Viruses (destroy address data, depletion of terminal resource, e.g. memory and battery) Unauthorized use of the terminal ("theft" of personal information) Connection of other device (reading data surreptitiously by spoofing)
Threat to Internet access	Violation of copyright through streaming-data Unauthorised access and cyber-terrorism, distributed denial of service (DdoS) attacks, whereby a network intruder may cause network problems or shut-down. Spam mail

Source: Report from "Study group on security and reliability of 3G mobile communications systems", MPHPT, Japan.

As more and more information of a private or sensitive nature is stored on mobile devices, strong authentication procedures are required to prevent security breaches. The new WAP (Wireless Application Protocol) 2.0 protocol has a security layer embedded into it known as WTLS, or "Wireless Transport Layer for Security". Also, both 3GPP and 3GPP2 have approved security principles for 3G. 3GPP's security principles, for instance, are based on countermeasures and problems already encountered in 2G networks. They include the following:

- 3G security will build on the security of second-generation systems. Security elements within GSM and other second-generation systems that have proven to be necessary and robust, shall be adopted for 3G security.
- 3G security will improve on the security of second generation systems ; 3G security will address and correct real and perceived weaknesses in second-generation systems.
- 3G security will offer new security features and will secure new services offered by 3G.[51]

Authentication using "public key infrastructure" (PKI) is seen as an essential method for addressing the wireless security paradigm. 3G mobile handsets will have (1) a USIM card that has tamper resistance (technology protecting IC chips against data analysis and modification), (2) a function as an IC card reader with input and output device and (3) function of input and output by radio. However, handsets will still have less capacity than PCs, making it difficult to directly utilize the current " strong" PKI technology standard used for the fixed-line Internet for the mobile Internet. In establishing a PKI for the mobile Internet (or "wireless PKI", as mentioned in Chapter two), it will be necessary to take into account the limitations of current mobile handsets.[52]

In data transactions between service providers and their customers, the providers are in possession of more information than the average non-technically savvy user, and therefore of greater bargaining power. Assuming that most mobile users have little knowledge of mobile technology and legal issues, it is imperative that consumers' rights be protected by appropriate measures. To that end, regulators will need to establish recognized consumer protection rules.

As mentioned previously, compared to e-commerce over PCs, m-commerce will usually involve terminals that have a smaller display and less convenient input methods than PCs. These characteristics may cause consumers to misunderstand information, or mistakenly press the wrong keys, when undertaking contractual engagements,. To protect consumers, service providers should therefore foresee countermeasures. In fact, the European Union has issued a directive on electronic commerce, in which it states that service providers should clearly set out for their customers: "the technical means for identifying and correcting input errors prior to the placing of the order".[53]

4.6.3 Mobile spamming

"Spam" mail is mail that is unsolicited by receivers, and that is typically sent for the purpose of advertising the services of the sender. This in itself may not be harmful, particularly where the service provider sends advertising mails that match the preferences and interests of the consumer; it may even be more appropriate and efficient for providers to adopt a one-to-one approach to consumers. The problem arises however, when the mails received are unwelcome; for instance in a receiving party pays (RPP) environment where the receiving user incurs charges. Not only is there the factor of annoyance, but also that of the cost and extra burden to the user's system of files that can be large and timely to download. Table 4.6 shows a comparison of Spam mail effects between PCs and mobile phones, demonstrating that mobile phones are more vulnerable, leading to greater financial consequences for mobile users.

Legal and technical countermeasures are also available against spam mails. Among legal countermeasures, there are two main approaches. One is the "opt-in" approach, whereby service providers can contact only consumers who specify that they are willing to receive messages. Under this approach, all other commercial mails would be prohibited. The European Parliament recommended that Member States adopt this approach to control both e-mails and SMS messages in April 2002.[54] Similar opt-in legislation already exists in some European Union Member States, such as Italy and Germany. One difficulty raised by this approach however, is how to legitimate consumers' intention of receiving in advance. The other approach is the so-called "opt-out" approach. Under this approach, service providers may send mails or SMS, unless consumers request that they stop. The reasoning behind this approach is that unsolicited SMS can sometimes be an effective and desirable marketing tool. The United Kingdom and France have adopted this approach. Industrial bodies also generally prefer this "opt-out" approach to the "opt-in" approach.

There are also a number of technical countermeasures, of which filtering is perhaps the most significant. Filtering is applied by the user, and involves the systematic deletion of mails sent by specific senders or containing specific word(s) by an ISP's mail server or terminal. For this measure to work, users must first understand what the filtering system is, and then must identify senders' names, or select the most appropriate word(s) contained in the unwanted spam mails. Failing this, the system may delete wanted, as well as unwanted, mails. Box 4.12 shows the situation in Japan since mobile Internet access services were first introduced, together with operators' and governmental countermeasures. However, even as countermeasures are developed and implemented, new ways of overcoming such measures are also being developed, as blocking spam requires ongoing effort and inventiveness.

Table 4.6: Comparison of SPAM mail effects to PCs and mobile phones

	PC	Mobile handset
Billing	Many broadband service providers offer flat rate service	Billing in proportion to the number of mails
Capacity of mail box	Large (hard disc or other storing devices)	Small (spam mails may fully occupy mail box capacity)
Header information	Users can read header information that show routing information from mail senders	Users can read only sent and received mail addresses
Filtering function in terminals	Various systems are provided	Handset capacity is limited

Source: Report from "Study group on Security and Reliability of 3G Mobile Communications Systems", 12 December 2001, MPHPT, Japan.

Box 4.12: Serious SPAM damage in Japan, and the countermeasures

NTT Docomo had initially given its 'i-mode' mobile handsets e-mail addresses as follows: '(phone number)@DoCoMo.ne.jp'. Spammers could send-users mail by generating random 8-digit e-mail addresses. As a result, in October 2001, DoCoMo users received some 950 million e-mails every day, of which about 800 million are returned to senders because of unknown addresses, putting a huge strain on its servers. Users of other operators also receive a lot of spam mail. In June 2002, operators received 140 thousand complaints about spam mail. Some complained that they receive hundreds of spam mails per day. Since July, Docomo has urged its subscribers to change to new addresses containing alphanumeric characters. Now, spammers have to introduce new systems to create random addresses including alphanumerics.

In November 2001, DoCoMo built a system to block e-mails sent to unknown addresses, whereby error messages are not returned to senders in order not to inform them of non-existent addresses. DoCoMo also won a temporary injunction in the city of Yokohama to bar the Web company Global Networks from sending randomly generated e-mail to addresses with the suffix '@DoCoMo.ne.jp'. In January 2002, it launched a service enabling users to designate a maximum of ten domain names from which they want to receive e-mails, and to block e-mail from others. Other operators have introduced similar systems. However, devious spammers have been able to get around this by sending spam mail using fake domains. In April 2002, DoCoMo upgraded its mail server to block such forged-domain spam mails.

The Government also provides countermeasures. In January 2002, METI (Ministry of Economy, Trade and Industry) obliged content providers to show 'mi-syoudaku-koukoku (non-agreed advertisement)' in the mail header, so that users can delete these mails without opening them. The MPHPT has also established a new law adopting the "opt-out" approach, prohibiting the sending of random bulk mail.

Source: NTT DoCoMo, http://www.nttDoCoMo.com/home.html; MPHPT, Japan, http://www.soumu.go.jp/.

4.6.4 Health protection

With growth in mobile handset ownership, fears have been raised that radio frequency energy emitted by handsets are harmful to human health, even though the energy is said to be at a low level.[55] In many countries, both governments and the private sector have been studying the relation of cause and effect between mobile handsets and human health, especially in relation to brain tumors, giving rise a number of reports. The conclusions to date vary widely. But all reports concur that no *definitive* results have been found and that more research is needed into the long-term effects. Box 4.12 summarizes a United States General Accounting Office (GAO) report about this issue published in May 2001. It recommends a methodology for regulators to provide consumer information about this issue. The World Health Organization (WHO) has also initiated an International EMF (Electromotive Force) project[56] intended to address concerns about possible health effects from exposure to radio frequencies.

While many regulators have established regulations to limit radio frequency energy, several industrial and international groups have also set out some kind of self-regulation, largely based on criteria using the specific absorption rate (SAR) measurement.[57] In the United States, manufacturers are obliged to respect the exposure limit determined by an FCC rule. Since June 2000, manufacturers also have to provide information on the SAR exposure rate of each handset type.[58] In the European Union, the European Parliament recommended an SAR exposure limit in July 1999. For its part, the *Comité Européen de Normalisation electronique* (CENELEC) standardized a measurement method in July 2001, and member states have introduced SAR regulations using this method. The Mobile Manufacturers Forum (MMF) has voluntarily published each handset's SAR rate since October 2001.[59] Since June 2002, Japan has also started to regulate exposure based on the SAR rate. In another initiative, the Association of Radio Industries and Business (ARIB) has decided to publish the SAR of all mobile handsets on the Web.

Box 4.13: United States General Accounting Office (GAO) Report, "Research and regulatory efforts on mobile phone health issues"

This report covers (1) the status of scientific research on mobile phone radio frequency energy as it relates to human health, (2) the United States Government's radio frequency exposure limit for mobile phones and status of ensuring compliance with this limit, and (3) key actions to inform the public about issues related mobile phone health effects.

(1) the consensus of the US Food and Drug Administration (FDA), the World Health Organization (WHO) and other major health agencies is that the research to date does not show radio frequency energy emitted from mobile phones to have adverse health effects but there is not yet enough information to conclude that they pose no risk.

(2) FCC established rules setting a limit for human exposure to radio frequency energy in 1996. Manufacturers are responsible for testing mobile phones to certify compliance with FCC's exposure limit. However, no major engineering organization has developed uniform procedures for the testing of exposure. This causes variability in test results.

(3) the FDA has not revised its consumer information on this issue since 1999, and consumers therefore remain unaware of updated information and FDA's views on recent research developments. FCC makes information on radio frequency exposure issues publicly available, but it is typically at a level of technical detail that is not suited to a general audience.

The report recommends that the FCC improve its review of mobile testing, and that the FCC and FDA improve consumer information on radio frequency exposure and health issues.

Source: "Research and Regulatory Efforts on Mobile Phone Health Issues", 7 May 2001, The General Accounting Office, United States, at http://www.gao.gov/new.items/d01545.pdf.

In Japan, the MPHPT has published a report about the effects of radio frequency energy on medical devices worn in, or on the human body, such as pacemakers. The report states that the energy emitted by 3G (W-CDMA and CDMA2000 1x) mobile handsets is much lower than existing 2G (PDC) handsets, but recommends that handsets be kept at least 22cm from these medical devices in the body.[60]

With the growth in mobile devices that is likely to be generated by 3G technologies, regulators will have to continue and further develop research into potential harmful effects on human health in order to allay consumer fears.

4.7 Conclusions: A dynamic and flexible approach

The convergence of "mobility" and the "Internet" will create "ubiquitous computing", i.e. "anytime, anywhere" communications, with far-reaching implications for society and the economy. To cope with these technical and market trends, policy-makers will require the right mix of dynamism and flexibility. As this chapter has shown, policy-making cannot be independent from technical and market trends, but should reflect these and promote further developments in the interests of consumers. From this point of view, policies on the mobile Internet will need to expand in some areas: For instance, regulators should aim to ensure fair competition among operators and cheaper data transmission charges. The mobile Internet also creates various "sub-markets" such as content provision, bringing in newcomers to what was until recently a "walled garden". Regulators should also promote open mobile Internet platforms that enable market obstacles to be lowered. Furthermore, global roaming and global circulation of handsets will require greater levels of international cooperation. Finally, along with the advantages of the mobile Internet, including cheap and convenient Internet access, consumers are usually unfamiliar with the technology they are using, and unaware of their legal rights. Consumer protection is therefore another important issue for regulators.

The regulatory challenges mentioned in this chapter are perhaps merely the tip of the iceberg of the mobile Internet age. As mobile Internet technologies and markets evolve, the scope of policy will have to expand accordingly in the light of the social and economic impact of technological change. Just a few decades after the Internet was invented by a small elite in one corner of the globe, the mobile Internet could—quite literally—be in the pockets of a huge proportion of the world's population. A fundamental implication of this is that policy-makers will need to take on board an increasingly broad range of social and economic issues.

[1] ITU World Telecommunication Development Report 2002: "Reinventing Telecoms", March 2002, ITU.

[2] ADSL stands for asynchronous digital subscriber line. ADSL is an evolving high-speed transmission technology, and is a form of digital subscriber line (DSL) service that provides greater bandwidth for so-called downstream (from provider to consumer) traffic at the expense of (quantatively lesser) upstream (from consumer to provider) bandwidth. ADSL is technically capable of up to 8 Mbit/s.

[3] This particular forecast is from T Analysys forecasts it would reach 25 per cent by 2004. For a full discussion see *ITU Internet Reports 2001: IP Telephony*.

[4] CATV stands for Cable Television or Community Antenna Television.

[5] For the purpose of clarity, Hong Kong, China is hereinafter referred to as "Hong Kong".

[6] There are exceptions to this model: the Netherlands allocated a number of 3G licenses equal to existing 2G ones. Hong Kong selected "n-2".

[7] "Towards the Full Roll-Out of Third Generation Mobile Communications", 12 June 2002, European Commission, at http://europa.eu.int/information_society/topics/telecoms/radiospec/doc/word/3G_communication_2002/Acte_EN_final.doc.

[8] Workshop on the Licensing of Third-Generation Mobile: Chairman's Report, September 2001, ITU. See: http://www.itu.int/osg/spu/ni/3G/workshop/index.html.

[9] Ibid.

[10] "Comparative Assessment of the Licensing Regimes for 3G Mobile Communications in the European Union and their Impact on the Mobile Communications Sector", 25 June 2002, European Commission Directorate-General Information Society.

[11] Here the term "WLAN" refers to "nomadic" mobile wireless access using access points, as opposed to fixed wireless access (FWA) in or between buildings, that is an alternative to fixed wireline access.

[12] In the 5.2GHz band, 5.15 to 5.35 GHz and 5.475 to 5.725 GHz are allocated for free licences in the EU; 5.15 to 5.35 GHz and 5.725 to 5.825 GHz in the United States, and 5.15-5.25GHz in Japan (in Japan, usage is limited to within buildings).

[13] "Cable companies cracking down on Wi-Fi", 9 July 2002, CNET News Com, at: http://news.com.com/2100-1033-942323.html?tag=cd_mh.

[14] "Telecommunications Regulation Handbook", Module 5: Competition Policy; edited by Hank Intven of McCarthy Tétrault, *Info*Dev Program of the World Bank, and ITU.

[15] "Working document on relevant product and service markets within the electronic communications sector susceptible to *ex ante* regulation", Brussels, 17 June 2002, Commission of the European Communities, at: http://europa.eu.int/information_society/topics/telecoms/regulatory/publiconsult/comments/text_en.htm. The report is undergoing public consultation and a public hearing process.

[16] "Commission targets mobile operators", 18 March 2002, Communications Week International, No.281.

[17] In Article 13 of the EU Framework Directive, an SMP is defined thus: "*an undertaking shall be deemed to have significant market power if, either individually or jointly with others, it enjoys a position of economic strength affording it the power to behave to an appreciable extent independently of competitors customers and ultimately consumers*".

[18] "Directive of the European Council and of the Council on a Common Regulatory Framework for Electronic Communications Networks and Services", Article 14, European Union.

[19] "Directive of the European Council and of the Council on a Common Regulatory Framework for Electronic Communications Networks and Services"; EU Information Society Directorate-General, at: http://europa.eu.int/comm./dgs/information_society/index_en.htm; Telecom Business Law, MPHPT, Japan at: http://www.soumu.go.jp; Guidelines to implement Telecom Business Law, MIC, Republic of Korea at: http://www.mic.go.kr/.

[20] "Telecommunications Regulation Handbook", Module 5: Competition Policy; edited by Hank Intven of McCarthy Tétrault, *Info*Dev Program of the World Bank, and ITU.

[21] "Commission suspects KPN of abusing its dominant position for the termination of calls on its mobile network", 27 March 2002, European Commission at: http://europa.eu.int/rapid/start/cgi/guesten.ksh?p_action.gettxt=gt&doc=IP/02/483|0|RAPID&lg=EN&display=.

[22] "Horizontal Merger Guidelines", United States Department of Justice and the Federal Trade Commission, Issued: April 2, 1992; Revised April 8, 1997, at: http://www.usdoj.gov/atr/public/guidelines/horiz_book/hmg1.html.

[23] There are various different definitions of MVNOs. ITU defines an MVNO as an operator that offers mobile services but does not own its own radio frequency. Another definition of an MVNO (e.g. Pyramid Research) is that it is a company that provides mobile voice and data services to end-users through a subscription agreement, without having access to the spectrum. Through commercial agreements with licensed mobile network operators, an MVNO negotiates the purchase of excess capacity for re-sale to customers.

[24] "Towards the Full Roll-Out of Third Generation Mobile Communications", 12 June 2002, European Commission, at: http://europa.eu.int/information_society/topics/telecoms/radiospec/doc/word/3G_communication_2002/Acte_EN_final.doc.

[25] "European Commission strives to promote network sharing", 12 June 2002, 3G Mobile.

[26] "Telecommunications Regulation Handbook", Module 3: Interconnection; edited by Hank Intven of McCarthy Tétrault, *Info*Dev Program of the World Bank, and ITU.

[27] "Report on business models for next generation mobile systems", 26 June 2001, MPHPT, Japan.

[28] Ibid.

[29] "Report on Broadband competition policy in Telecommunication business field", 6 June 2002, MPHPT, Japan.

[30] "Mobile Commerce Standards –M-payments move a step closer", 8 October 2002, Total Telecom at: http://www.totaltele.com/.

[31] "M-Commerce hampered by lack of a single payment platform", 17 April 2002, 3G Mobile.

[32] A USIM card authenticates the subscriber and subscriber terminal to the 3G network, while also authenticating the network to the 3G subscriber. Key attributes of USIM are: (1) It carries subscriber data as well as operator-specific data, (2) It carries cryptographic algorithms and public key infrastructure functionality, and (3) A USIM card can act as a phone book, storing hundreds of phone numbers, e-mail addresses and fax addresses. It can integrate this data with the communication capability of the mobile device. 3GPP has developed a number of specifications to facilitate the development of a standards-based USIM card. From: "3G Portal Study", November 2001, UMTS Forum.

[33] In Japan, KDDI will start a trial m-commerce service using its CDMA 2000 1x handsets with a "Next Generation UIM card" that has credit card applications, in autumn 2002.

[34] China Unicom adopts R-UIM (Removable Universal Identity Module) supplied by Luxembourg-based smart card vendor Gemplus for its cdmaOne handsets. *Source:* "Gemplus to supply 'SIM' cards for Unicom CDMA network", 4 January 2002, Total Telecom at: http://www.totaltele.com/.

[35] In Korea, the initial subsidy of handsets by operators is banned. See: http://www.mic.go.kr/.

[36] "Effective Competition Review: Mobile", 26 September 2001, Office of Telecommunications (OFTEL), United Kingdom, at: http://www.oftel.gov.uk/publications/mobile/mmr0201.htm.

[37] The status of number portability introduction in Europe is available on ETO's website at: http://www.eto.dk/numbering/NP-Impl.htm#ServiceProviderMobile.

[38] "FCC extends wireless local number portability deadline by one year to November 24, 2003", 16 July 2002, FCC, at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-224368A1.pdf.

[39] "Report on Broadband competition policy in Telecommunication business field", 6 June 2002, MPHPT, Japan.

[40] For example, the Japanese cdmaOne operator, KDDI, offers an international roaming service to its users in eight regions/countries, such as the United States, China and the Republic of Korea.

[41] "Working Document on the Initial Findings of the Sector Inquiry into Mobile Roaming Charges", 13 December 2000, European Commission DG Competition at:

http://europa.eu.int/comm/competition/antitrust/others/sector_inquiries/roaming/working_document_on_initial_results.pdf.

42 "GSM roaming prices", November 1999, International Telecommunications User Group (INTUG), at: http://www.intug.net/surveys/gsm/.

43 Official EU website on sector inquiry into roaming, at: http://europa.eu.int/comm/competition/antitrust/others/sector_inquiries/roaming/.

44 See INTUG website at: http://www.intug.net/submissions/CITEL_XVI_roaming.html.

45 Global circulation is not related to the practice of placing terminals on local markets for sale, which is the subject of mutual recognition arrangements (MRA).

46 For further information about the work of Working Party 8F on IMT-2000 and systems beyond IMT-2000, see http://www.itu.int/ITU-R/study-groups/rsg8/rwp8f/index.asp.

47 The Istanbul Convention, which binds signatory countries to eliminating customs duties on personal effects and professional equipment carried by visitors, is one of the international agreements developed by the World Customs Organization (WCO), which are applicable to IMT-2000 terminals. See the WCO website at: http://www.wcoomd.org/ie/index.html.

48 Draft New Recommendation ITU-R M.[IMT.RCIRC] recommends that IMT-2000 terminals should conform to IMT-2000 standards referred to in ITU-R M.1457-1, and comply with Draft New Recommendations ITU-R M.[IMT.UNWANT-BS] (Generic unwanted emission characteristics of base stations using the terrestrial radio interfaces of IMT-2000); and 2), ITU-R M.1343 (Essential technical requirements of mobile earth stations for global non-geostationary mobile-satellite service systems in the band 1-3 GHz) and ITU-R M.1480 (Essential technical requirements of mobile earth stations for GSO MSS systems in the band 1-3 GHz) for satellite interfaces of terminals.

49 "Safe harbor workbook", Department of Commerce, United States, at: http://www.export.gov/safeharbor/sh_workbook.html.

50 ITU held a workshop on "Creating Trust in Critical Network Infrastructures" in May 2002 to discuss some of the issues arising from, and the work being carried out on, network security worldwide. See: http://www.itu.int/osg/spu/ni/security/index.html.

51 See 3GPP, TS33.120 V4.0.0 at: http://www.3gpp.org/tb/sa/sa3/specs.htm.

52 "Report on the safety and reliability of 3G mobile systems", 12 December 2001, MPHPT, Japan.

53 Article 10 1(c), Directive on electronic commerce 2000, European Union.

54 "Canned Spam", 1 June 2002, Total Telecom. at: http://www.totaltele.com/.

55 A mobile phone is designed to operate at a maximum power level of 0.6 watts. By contrast, household microwave ovens use between 600 and 1'100 watts of power.

56 See the World Health Organization (WHO) website at: http://www.who.int/home-page/.

57 SAR is the widely accepted measurement of radiofrequency energy absorbed into the body in watts per kilogram (W/kg) averaged over some amount of tissue ranging from the entire body to one gram.

58 These rates can be found on the FCC homepage. See the FCC's radio frequency safety page at: http://www.fcc.gov/oet/rfsafety/.

59 See http://www.mmfai.org/.

60 "Research on radio effect toward medical equipment", 2 July 2002, MPHPT, Japan.

5 CHAPTER FIVE: CASE STUDIES

5.1 Different economies, different stories

The technical, economic and regulatory and policy analyses presented so far in this report have begun to paint a picture of the mobile Internet landscape on a global level. To further complete this picture, this chapter looks at the experience of a number of economies, in different world regions, with different levels of economic and social development. The chapter is based on research carried out for specially commissioned ITU case studies on the topics of third-generation mobile licensing, Internet diffusion, and broadband, carried out on Chile and Venezuela, Ghana, Hong Kong, China[1] and China, Japan, the Republic of Korea, the Philippines, Singapore, Sweden and Thailand. In addition, this chapter draws upon a comparative analysis of the transition from GSM to IMT-2000 on 3G mobile licensing policy.[2] The countries selected, which vary widely in terms of regional, geographical and economic status, offer useful examples of different mobile markets and licensing procedures. These case studies were carried out under the ITU New Initiatives Programme, and form part of the research carried out by ITU on the latest trends in telecommunications and information and communication technologies.[3]

In general terms, the countries studied fall into three broad categories: Japan, Korea, Hong Kong, Singapore and Sweden, for example, are already in the "life after licensing" phase following the allocation of third-generation licences through auctions, "beauty contests" or a combination of these ("hybrid" approach), as described in Chapter four of this report. Other countries, including many developing economies, are poised to take the step to 3G licensing (such as Chile, the Philippines and Venezuela), while others still (such as Ghana and other less developed countries) are grappling with obstacles to overall telephone and Internet penetration, such as economic poverty, lack of fixed-line infrastructure, insufficient bandwidth, low literacy levels, language barriers, lack of local content development, as well as the transition from a monopoly towards a more liberalized telecommunication market.

On a region-by-region basis, the major Asian economies are the clear first movers in 3G licensing, with Japan and Korea being the first to actually deploy 3G services. Singapore, with its outstanding levels of ICT-friendliness, is another first mover in third-generation licensing, but may not make the move to 3G as rapidly as might be expected. Hong Kong also awarded 3G licences early on, in an exemplary licensing process (see Chapter four). Some of the less developed Asia-Pacific economies, such as China, the Philippines and Thailand are less ripe for 3G roll-out, and are in no rush to award 3G licences owing to their particular market contexts. This chapter will look at some of the foremost factors affecting these three markets, in particular the regulatory landscape in China, the popularity of SMS in the Philippines, and language and content considerations in Thailand.

In Europe, many countries opted for an auction approach to licensing, and sold them off at prices that might have seemed justified at the height of the mobile boom during 1999 and 2000, but which have since been crippling to operators left with huge investments to recoup in a much less favourable economic climate. Sweden provides an interesting example of a European country that chose the "beauty contest" approach to licensing, resulting in a lower cost of licences, and where 3G roll-out has not been delayed to the extent that it has in some other European countries, but where issues of infrastructure sharing and environmental concerns have also been raised.

Latin America will also be looked at, with a particular focus on two countries that liberalized early and fully embraced mobile telephony, both experiencing a mobile boom in relation to fixed-line penetration, Chile and Venezuela. Finally, we look at Africa, which has seen very high mobile growth rates, testifying to the capacity of mobile to substitute fixed-line telephones in developing economies, where fixed-line infrastructure is often lacking. However, Africa is still far behind other regions in terms of overall telephone penetration. It provides a variety of examples of different degrees of market liberalization, the effects of which are visible in levels of mobile penetration. The example of Ghana, one of the poorest economies in the world, will be looked at in an overall African context.

5.2 Asia-Pacific first movers: Japan, Korea and Hong Kong, China

5.2.1 The " mobile Internet" in Japan—success with lessons attached?

As at May 2002, Japan had some 70 million mobile subscribers, comprising over 52 million mobile Internet subscribers—impressive figures that bear witness to Japan's singularly dynamic mobile market. Japan has a liberalized mobile market, with the Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT) being responsible for the regulatory function. There are currently three 3G licensees, namely NTT DoCoMo, J-Phone and KDDI, which were the three major companies left on the scene following consolidation of a number of existing players prior to 3G licensing.

Japan's pioneering approach to the mobile Internet has earned it worldwide notoriety. It is a first mover on three counts: it was one of the first countries to award 3G licences, the second to launch 3G services (in October 2001, following closely on the heels of Korea—see section 5.2.2) and the first to offer 3G multimedia services commercially. The success of 3G in Japan can be partly attributed to its bold and groundbreaking approach to the adoption of new technologies, but also to effective billing and marketing strategies. Japan is also remarkable for the fact that has leapt directly to 3G technologies, without following the migration path through 2.5G technologies which is typically being followed elsewhere. As well as its 3G licensing policy which established a favourable base for competition and network roll-out, the Government has played an important and unique policy-making role in establishing standards, billing and open business platforms, although there has as yet been little drive to broker international roaming agreements—a need that may have to be addressed soon (see Box 5.1).

i-mode and the mobile Internet boom

NTT DoCoMo's i-mode mobile Internet access in Japan, with over 40 million subscribers in May 2002, has been cited as evidence that consumers want the kind of "always-on" services offered by the mobile Internet, and that these will be commercially viable. Similar services offered by J-Phone and KDDI have been almost as successful.

The downside of Japan's extraordinary mobile growth, is that, sooner or later, saturation point will be reached—a trend that may already be visible in the slowing growth in mobile subscriptions since mid-2001 (see Figure 5.1). On the other hand, fixed broadband Internet services are growing, with around three hundred thousand new subscribers—most of them ADSL users—a month since late 2001. In 2002, commercial WLAN "hot spot" services were also launched. The result is that the Japanese Internet market is almost certainly experiencing a turning point in 2002.

Box 5.1: The freedom to roam, from Japan

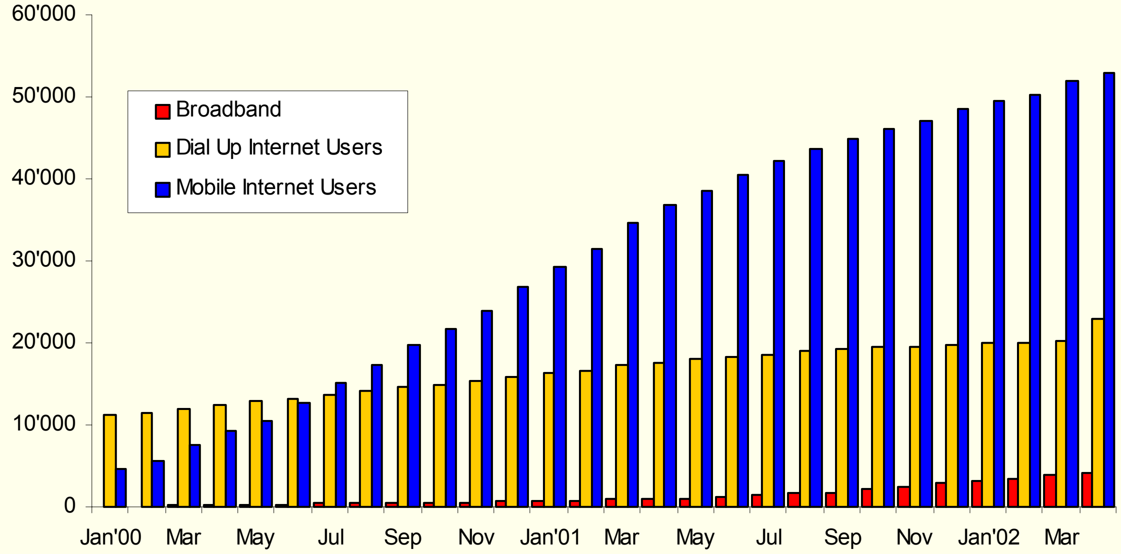
If there is one blot on the predominantly rosy landscape of mobile services in Japan, then it is probably the lack of international roaming capacity. As mobile goes increasingly global, Japan provides an interesting example of potential difficulties of "walled garden" approaches to 3G development. In contrast to their European counterparts that are faced with a more fragmented, multinational market, Japanese operators have until recently had little need to enter into international roaming agreements. Within Japan, all operators have nationwide licences, obviating the need for national roaming (one exception to this being Tu-ka, one of Japan's smaller operators, which has a roaming agreement with J-Phone). But the lack of international, or global, roaming capabilities is an important constraint for the further expansion of 3G services. Unlike operators belonging to the GSM world, Japan has very little experience with global roaming—no doubt this is one of Japan's key challenges, and one which its three 3G operators, NTT DoCoMo, J-Phone and KDDI, are now starting to wake up to.

Neither DoCoMo nor J-Phone has offered an international roaming service in the past, although J-Phone plans to have international roaming capability on its dual mode handsets as of its full 3G service launch in December 2002. DoCoMo's i-mode service is now being offered in a number of European countries, but with a specially designed European handset.

KDDI already offers a partial roaming service to some of its users, partly owing to the fact that its network is based on cdmaOne. With the special (colour) dual-frequency handsets from Sanyo, an "au" service subscriber can, for instance, use their mobile phone to make and receive calls in Australia, Canada, Hong Kong, Korea and the United States.

Figure 5.1: PC Internet access and mobile Internet access in Japan:

By number of subscribers, 2000/2002(000s)



Note: Broadband' includes ADSL, CATV Internet access and FTTH (Fibre to the Home).
Source: ITU, "3G Mobile: The Case of Japan", July 2001, adapted from MPHPT website at http://www.soumu.go.jp/.

Although Japan is famous for its mobile Internet services, and Japanese mobile business is characterized by a lower prepaid rate and higher average revenue per user (ARPU) than other major markets (see Table 5.1), at around 57 per cent, mobile penetration is not so high compared with other major markets, where penetration rates of up to 100 per cent have been attained (in Hong Kong and Taiwan, China, for example). Some analysts have concluded that the reason behind this is the difference in business strategy: Japanese operators have focused on maximizing ARPU, while not placing much emphasis on promoting prepaid card services which typically generate a lower ARPU than that generated by standard subscriptions. Providing access to Internet services is also a way for operators to maximize ARPU.[4]

3G licensing and roll-out in Japan

The licensing process took place in June 2000, through a "beauty contest" in which three licences were offered at no fee, reflecting the fact that the radio spectrum is considered a public resource in Japan. The three licences were granted to the three applicants, NTT DoCoMo, KDDI and J-Phone, of which only J-Phone remains to launch 3G services.

Table 5.1: Average revenue per user (ARPU) in major markets

	Japan	France	Germany	UK	US
Penetration rate (%)	52	50	58	68	39
Prepaid rate (%)	3	45	60	63	10
ARPU (US$)	66	38	35	40	42
ARPU for data (US$)	5	1	4	2	1

Note: Data as at May 2001.

Source: Total Telecom at http://www.totaltele.com/.

NTT DoCoMo officially launched its W-CDMA service, FOMA ("Freedom of Mobile Multimedia Access") in October 2001, aiming to acquire 150'000 subscribers by the end of March 2001. In fact, it fell well short of that target, with just 89'000 subscribers signing up by the end of March. DoCoMo has predicted that there will be 30 per cent fewer subscriptions in 2002 than in 2001. The disappointing take-up of DoCoMo's 3G service has been blamed on patchy coverage[5], the short battery life of 3G handsets, and lack of "killer" content. But pessimism may be premature: some of these drawbacks will certainly be overcome in the future, with plans afoot to offer upgraded 3G handsets and to double current battery life in 2002. Additional features may yet make 3G services more attractive. In addition, coverage is rapidly being extended to reach a larger portion of the population.[6]

KDDI launched its 3G service—based on CDMA2000 1x technology—in April 2002. Its data transmission speeds are up to 144 kbit/s, and it initially covers 60 per cent of the population. KDDI aims to attain coverage of 85 per cent of the population by the end of 2002. The main feature of this service is that the network has high compatibility with its 2G network—cdmaOne—meaning that KDDI has been able to utilize its existing cdmaOne facilities. Thus, it is estimated that upgrading the network from 2G to 3G will cost around half as much as the establishment of DoCoMo's new 3G-network. A CDMA2000 user can use their single handset as a 3G handset within the 3G coverage area, while still being able to use it as a 2G phone outside the area. This enables voice calls to be made as usual, but with reduced data transmission speeds of a maximum 64 kbit/s). In April and May 2002, subscriptions to this service grew by some 300'000 subscribers each month. KDDI has announced that it will run a CDMA2000 1xEV-DO trial service as from April 2003. This service is specifically for data transmission and can transmit up to 2.4Mbit/s.

J-Phone—47 per cent of whose shares are held by Vodafone of the UK—delayed its launch until December 2002, offering trial services only from June 2002. The main reason for this delay was for the adoption of W-CDMA Release 4 technology for its 3G network, in order to preserve its global roaming ability.[7]

Opening networks and platforms towards open business in Japan

Once the licences had been awarded, the Japanese Government's focus shifted to enhancing competition. The Japanese mobile market has, until recently, been a relatively closed and "self-sufficient" one, but recent developments are allowing already established ISPs to provide mobile Internet content. These important steps towards opening up platforms will allow new players to enter the mobile Internet market, including mobile virtual network operators (MVNO) and alternative information providers.[8]

All three 3G mobile operators in Japan offer Internet access service single-handedly: users access their portals, access the Internet through their gateways, and the operators themselves, rather than "official" content providers, collect the charges for content subscription. This "walled garden" approach has proven good for creating demand during the infancy stages of the service. However, once mobile Internet access has reached a certain level of penetration, an open platform is important for the expansion and success of future mobile Internet services.[9] Currently, all three major operators are planning to open, or are considering opening, their platforms to other Internet service providers (ISP).[10]

In January 2002, for instance, building further on the success of i-mode, DoCoMo released a series of guidelines to assist ISPs in gaining access to DoCoMo's packet-based network, enabling them to provide content to the company's i-mode service users. KDDI also announced plans to simplify its "official content" adoption process, while maintaining the criteria of non-violation of standards of public order and of decency.

The market is also being gradually opened up to MVNOs. In June 2002, the MPHPT released its "MVNO guidelines" which clarify how telecommunication business law and radio law apply to MVNOs. In the current regulatory environment, MVNOs do not need a business licence, however they must register with the Ministry. In fact, Japan Communications Inc. launched MVNO services using DDI Pocket's PHS network in October 2001, while the United Kingdom's Virgin Group entered the MVNO market in Japan in April 2001.

Future trends

Given the large number of mobile data users, the focus in Japan has now shifted from increasing the take-up of mobile data to developing multi-purpose and multi-functional handsets, including one which is most likely wearable and capable of machine-to-machine (M2M) communications. The experience of Japan may give a taste of things to come elsewhere: if so, the 3G market will hinge less on network development and more on application development. If Japan's lessons are heeded, mobile operators will have to be more and more imaginative about the purpose of the mobile phone.

5.2.2 The Republic of Korea: fast mobile grower and broadband wonder

The Republic of Korea has one of the fastest-growing mobile penetration rates in the Asia-Pacific region: mobile phone subscribers topped 29 million at the end of 2001, representing over 56 per cent of total telephone subscribers, with a mobile penetration of 60.84 per cent. It has also been estimated that some 59 per cent of Korean mobile subscribers already have phones equipped with mobile Internet browsers. However, according to some analysts, actual mobile Internet use may be lower than these figures suggest, owing to underdeveloped content, high charges and slow download speeds.

Together with Japan, Korea was a first mover in introducing 3G services. Similarly to Japan, three licences were awarded through a "beauty contest" by the regulator, the Ministry of Information and Communications (MIC), to the three candidates. Following the adoption of the CDMA 1x standard by ITU as one of the IMT-2000 family of standards[11], Korea was recognized as the first country to have deployed 3G services, closely followed by Japan. KT Freetel, one of the three 3G licensees alongside SK Telecom and LG Telecom, first launched its CDMA 1x-based service in April 2001. Korea has also been a pioneer in developing broadband—a policy that has worked to its credit (see Box 5.2).

Box 5.2: Korea's broadband success: Can it be replicated?

While most of the world has been discussing broadband access, Korea has been installing it. As of the end of February 2002, just over half of the 16 million households in Korea had broadband access. To put this in context, dial-up access to the Internet at speeds of below 56 kbit/s, which is the norm in most of the world, is used by fewer than five per cent of Korea's 24 million Internet users. Instead, half of them have ADSL access, a further 15 per cent have cable modems or other forms of broadband access (e.g. WLAN) and the remaining 30 per cent have ISDN or access through leased lines from business premises.

Korea's level of penetration of broadband is almost twice that of the next highest OECD country (Canada) and is seven times higher than the average for the high-income OECD economies (see Figure 5.2). Furthermore, not only is the quantity superior, but so is the quality and the price. The OECD reports that a Korean consumer can purchase up to 150 kbit/s in upload/download capacity for each US dollar spent compared with, say, just 18 kbit/s in the United States or 5 kbit/s in Spain. Broadband access is having a profound effect on the lives of ordinary Koreans, especially in schools and universities. Some of the fastest growing broadband applications in Korea are multi-player games, download of MP3 files and video-clips and IP telephony.

What puts Korea so far ahead of the rest of the world in this emerging sector? It seems to be a combination of:

- Favourable geography: a high percentage of Korea's population lives in towns, and a high percentage of them live in easy-to-serve apartment blocks;
- Government push, especially through the Korea Information Infrastructure (KII) project which began in 1993 but which was given extra impetus by the Asian financial crisis of the late 1990s;
- Competition: there are at least four different platforms for the provision of broadband service (DSL, cable modems, fixed wireless, satellite) and several providers in each category. An early mover was Hanaro Telecom, a company funded by some of Korea's largest industrial conglomerates or *chaebol*. Hanaro's early success in the market forced the incumbent operator, KT, to enter the market earlier than it might otherwise have done.
- Cultural factors: in addition to the above, there are other factors which seem to be important in driving the market, such as Korean teenager's love of games and the family emphasis on investment in education.

Some of these factors can be replicated elsewhere, for instance the government push and the market liberalization. Other factors are unique to Korea. If Korea's success can be replicated, it is more likely to be in other Asian economies, such as Hong Kong, Singapore, and Taiwan, China, than in Europe or North America. Indeed, the Korean model is being actively studied in emerging Asian markets, such as Malaysia, Thailand and the Philippines.

Historically, SK Telecom, was the first to offer mobile data services over its standard CDMA network (IS-95). In January 2000 it launched its 1x service, under the brand name *Nate*, and in February 2002 it announced its 1xEV-DO service. As of April 2002, it had 11.9 million wireless Internet-enabled handsets in use and 5.9 million regular *Nate* users (defined as using the service at least once a month).

KTF is the second largest mobile network operator with a 33 per cent market share in March 2002 and a turnover of 4.49 trillion Won (around US$ 3.7 billion). Like its great rival, SK Telecom, KTF has its roots in Korea Telecom, which still owns a 40 per cent stake. This came about through KT FreeTel which merged with M.Com (now KTM.Com) in May 2001. KTF has a CDMA licence to operate in the 1'800 MHz band. Like SK Telecom, KTF records wireless Internet users as all those that have suitably equipped handsets. This amounts to 9.79 million in April 2002, of which 2.5 million are 1x users and 0.67 million are equipped to use the Multipack service (CDMA2000 1x) service, which was launched in May 2001.

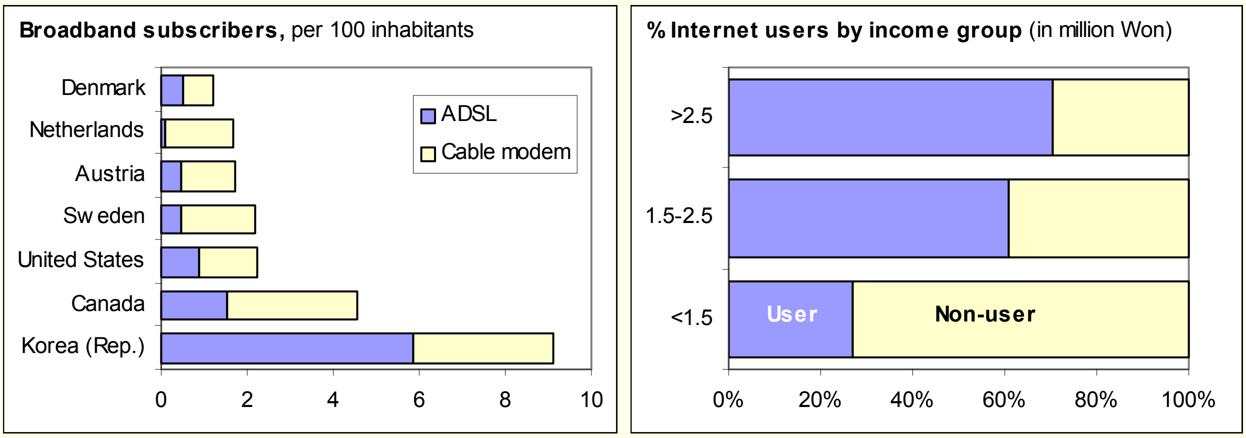
LG Telecom is the third mobile operator, with a market share of around 14 per cent in April 2002. As its name suggests, it is part of the Lucky Goldstar (LG) *chaebol* (conglomerate) with LG holding a 26.6 per cent share and BT of the United Kingdom a further 21.7 per cent (though it is reportedly looking to sell this stake). LG missed out on the consolidation that has taken place in the mobile market since the year 2000; being neither acquired not acquiring. It also missed out on the wideband CDMA licences for IMT-2000, having to be content with a less valuable CDMA2000 licence.

LG relies heavily on its sister companies for distribution. These include, for instance, petrol stations and supermarkets. It has a 1'800 MHz PCS licence which it markets under the brand name "PCS 019". As of April 2002, LG Telecom had 3.17 million Wireless Internet users and 583'000 CDMA2000 1x users.

The importance of language for accessing text-based mobile applications is often overlooked, but the case of Korea, as further illustrated by the case of another ICT-friendly Asia-Pacific country, Singapore (see Box 5.3), underscores how taking the language issue on board can facilitate and encourage user access to the mobile Internet. This factor has undeniably played a role in the mobile success story of Korea, with the relatively high level of local content, available in local languages and the availability of handsets that support the language character sets. With the language barrier to Internet access thus reduced, other barriers to widespread mobile Internet use, including transmission speeds picture quality and prices, are likely to be overcome gradually with time.

Figure 5.2: Broadband king: The Republic of Korea

Top 7 broadband economies in the OECD (June 2001), and Internet usage rates according to monthly income in the Republic of Korea (January, 2002).

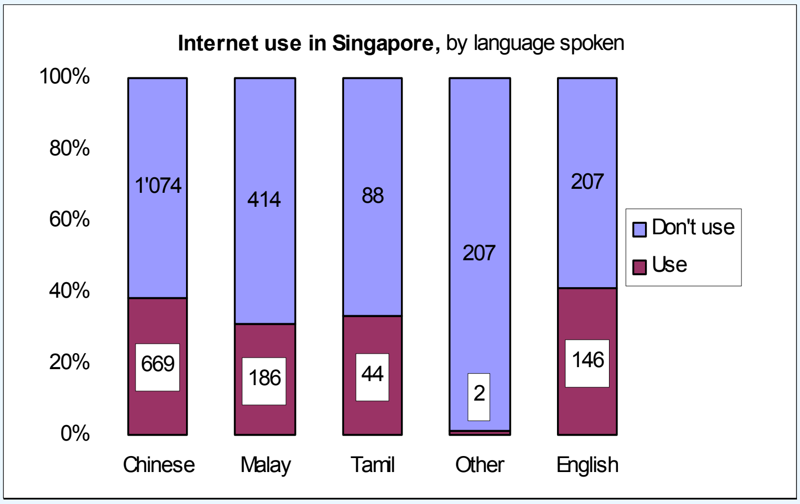


Note: At January 2002 rates of exchange, 1.5 million Won was approximately US$ 1'142, and 2.5m Won was US$ 1'902.
Source: OECD Broadband report[12] (left chart) and Korea Internet Information Centre (KRNIC) at: http://www.nic.or.kr/ (right chart).

Box 5.3: Singapore—e-ready, but not so Internet mobile…

Singapore has almost 70 per cent mobile phone penetration, over 50 PCs per 100 inhabitants, and over one-third of its inhabitants are Internet users[13], making it one of the most ICT-connected and -adept nations worldwide. Internet use has been actively promoted by the Government, with evident results: Singapore is considered a world leader in ICT use in education, with innovative programmes run in schools and universities.[14] Moreover, the high level of literacy in English means that Internet content in English can be easily accessed; 71 per cent of Singapore's population over the age of 15 years is literate in English. The significance of the language factor is underlined by the fact that almost half of Singaporean adults with English as a first language are online (see chart below).

Internet use by first language spoken in Singapore, in thousands and by percentage



Rather surprisingly though, the take-up of mobile Internet has been lukewarm. Although all three mobile operators, SingTel (the former incumbent), MobileOne (M1), and StarHub, obtained 3G mobile licences when these were auctioned in April 2001, none has yet proceeded to roll-out 3G networks and there has even been pressure on the regulator, the Infocomm Development Authority of Singapore (IDA) to delay or abolish the 31 December 2004 deadline for national 3G network roll-out.[15] The IDA, however, arguing that European and Scandinavian regulators have not modified their 3G roll-out requirements and that operators in those countries are on schedule to provide services according to deadline, held onto its position. Notwithstanding the optimistic regulatory stance, the operators themselves are not yet proceeding with 3G network roll-out, more cautiously opting to further exploit the possibilities offered by WAP and GPRS.[16] SingTel Mobile, for example, plans to introduce MMS services in 2002.

An important factor that may be dampening enthusiasm for 3G mobile deployment, as well as kindling doubts about uptake of 3G services, is the prevalence of home- and work-based Internet connectivity in Singapore: the Internet is a primarily desktop activity for Singaporeans, and the habit may not change overnight. Moreover, there were an estimated 950'000 active broadband users in April 2002[17], and further broadband development is being actively promoted. With the faster connectivity afforded by broadband access, the price of which has already decreased substantially since broadband was first introduced, using the fixed-line Internet may become still more attractive yet.

Note: Chart values from 2000/2001.

Source: ITU adapted from Internet case study on Singapore, available at: http://www.itu.int/osg/spu/casestudies/index.html.

The Internet factor

It is interesting to note that, while mobile growth has been strong in Korea, and mobile data use is increasing, growth in Internet user numbers has been slowing, reflecting the wider global trend. This slowdown has been attributed by some to market saturation. There is also a notable difference in Internet usage rates according to income level (see Figure 5.2, right chart). Perhaps more encouraging though, is the growing rate of female users, which reached 50.2 per cent in 2002, gaining ground on the 63 per cent of male Internet users.[18]

Box 5.4: Asia's first multimedia messaging over the MMS platform, in Hong Kong, China

Multimedia messaging is one of the latest services available in Hong Kong. In March 2002, CSL announced the launch of Asia's first multimedia messaging service (MMS), available to 1O1O and One2Free customers over CSL's high-speed GPRS network, via Sony Ericsson T68i handsets. As well as coloured pictures and multimedia messages, photos can be taken and sent using the mobile camera included in one of the handsets on offer. However, subscribers can only send MMS messages to other customers using the same handsets and they must subscribe to CSL's GPRS service. CSL has also entered into a roaming agreement with China Mobile and Nokia to ensure roaming between its Hong Kong customers and MMS subsribers in China.

At the opening special offer prices, the Sony handsets were sold at HK$ 3'088 (approximately US$ 400) or for HK$ 3'988 (US$ 510) for a handset with a mobile camera. Charges for content ranged from HK$ 3 for the stock quote service to HK$ 15 for greetings cards and comics, and introductory offer GPRS service packages were charged at a monthly fee of HK$ 149, with 2 megabytes of data usage, subsequently charged at HK$ 0.16 per kilobyte, or HK$ 49, with 1 megabyte of usage, subsequently charged at HK$ 0.2 per kilobyte.

In early 2002, there were no visible stirrings from the other three 3G operators to start offering comparable multimedia services, although SMS, infotainment and e-mail services are already offered; Hutchison 3G has even begun offering personalized animated SMS messages.

Source: CSL website at : http://www.hkcsl.com/main.html.

5.2.3 Hong Kong on 3G: Groundskeeper of a top-notch playing field

Hong Kong has one of the highest mobile penetration rates worldwide, with some 84 per cent at year-end 2001 (with coverage of over 80 per cent of the population), compared with just 58 per cent fixed-line penetration for the same period. Liberalization took place early in Hong Kong, with an independent regulator, the Office of Telecommunications Authority (OFTA), established as early as 1993. There are six mobile operators in Hong Kong, namely, Cable & Wireless HKT, Hutchison, New World, Peoples, SmarTone, and Sunday (Hong Kong).

The outstanding performance of mobile telecommunications in Hong Kong is due to a number of factors, not least to the highly competitive market, and strong deregulation striven for by the Government and OFTA. Although pro-competitive initiatives have been the hallmark of Hong Kong's telecommunication policy throughout its telecoms history, its 3G licensing process was a particular milestone. The licensing policy implemented in Hong Kong struck an exemplary balance by optimizing established operators' infrastructure and market bases, while letting in new players and ensuring competition, thereby establishing a level playing field for incumbents and new entrants alike. As described in Chapter four of this report (see Box 4.2), Hong Kong awarded four 3G licences, (to CSL, Hutchison 3G, SmarTone 3G, and Sunday 3G) in a unique "hybrid" licensing process based on the payment of royalties rather than a fixed fee, in September 2001, with the requirement that the operators open up at least 30 per cent of their capacity to MVNOs, or outside content or service providers. As of May 2002, there were six MVNOs holding operating licences in Hong Kong.

While in many countries operators and regulators have been tentative, or slow off the mark, in developing interconnection agreements between operators, Hong Kong has been striding ahead in this regard. For instance, number portability was introduced in Hong Kong's fixed services in July 1995, and for mobile services in March 1999. Furthermore, inter-operator SMS was launched by all six mobile network operators in December 2001, allowing customers to send SMS messages to subscribers to other networks. The Hong Kong experience is an important testimony to the beneficial impact of answering users' interconnection needs, the benefits of which would seem to override any perceived benefits in operators "protecting" their market niche. Multimedia messaging services (MMS) have also been on offer in Hong Kong since March 2002 (see Box 5.4).

Another factor contributing to Hong Kong's potential for success in mobile data services is the high level of literacy, and widespread knowledge of English, which play such an important role for users wishing to use and access the vast panoply of English language-based technology, content and services. Also on a more social level, the population is more business-oriented and urban-based, than agricultural and rural.

5.3 Other Asia-Pacific economies: China, the Philippines and Thailand

5.3.1 China: a duopoly at play

China had a fixed-line penetration of 13.81 per cent, and a mobile subscriber penetration of 11.17 at year-end 2001, not necessarily an impressive figure in itself, but given China's huge population, the actual number of subscribers—over 144 million in mid-2002—exceeds that of any other country in the world! China's mobile environment is an intriguing one for several reasons: the relative lack of liberalization and deregulation, the duopoly situation in the mobile telecommunication sector, the historically tightly-knit roles of the Government and regulator, as well as the development by China of its own breed of third-generation standard.

The incumbent operator, the former Ministry of Posts and Telecommunications (MPT), which was the sole mobile operator until 1994 when China Unicom was established, was historically affiliated to the regulator until 1999. With the establishment of the Ministry of Information Industry (MII), the regulatory function was separated from the operational function. However, State involvement in the telecommunication sector remains close, and competition is limited by a duopoly situation, with the incumbent China Telecom, the mobile branch of which is China Mobile, and its sole competitor, China Unicom.

Competition was effectively introduced in China in July 1995, when China Unicom formally launched its mobile service in Beijing, Shanghai, Tianjin and Guangzhou. Since then, customers have benefited enormously from the competition between the incumbent, China Mobile, and China Unicom. They have already benefited from reduced handset prices and installation fees, reduction in the per-minute retail tariff (among the lowest in the world), shortened waiting lists and improved quality of service. Figure 5.3 (left chart) illustrates the dramatic reduction in average mobile handset prices (including connection fees) since China Unicom entered the market.

The introduction of competition stimulated the adoption of more advanced technologies for mobile services. Under competition from China Unicom, which used the digital GSM system, China Telecom was forced to upgrade its own network from analogue to digital in 1995. By the end of 2001, all Chinese mobile subscribers were using the digital system.[19] China Mobile's GSM networks have also been upgraded to GPRS in order to support 2.5G services, while providing higher transmission speeds.

Market liberalization has significantly boosted mobile communications in China, which have enjoyed impressive growth in terms of the number of subscribers. Indeed, China overtook the United States as the country with the most mobile subscribers in 2001. It is notable, however, that 76 per cent of mobile phone subscribers in China are male.

The most recent regulatory move by the MII has obliged the incumbent operator (China Mobile) to provide a roaming service to China Unicom's subscribers in areas that have not yet been covered by new entrant's mobile network. As a result of these regulatory changes, China Unicom achieved rapid network expansion from 1999 to 2001: its market share jumped from less than 6 per cent in 1998 to more than 28 per cent in 2001 (see Figure 5.3, right chart).

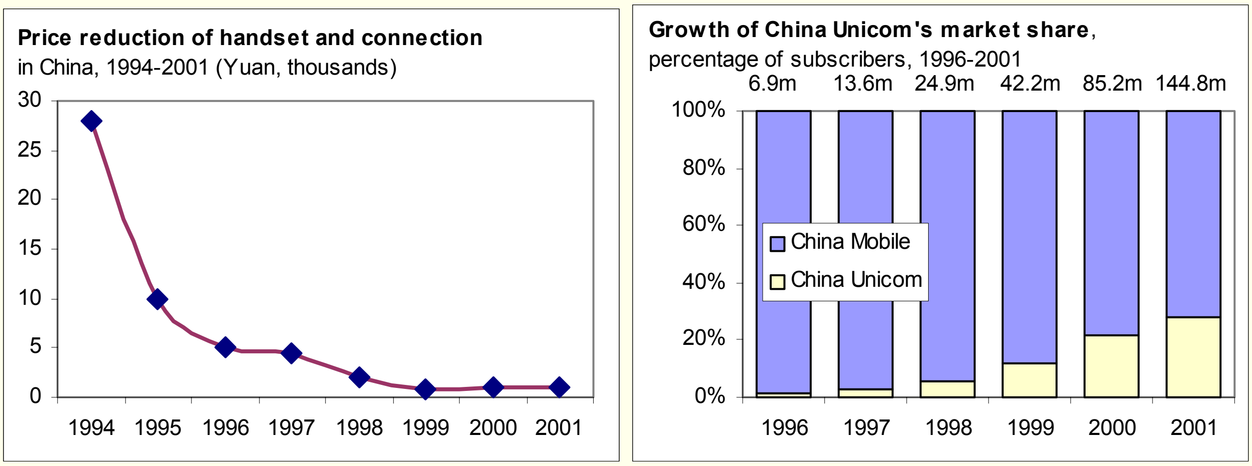
China's accession to WTO

On 11 December 2001, China formally joined the World Trade Organization (WTO) marking a new milestone for the Chinese telecommunication sector. A key element in the Chinese Government's WTO commitments, the details of which are shown in Table 5.2, was a concession over foreign direct investment in telecommunications. For the first time, foreign investors can directly invest in the Chinese telecommunication market. To prepare for the fierce competition in the post-WTO era, China Telecom has been undergoing restructuring.

With its ongoing duopoly status and State involvement in the telecoms sector, China seems to have broken the rules by attaining a remarkable level of mobile growth without much liberalization and with a developing economy status, contrasting starkly with the patterns of radical and rapid liberalization that have characterized other high growth telecom markets in developing economies.[20] But the effects of gradual opening up of

Figure 5.3: The impact of a competitor in China

Price reduction of handset and connection, 1994 to 2001 (Yuan, thousands) and growth of China Unicom's market share, 1996 to 2001



Note: *1'000 Yuan was approximately US$ 121 at year-end 2001.*
Source: *China Unicom (left chart), Ministry of Information Industry (right chart).*

the market have undeniably played a role. Efforts at further sector development have also been increasing, with China's accession to WTO, and the development of its own standard (TD-SCDMA), accepted as an IMT-2000 standard. China has also benefited from high demand for mobile data services, like SMS, and the opening up of content provision to other ISPs (as described in Box 5.5 on China Mobile's Monternet Programme).

Table 5.2: China's commitments on foreign direct investment in telecommunications under its WTO service schedule

Type of Service	Percentage and geographic coverage of foreign investment permitted					
	12/2001-02	12/2002-03	12/2003-04	12/2004-05	12/2005-06	12/2006-07
Basic telecom services - fixed	0%	0%	0%	25% in Beijing, Shanghai and Guangzhou	35% in 17 cities	49% with no geographic restrictions
Basic telecom services - mobile	25% in Beijing, Shanghai and Guangzhou	35% in 17 cities	No change	49% with no geographic restrictions	No change	No change
Value-added services and paging service	30% in Beijing, Shanghai and Guangzhou	49% in 17 cities	50% with no geographic restrictions	No change	No change	No change

Source: World Trade Organization website at http://www.wto.org/english/thewto_e/acc_e/protocols_acc_membership_e.htm.

Box 5.5: China Mobile's Monternet programme

In November 2000, China Mobile introduced the Monternet programme. Under this programme, service providers can access the carrier's mobile network at any place to provide nationwide service. This is also known as the "one-stop shop, China-wide service" arrangement. China Mobile keeps nine per cent of the traffic revenue while the information service providers receive 91 per cent of the revenue.

The Monternet programme has generated an overwhelming response from service providers. By the end of March 2002, more than 300 service providers had joined the Monternet programme for cooperation in the mobile Internet market.[21] These service providers include Sohu, Sina and other Internet portals. None of these companies has made any profit through their Internet businesses, but Monternet has opened up new possibilities, with subscribers paying for every message they receive—in the world of the mobile Internet, there's no such thing as a "free lunch"!

In order to facilitate the Monternet programme, China Mobile set up a subsidiary by the name of Aspire in the last quarter of 2000. Hewlett Packard invested US$ 35 million in the company and owns 7 per cent of it. On 9 January 2002, Vodafone made an investment of US$ 34.9 million for a 9.99 per cent equity stake in Aspire. Aspire is currently involved in the construction of the Mobile Information Service Centre (MISC) platform. The MISC is meant to serve as the common platform for all mobile Internet services of China Mobile. It is installed in stages based on a distributed structure in China Mobile's provincial operating subsidiaries. A unified MISC platform will provide mobile subscribers with mobile data roaming capabilities. The MISC will also provide a uniform data interface open to third party service providers, through which standard network information (such as billing) can be provided. The segregation of service platforms from the base mobile communication services will ensure that all mobile communications networks developed through the platform can be smoothly migrated when they are upgraded to 2.5G and 3G, making them truly "future compatible networks".[22]

Another strategy for facilitating China Mobile's Monternet programme has been the upgrade of its current circuit-switching network to a packet-based one. On 21 January 2001, China Mobile formally kicked off its General Packet Radio Service (GPRS) network project. On World Telecommunication Day, 2002 (17 May), China Mobile formally launched commercial GPRS services in 160 cities, as well as its Monternet brand of mobile messaging services.

5.3.2 Mobile Internet in China

In an effort to keep up with mobile developments worldwide, both China Mobile and China Unicom formally launched their nationwide WAP service on 17 May 2000, World Telecommunication Day. Services available through WAP include mobile banking, stock trading, news, weather reports and e-mail. But, contrary to WAP-based i-mode services in Japan, WAP services have not had much success in China, owing to slow download times and bulky handsets.

However, as in other countries, SMS messaging services by far outstrip WAP as the most successful mobile data service. For China Mobile, the usage volume of SMS increased from 126.7 million messages in the first half of 2000 to 4.7 billion messages in the second half of 2001, representing an average compound half-yearly growth rate (CHGR) of 235 per cent (see Figure 5.4, left chart). On Chinese New Year's Day, on 12 February 2002, more than 100 million short messages were delivered over China Mobile's network, generating revenue of around 10 million Yuan, or US$ 1.21 million, in a single day. Since 1 May 2002, cross-network SMS has been available.

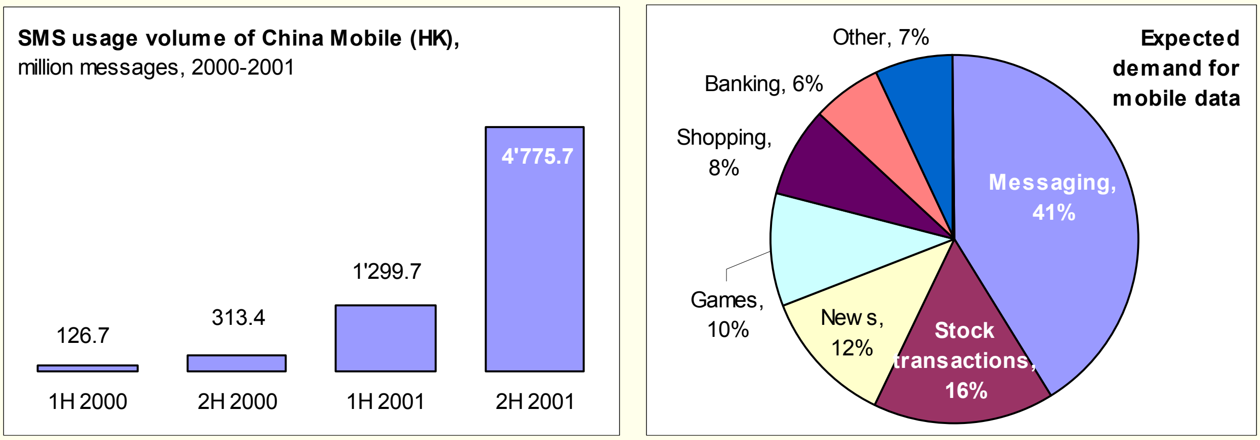
Market research sponsored by China Mobile shows that the mobile data service most in demand is e-mail (see Figure 5.4, right chart).[23] SMS messaging also has the attraction of being an alternative form of communication to official media, and is seen by some as a culturally important new vehicle for informal or humorous "literature" in China.

The unique Chinese standard: TD-SCDMA

TD-SCDMA[24], which stands for "Time Division Synchronous Code Division Multiple Access", is China's home brand of 3G standard, and its inclusion among IMT-2000 standards has enabled China to place itself firmly on the world map of 3G network evolution, a reward for the hard work invested in developing the standard to the levels required to have it accepted internationally.

Figure 5.4: SMS usage and demand for mobile data in China

SMS usage volume of China Mobile (HK) and breakdown of expected demand for mobile data services, percentage



Source: 2000 China Mobile (HK) Annual Report (left chart) and China Mobile market research (right chart).

TD-SCDMA was accepted as one of the IMT-2000 family of standards in May 2000, at the ITU World Radio Conference (WRC) in Istanbul, together with CDMA2000 and W-CDMA (wideband CDMA). On 16 March 2001, TD-SCDMA made another breakthrough: at the 11th plenary session of 3GPP (Third Generation Partnership Project), all technical schemes of TD-SCDMA standard were accepted: in other words, TD-SCDMA has not only been accepted by ITU, but also by an industry alliance of operators and vendors.[25] TD-SCDMA marks a milestone for the Chinese telecommunications industry, as it is the very first telecommunication standard proposed by China to be internationally accepted.

Compared with W-CDMA and CDMA2000, TD-SCDMA has certain distinguishing characteristics. First, the application of smart antenna and the low chip rate of 1.28Mbit/s can significantly improve the efficiency of spectrum usage. For example, in order to transmit traffic at the rate of 2Mbit/s, both CDMA2000 and W-CDMA need two 5M bands while TD-SCDMA only requires one 1.6M band. This feature is critical, particularly for densely populated economies like China, and especially in metropolitan areas.

But the most important feature of TD-SCDMA is that it can enable a smooth transition from current GSM system to future 3G systems. The TD-SCDMA is designed as a dual band and dual mode system. When 3G base stations are available, they can be installed in the same place as the GSM base station. In its coverage area, therefore, TD-SCDMA could support both GSM and 3G services. However, the TD-SCDMA system also has certain limitations: for instance, it is considered to be more suited to metropolitan areas than to remote areas.[26] Perhaps the true weakness of TD-SCDMA lies in the fact that it was proposed two years later than CDMA2000 and W-CDMA. The first test of the system was successfully conducted in Beijing on 11 April 2001. By that time, NEC, Ericsson and other foreign vendors had received a certain amount of orders for the W-CDMA system. Although much effort has gone into developing a "homegrown" 3G standard, no decision has yet been reached in China as to future licensing arrangements and deployment of 3G services.

5.3.3 The Philippines: A voracious appetite for mobile data

Mobile penetration in the Philippines stood at 13.7 per cent at year-end 2001, compared to just around 4 fixed lines per 100 inhabitants. The Department of Transportation and Communications (DOTC) is the ministry responsible for telecommunications, while the National Telecommunications Commission (NTC) is the industry regulator, created in 1979. The telecommunication market is highly competitive, with five mobile operators, namely Extelcom, Globe, Islacom, Piltel and Smart. Although not a highly developed economy, the Philippines holds the rank of number one worldwide for one particular mobile data service: SMS messaging.

SMS in the Philippines

The European engineers who defined the GSM standard did not imagine that their throwaway service would find its apotheosis in the Philippines. Around Christmas 2001, the volume of messages there reached around 90 million per day, or around ten for each user, creating a considerable source of revenues for the Philippines' two main mobile operators, Smart and Globe. The some 10 million mobile subscribers in the Philippines send an average of 75 million text messages per day.

SMS even played an important part in Filipino history. When President Joseph Estrada refused to stand down, even after being implicated in a corruption scandal, Filipinos used SMS to coordinate the demonstrations that eventually led to his downfall; so-called "People Power 2".

The success of SMS in the Philippines was partly a result of pricing policies: a number of free SMS messages were included in each prepaid subscription, and when the prepaid minutes ran out, Filipino teenagers simply started sending messages asking their friends to call them back. The popularity of SMS is also partly due to the fact that a user can send around eight SMS for the price of one minute of voice call and the price is independent of distance (until recently, there was no surcharge for sending SMS overseas, where many Filipinos work).

There are also cultural reasons for the take-off of SMS. The Filipino language, Tagalog, uses Roman characters and can thus be used with any mobile phone. Many Filipinos also speak English and indeed a hybrid 'Taglish' has emerged for sending SMS messages. Texting (or "Txting" as it is known) may also be supplementing the traditional Filipino love of writing. In a country where courting was traditionally conducted via love letters, txting is said to be a natural progression. Also, socially, the extended family is important for Filipinos, and keeping in touch is an important part of their family-oriented culture.

So far, the SMS habit has stuck despite recent reductions in the number of free messages that may be sent (the two major mobile operators, Globe and Smart, cut free SMS by around 33 per cent in November 2001, followed by a similar reduction in January 2002). The real test will be when, as is envisaged, free SMS disappear altogether, thereby removing the key impetus that originally led this cheap and highly accessible service to its breathtaking success. However, the collective decision by the Philippine mobile operators to cut free SMS has been highly controversial, and has met with accusations of cartel-like behaviour. It remains to be seen what the long-term impact will be, and whether the texting craze will survive.

Assuming that person-to-person SMS messaging growth will see a slowdown in the future, other wireless value-added services via SMS may be what sustains the market. Smart, a subsidiary of the Philippine Long Distance Telephone Company (PLDT), offers mobile commerce and 'Smart Money' services through its M-Com subgroup. The Smart Money service allows users to pay using a debit card, either used as a swipe card or for phone purchases. Furthermore, the card can be used to recharge the phone, or to load value to it.

Globe is also expected to further develop SMS value-added services and business use. Businesses have already successfully used SMS for advertising, offering vouchers for free giveaways, or getting users to compete for prizes. Infotainment services and games are also on offer. Globe has also recently launched a visual SMS messaging system called "FunMail", which enables users to "txt" cartoons to each other.

Third-generation licensing in the Philippines

There is no rush to issue 3G licences in the Philippines: 2G and 2.5G services have the potential to go on fulfilling consumer demand for some time yet. The 2G networks are still in the process of being developed, and with each new technology, handsets have to be upgraded to follow suit. The market for 3G *per se* is obviously not ripe. When the time comes though, the Philippines' regulator, the National Telecommunications Commission (NTC), has stated that it will allocate three 3G licences.

5.3.4 Mobile data—tongue-tied in Thailand

Thailand was among the countries that suffered badly from the Asian financial crisis in 1997, and despite some recovery since then, its economy still remains fragile. The country ranks 66th out of 174 in the United Nations Development Programme's Human Development Index (1999—latest available figures), placing it in the “medium” human development category. At year-end 2001, fixed-line penetration in Thailand was 9.39, while mobile subscriber penetration stood at 11.87 per cent, a comparable level to that of other similar-status countries such as Belize, China, the Dominican Republic, and the Former Yugoslav Republic of Macedonia.[27]

5.3.5 The Thai mobile market

There are two major mobile telephony providers in Thailand. The market leader is AIS Mobile (Advanced Information Systems, or ADVANC), a subsidiary of Shin Satellite, which has close ties to Thailand’s Prime Minister. It runs a GSM digital mobile network, and, more recently, GPRS services. Despite its relatively late introduction, prepaid has contributed to rapid subscriber growth (subscriber numbers doubled in 2001). However, there is no cross-subsidy of handsets by either manufacturers or service providers and handsets remain relatively expensive in Thailand. There is also no *legal* market for second hand telephones, although prices have come down since the start of 2001. The second major player in the Thai market is TAC (Total Access Communication), which rebranded itself as DTAC in March 2001. DTAC’s concession agreement is with CAT, Thailand’s State-owned international operator, to which it hands over 20 per cent of revenue, to increase to 25 per cent in 2004. DTAC also pays an access charge of 200 Baht (US$ 4.50) per subscriber per month. In addition to the 20-25 per cent it pays to CAT, for prepaid, DTAC hands over 18 per cent of its revenue to TOT, the State-owned domestic operator. These payments effectively keep prices high.

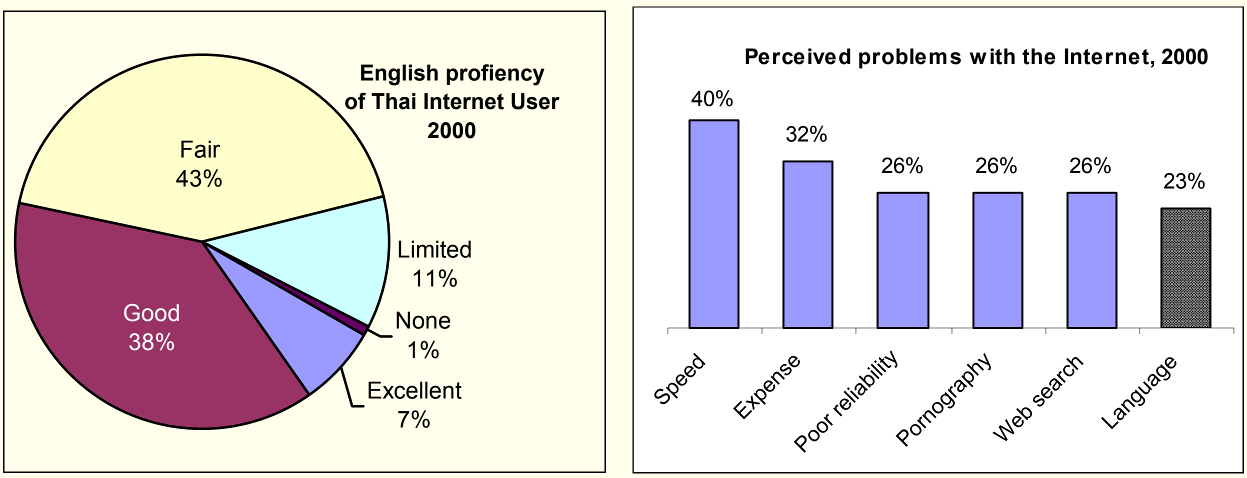
Mobile data use in Thailand

By comparison with its South East Asian neighbours, notably the Philippines, Thailand has only limited mobile data use and relatively little use of SMS. It is estimated that in August 2001, there were around five million SMS messages a day sent in Thailand. This compares with around 50 million per day in the Philippines! What are the factors that have limited SMS use in Thailand?

Probably the biggest barrier—both to Internet, and to mobile data services usage—is language. While it has a high literacy rate for the region—around 95 per cent—it is estimated that less than five per cent of the Thai population speaks English. The absence of Thai language Internet content is still an obstacle to users wishing to access predominantly English-language Internet content (see Figure 5.5). Similarly, the relatively poor take-up of SMS services has been attributed to the lack of Thai language support in mobile handsets.

Figure 5.5: Thailand, English and the Internet

English proficiency and perceived problems with the Internet, Thai Internet users, 2000



Source: ITU adapted from NECTEC “Internet User Profile of Thailand 2000”.

Surprisingly, to date, no Thai language interface has been developed for GSM mobiles, meaning that it is not possible to input Thai text, though it is possible to receive messages in Thai sent via the Internet, although the market entry of CP Orange and Hutchison could change this situation. A second barrier is that, unlike elsewhere, SMS was never free in Thailand. The price was originally set at 4 Baht (around 9 US cents) per message, though this has been reduced to 2 - 3 Baht, depending on the package. The ratio between the price of a local call and the price of an SMS message is consequently around 1.5:1 as opposed to 9:1 in the Philippines. Furthermore, as mentioned previously, local language content is also lacking: although ring tones and Chinese horoscopes have become popular, there is still a long way to go. As a result of these problems, take-up of WAP has also been slow. DTAC introduced its WAP service in June 2001. It is using Telenor technology and work closely with ISPs KSC and Internet Thailand. It has a WAP portal called Djuice, but there is still a lack of local language content. Traffic is currently running at around 30'000 minutes per day. With the entry of CP Orange, GPRS—which has also been introduced by DTAC and AIS—looks likely to take off. The situation with regard to third-generation is somewhat confused by the regulatory situation. There is currently no great push for 3G. However, given the Thai predilection for awarding franchises, it is likely that they will be awarded sooner rather than later once the independent regulator, the National Telecommunication Commission (NTC) is established.

5.4 Latin American experiences: Liberalization can be liberating!

Latin America is home to some of the fastest growing mobile markets in the world and has an impressive track record in the adoption of mobile technologies and services. As of mid-2002, some 74 per cent of the countries of the region had created a separate regulatory agency, making the Americas as a whole (including North America) the region with the highest percentage of separate regulators in the world (see Figure 5.6, left chart). Mobile data services such as SMS have proven particularly popular in many countries of the region. Furthermore, in Brazil, Mexico and Puerto Rico, services based on the CDMA2000 1x standard (a recognized IMT-2000 standard—see section on Korea) are already commercially available. In many countries of Latin America, as in Africa, the advantages of mobile in developing economies with underdeveloped fixed-line networks have been a major driver for mobile take-up. Latin America also has a further string to its bow: locally relevant Internet content—particularly in the Spanish language—has been widely developed thanks to numerous government initiatives (see, for example, Box 5.6 on Internet initiatives in Chile). This may bode well for the future deployment of third-generation services, although their deployment is not imminent: one of the main reasons for which seems to be the fact that second-generation and 2.5G services still have a lot of untapped potential in many parts of the region.

Within the Latin American context of enthusiastic and rapid liberalization of the telecom markets, Chile and Venezuela provide interesting examples of countries that have both performed outstandingly in terms of mobile growth in the wake of liberalization (see Figure 5.6, right chart). In both countries, mobile has overtaken fixed-line penetration in the last two years: as at year-end 2001, Chile had over 58 per cent of mobile subscribers as a percentage of total telephone subscribers, and Venezuela had an impressive 70 per cent. The two countries ranked second and third only to French Guiana in terms of mobile teledensity in the whole of South America, with rates of 34.0 (Chile) and 26.3 (Venezuela) (see Table 5.3).

Despite having similar mobile growth patterns, there is a surprising discrepancy in levels of penetration of ICTs in the two countries: while Chile has embraced ICTs with great enthusiasm, Venezuela is lagging behind. Internet promotion has been largely policy-led by the Chilean Government, which has set the tone through various e-initiatives for services to the general public and private businesses. The result has been the fostering of a kind of "e-culture", where the high quality and utility of website content have been self-promoting, and have encouraged businesses to jump on the "e-bandwagon". Venezuela, by contrast, has relatively low Internet diffusion. It lags behind Chile both in terms of Internet subscriber numbers, and of PC ownership.[28]

Box 5.6: Paper-pushing over the Net: Chile's Internet-friendly government initiatives

In early 2002, around 30 per cent of the Chilean population had access to a computer, and Internet usership has been growing at sustained pace in spite of a relatively high penetration rate. As at year-end 2001, Chile had over 3.1 million Internet users, with a penetration rate of around 20 per cent.

Internet use has been strongly backed by the Chilean Government. In a recent speech, Chilean President Richard Lagos said that:

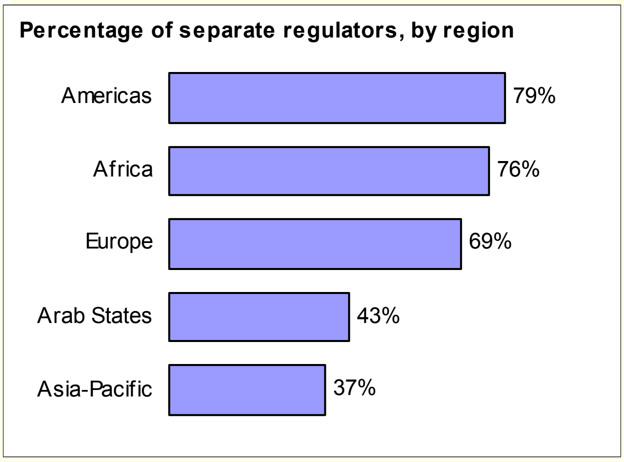
"In the digital world, there are no longer countries at the centre and others on the periphery. Some observers have proclaimed the death of distance. Yet at the same time, new challenges have arisen from these technological advances: some people will have access to new technology, while others fall behind. This "digital divide" calls for imaginative responses within our own country, as well as in our country's relationship with the world."[29]

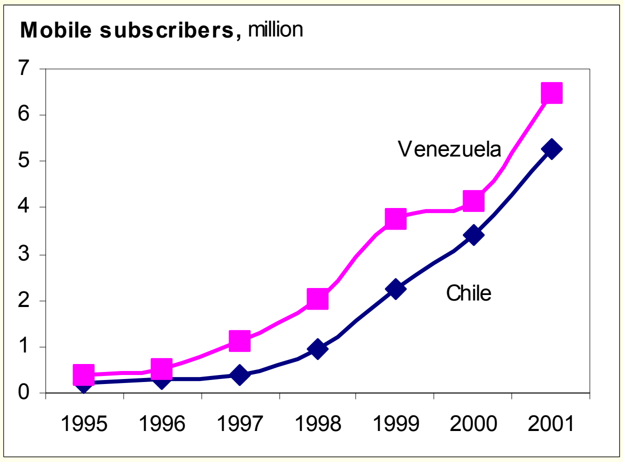
The Chilean Government has been proactive in promoting the use of the Internet through a variety of projects under the umbrella of the "*Ventanilla Unica*" (meaning "single window"). The main thrust of these initiatives is to get Chileans to carry out administrative and commercial procedures over the Internet. In 2001, an e-government project was launched, including an Internet fund amounting to 395 million Pesos (around US$ 596'000), a national survey to evaluate information technology resources and an e-government training programme. In addition, the Government's "*Trámite fácil*" website is devoted to a vast range of services for public and business users, such as various registration and certification requests, housing, employment, sport, health and education services. Chileans can submit their tax declarations over the Internet. This type of government activity is an excellent means of stimulating locally relevant Internet content development and encouraging e-business. However, administrative tasks of this kind seem unlikely fodder for widespread use over a mobile phone unless the cost is significantly lower than dial-up Internet use. Even if Chileans can be further encouraged to execute such procedures electronically, they are not the kind of spontaneous, communication- and entertainment-oriented applications that have typically taken off over mobile data systems.

Source: Chilean Government website at: http://www.gobiernodechile.cl/.

Figure 5.6: Mobile growing in fertile markets

Separate regulators by region, percentage and Mobile subscriber growth in Chile and Venezuela, 1995-2001





Source: ITU World Telecommunication Regulatory Database (left chart) and ITU World Telecommunication Indicators Database (right chart).

Table 5.3: Growing fast: Mobile in the Americas

Profile of mobile markets in the Americas, Chile and Venezuela, 1995/2001.

Region/country	1995 (k)	2001 (k)	CAGR (%) 1995-01	Per 100 inhabitants	As % of telephone subscribers
Central	756.7	25'024.2	79.2	18.2	59.5
North	36'381.8	136'937.2	24.7	43.2	39.4
South	2'698.5	55'800.3	65.7	15.9	46.3
Caribbean	420.2	4'300.5	47.7	11.2	47.9
Americas	40'257.1	222'062.2	32.9	26.3	42.8
Chile	**197.3**	**5'271.6**	72.9	34.0	58.7
Venezuela	**403.8**	**6'489.9**	58.9	26.3	70.2

Note: Compound Annual Growth Rate (CAGR).

Source: ITU World Telecommunication Indicators Database 2002.

5.4.1 Chile

The Chilean telecommunication regulator is the Subsecretaría de Telecomunicaciones (SUBTEL), created in 1977, overseen by the Ministry of Transportation and Telecommunications. Four operators have mobile licences in Chile, namely, BellSouth, Entel, Telefónica and SmartCom, of which BellSouth and Telefónica operate using TDMA, Entel using GSM, and SmartCom using CDMA technologies.

Mobile data services

In spite of the growing presence of WAP services, such as banking transactions and cellphone reloading, in the Chilean market, these services have not taken off in a big way. This is in part due to the high cost (almost double the price of voice service) and slow speed of services. Some companies, like Telefónica Móvil, have chosen not to introduce the service. Nor have GPRS services made any significant market inroads.

In contrast, all four Chilean operators provide SMS services. There has been a rapid expansion of demand for the service and all operators are working to improve the service (including, for example, chat and payment applications). Given that SMS offers considerable value for a relatively low cost, it has been enthusiastically adopted by many prepaid clients. From 2001 onwards, operators began to seek interconnection agreements (as detailed in Chapter four of this report) in a move which should help to further promote mobile data services and establish a useful interconnection framework for a future deployment of 3G services.

As elsewhere in Latin America, the scheme of things to come is not fully clear in Chile, and much will depend on which standards become dominant, and where the growth of data services lies. Some observers of the Chilean mobile market have speculated over the possibility that, in the near future, the move towards full 3G services will go first via applications such as those that have made the Japanese i-mode a great success. However, it is more likely that Chilean operators would lean more towards open systems, or towards advanced SMS applications. The signs seem to confirm this prognosis: in November 2001, Entel PCS launched GPRS services, offering data transfer rates of 44.4 kbit/s, and making it the first operator in South America to offer GPRS. It is expected that EDGE will follow sometime during 2002.[30] According to some analysts, the predominance of TDMA technology (accounting for some 48 per cent of all mobile subscriptions in Chile in 2001) will gradually give way to GSM-based technologies as some operators (such as Telefónica Movil) migrate to follow the GSM-GPRS-EDGE-UMTS evolution path, while BellSouth is considered more likely to migrate towards the CDMA 1x RTT upgrade technology.[31] In any event, consolidation of networks and technologies, as well as the continuation of policies geared towards promoting affordable and appropriate services, will be prerequisites to prepare the Chilean market for 3G deployment.

5.4.2 Venezuela

Despite the recent economic and political upheavals in Venezuela, the telecommunication sector has continued to grow, with outstanding performance in mobile growth. As shown previously in Figure 5.6, following the full opening up of the market to competition, mobile telephony grew rapidly during 1997 and 1998, with slower growth in 2000 following the economic slump of 1999, to pick up strongly again in 2001. At year-end 2001, fixed-lines stood at 11.2 per 100 inhabitants (down from 11.38 in 1995), while cellular subscriptions stood at 26.35 per cent, representing some 70 per cent of total telephone subscriptions. Venezuela was one of the first countries in the world where, as early as 1998, mobile subscribers had already outnumbered fixed-line subscribers.

As in Chile, policy-makers chose the path of rapid and extensive market deregulation, which has paid off in the Venezuelan marketplace. The sector has also been successful in attracting investment: according to the National Council for Investment Promotion (CONAPRI), over US$ 1 billion a year have been invested since 1999, with a growth of 500 per cent over the past five years (to year-end 2001). Venezuela ranks third in Latin America (after Chile and Brazil) in terms of investment in telecommunications as a percentage of GDP.

Venezuela's fixed-line network is, however, relatively underdeveloped, and Internet and PC use is correspondingly low. With just 5.27 Internet users, and 5.28 PCs per 100 inhabitants, Venezuela is far behind Chile, which has over 20 Internet users, and over 8 PCs, per 100 inhabitants.

The success of mobile is partly a reflection of the aspirations of young Venezuelans to acquire all things technologically innovative, and all things American. The United States' influence is also reflected in the fact that the biggest three providers—Bellsouth Telcel, CANTV and Movilnet—are all US-owned companies. But it is also largely due to the introduction of prepaid calling cards (see Box 5.7). Of course, it could just be that Venezuelans love to chat!

Box 5.7: Where credit is due: Prepaid in Venezuela

Credit card ownership is not only a sign of wealth, but is also often a prerequisite for becoming a telephone subscriber. In societies where credit cards belong only to a privileged few, prepaid cards are a blessing for would-be mobile subscribers with little or irregular disposable income. Prepaid systems open up the market to low wage earners such as youth, the elderly, women and students, spurring subscriber growth and extending access to affordable communications.

The real key to mobile success in Venezuela, as elsewhere, was the introduction of prepaid calling cards, enabling users to budget their expenditure and opening up access to those with limited financial means. Indeed, credit card ownership is an important part of the picture: in a society where credit card ownership is not widespread, prepaid mobile allows for cash payments, as and when money is available. Whereas in 1996 the majority of Venezuelan mobile users were credit card holders, the recent economic situation, as well as problems of bank fraud, mean that today less than 20 per cent of Venezuelans have a credit card, below the average for Latin America (20 per cent). For comparison, in the United States, credit card possession stands at an average 1.8 credit cards per head of the population. In Venezuela, the success of prepaid cards was immediate, with mobile service boosted by 221 per cent in 1997, when prepaid cards were first introduced. In 2001, around 85 per cent of mobile subscribers were part of prepaid plans, and by mid-2002, 90 per cent of new subscribers were choosing prepaid.

The major operators, Telcel, CANTV and Movilnet have recently begun to sell multi-use prepaid cards that can be used not only for fixed-line and mobile access, but also for Internet access. Prepaid may also contribute to future growth in Internet access: tele- and infocommunication centres, and cybercafés have been sprouting up at a tremendous rate, up from 112 in 2000 to 775 in 2001. This trend could bring a change-around in Venezuelans' current Internet habits: if Internet use catches on, this may prime the market for mobile Internet.

5.4.3 Mobile data services in Venezuela

WAP services were first launched by Telcel at the beginning of 2000. Movilnet followed suit six months later. As WAP services are not offered on a per-minute pricing basis, it was expected that the service would grow rapidly. However, this was not to be the case.[32] As elsewhere in Latin America, Venezuelan operators have been switching from TDMA to CDMA networks. In the second half of 2001, Movilnet took the decision to gradually replace its TDMA network with CDMA 1x RTT, preparing for the migration to CDMA2000. Around the same time, Digitel announced the introduction of GPRS in the 900 MHz band.

All five Venezuelan operators provide short message services (SMS). Here, the three regional operators took the lead, equipping their GSM networks as well as terminals with SMS from the first day of operations. Similarly to WAP, the SMS service is provided on flat tariff that ranges between US$ 3 to 6, depending on the operator. In contrast to WAP, however, SMS has taken off among the Venezuelan population. Infonet, for example, claims that 50 per cent of its subscribers are using SMS, while Digitel claims to have a daily average of seven SMS per terminal. Two-way SMS was introduced by Movilnet in October 2000, and by Telcel in May 2001.

Licensing of 3G in Venezuela

The decision of Movilnet to switch from TDMA to CDMA leaves the vast majority of the Venezuelan market (Movilnet and Telcel) with CDMA technology, and therefore no technological need for additional spectrum in the 1900 MHz UMTS "core-band", as they plan to start migrating towards 3G in their existing 800 MHz bands. The country's largest GSM operator, Digitel has announced that it will invest in the build-out of a GPRS network in its 900 MHz band. These decisions certainly take the pressure off the licensing process of the 1900 MHz band, and give the regulator time to evaluate the present development in the European 3G market and to wait for the recommendations of the 8F Work Group of ITU-R with regard to spectrum allocation of IMT-2000 (due for completion in September-October 2002).

Initially, CONATEL planned to start the preparations for the public offering in the last quarter of 2001, and to open the auction in the first quarter of 2002. The private sector players involved—in particular the existing mobile operators—however, preferred that the process be postponed for another year, on the grounds of current uncertainties in technology, unclear market demand for advanced mobile services, and the fact that 2.5G services have not yet been adequately exploited. CONATEL plans to present the final schedule for 3G licensing in the third quarter of 2002.

5.5 The European experience

The most popular methods applied in 3G licensing processes in European countries have been auctions and "beauty contests". On average, Europe-wide, four licences were offered, with from two (France) to six (Austria and Germany) licences actually awarded.[33] The auction process, used in the United Kingdom, Germany and Italy, for instance, invariably led to higher fees being paid for licences—also a reflection of the buoyant telecoms bubble of late 1999 and early 2000. The huge investment in fees thus incurred by operators has inevitably had an adverse impact on their ability to invest in equipment manufacture and network development, and their reluctance has been compounded by the tough licence requirements and subsequent downturn in the financial markets. The result has been delayed readiness for 3G deployment, and a spiralling climate of caution and doubt. It is interesting to note that, whereas "beauty contests" mostly resulted in national players being awarded licences, auctions attracted more multinational operators: Across Europe, 72 per cent of licences awarded by "beauty contest" are held by national operators, while 68 per cent of those awarded by auction were allocated to multinational operators.[34]

Within in the European context, the Nordic countries have been mobile trendsetters, with Finland, Norway and Sweden in particular attaining sky-high levels of mobile penetration (around 80 per cent). Sweden is an noteworthy example in that, not only have high levels of mobile penetration been attained, but there has been a remarkable level of alliance-building and infrastructure sharing between operators.[35] For example, Hi3G, Europolitan and Orange (Sweden), fully share their networks, including site, radio access network equipment and some core network equipment. But the example of Sweden is also interesting in that, in attempting to meet economic and market demands on one hand, and consumer and environmental concerns on the other, harmonious sharing arrangements are not always easy to achieve: the issues raised, including issues of rental charges (described more fully in the section below), may provide interesting lessons for future network development elsewhere in Europe.

5.5.1 Sweden—beauty *can* be bought, if the price is right

As in other Nordic countries, such as Finland and Norway, mobile took off rapidly to reach among the highest penetration rates worldwide. Internet growth has also been strong in Sweden, with 58 per cent of households having Internet access. However, as in other countries with a high level of mobile penetration, the pace of growth slowed during 2001. This may not seem surprising: in a population of some 9 million, and with mobile penetration (measured as the number of active subscriptions divided by the population figure) at around 80 per cent, saturation is not far off. Sweden had 7.15 million mobile telephone subscribers at the end of 2001, up from 5.16 million subscribers at the end of 1999 (see Figure 5.7, left chart).

Prepaid cards now account for 49 per cent (3.53 million) of total mobile subscriptions, with 49 per cent of subscribers holding normal GSM subscriptions, and two per cent NMT 450[36] subscriptions. The NMT 900 network, which never achieved the levels of coverage reached by GSM and had roaming capacity that was limited to the Nordic countries, is no longer in operation. Private subscriptions account for 79 per cent of total mobile subscriptions, while organizations hold the remaining 21 per cent.

5.5.2 Mobile data services in Sweden

WAP and SMS services

As elsewhere in Europe, WAP services never really took off in Sweden, and for much the same reasons: slow download times, high charges and poor quality of content.

Like overall mobile growth, the growth of SMS messaging slowed in 2001. Although the number of messages sent more than doubled from 494 million messages in 2000 to 1.02 billion messages in 2001, there was barely any increase between the first six months of 2001 (463 million messages) and the second six months (557 million). For comparison, in 2000 the number of messages sent more than doubled in the second half of the year to reach 333 million, from 161 million during the first half of the year (see Figure 5.7, right chart). Multimedia messaging services (MMS) are not yet available in Sweden, although Hi3G, Telia and Europolitan/Vodafone have all awarded MMS contracts in the last year.

The price for sending SMS remains high, despite repeated complaints from the Swedish regulator, the National Post and Telecom Agency (PTS). They went down from Sk 2.50 (around 26 US cents) to Sk 1.50 per message in early 2000, but have not budged since, with the major operators still charging between Sk 1.30 (around 13 US cents) and Sk 1.50. A couple of minor actors offer lower rates, such as Spray Smart Mobile and Universal Smart, which both charge Sk 0.95. One subsidiary of Telia (Halebop) offers a special SMS package formula for Sk 49 (around US$ 5) per month, allowing the user to send unlimited messages.

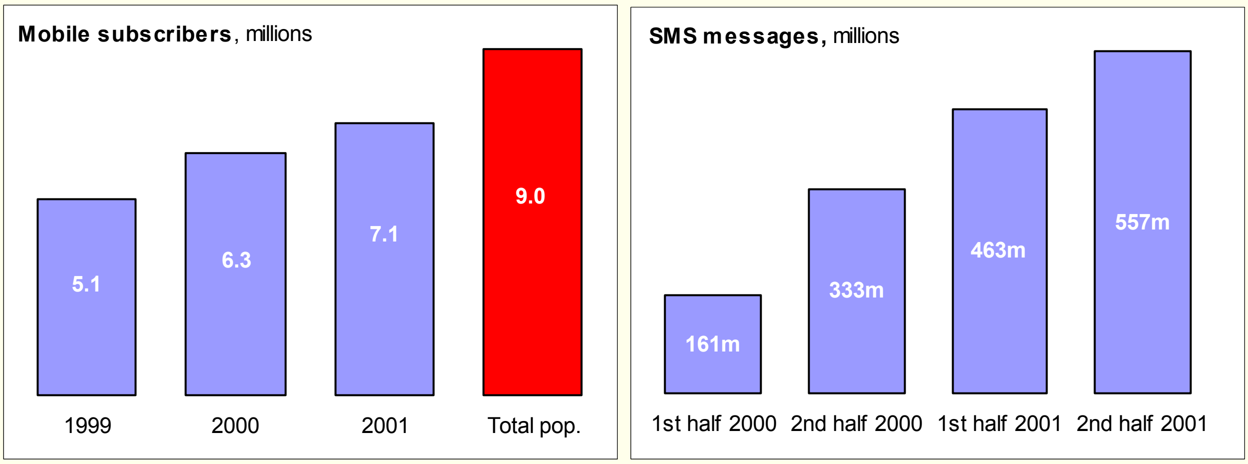
Third-generation roll-out

Although 3G services have not yet been deployed in Sweden, three third-generation licences were awarded by "beauty contest" in December 2000, for a total of US$ 44.1 million—a relatively low sum compared to those paid in the auctions elsewhere in Europe. The awardees were Telia, Tele2 and Europolitan/Vodaphone.

The ground for future 3G deployment was significantly prepared in Sweden with the introduction of GPRS by the three 3G operators in late 2001. The progression to GPRS certainly seemed like a sound move: WAP has never really taken off successfully in Sweden, and market potential for GPRS should be good, given that nearly all new phones are GPRS-enabled. In November 2001, Telia and Tele2 offered free GPRS for a limited introductory period. Since then, an array of different payment models have been introduced by providers.

Figure 5.7: Nearly hitting the ceiling with mobile

Mobile subscribers in Sweden 1999-2002 (millions), and Number of SMS messages sent in 2000 and 2001 (half-yearly, millions)



Source: ITU World Telecommunication Development Indicators and Svensk Telemarknad 2001.

Telia, for example, started with two subscription formulas. One of these was charged at a high rate of Sk 300 (about US$ 31) per month for 25 megabytes of communications, the other was charged at a lower rate of Sk 100 for 5 megabytes. Telia later added a third service, with a charge of Sk 30 per month for 0.5 megabytes. Halebop, a subsidiary of Telia, offers a rate of Sk 0.05 per kilobyte. In February 2002, Telia started to offer its subscribers GPRS roaming in the four biggest Nordic markets, Denmark, Finland, Norway and Sweden. Europolitan/Vodaphone followed suit shortly afterwards, launching a service with GPRS roaming in the biggest European markets.

Box 5.8: Swedish operators: Sharing doesn't come easy

As discussed in Chapter four, sharing networks and network resources is one way for operators to optimize investments and expedite network roll-out, while maintaining the all-important market stimulus of competition. True to the strong Swedish tradition of forging alliances among telecoms operators—one which has set Sweden in good stead for rapid and effective network growth in the past—Telia and Tele2 have joined forces to create a mutual infrastructure company for the 3G network called Svenska UMTS-nät. Along the same lines, Hi3G, Orange and Europolitan/Vodaphone have jointly created a company called 3GIS (IS stands for "infrastructure services"). With its more advanced national networks, the Telia/Tele2 alliance has a substantial advantage over its counterpart when in comes to radio mast coverage: Orange and Hi3G are relative newcomers to the Swedish 3G mobile market, and Europolitan/Vodaphone has less area coverage than its two GSM competitors.

This situation has resulted in a number of conflicts, including some dispute about fair prices for renting space on radio masts. 3GIS, for example, has expressed its concern that Telia charges Sk 200'000-250'000 (US$ 20'800-30'000) per year for access to a single radio mast, while Telia contends that the normal rent is Sk 100'000 (around US$ 10'400) per year.

Space sharing on newly constructed radio masts has also been a touchy issue, and harmonious solutions have not always been forthcoming. In one region, the two consortia are building 23 and 17 radio masts respectively, but only plan to share four of them.

In the meantime, following the weight of public opinion, local authorities have been expressing concern about the lack of coordination in infrastructure planning, which they do not want to result in an explosion of masts. This reticence has resulted in long waiting times for building permits for masts. The planning delays incurred may have an impact on the timing of bringing networks into service. The cost of sites for masts may be a further disincentive to network growth: one manager from Svenska UMTS-nät has complained about the rents demanded by the local authorities for radio mast sites, claiming that they ask as much as Sk 100'000 per year.

Source: PTS, Sweden.

Hi3G has begun to build content for its 3G network. It has, for example, purchased the exclusive 3G rights for first-division Swedish ice hockey and has concluded an agreement with Aspiro to develop "new age services" such as tarot and horoscopes. In a venture of a less frivolous kind, Hi3G has initiated a project to offer banking services, such as payments and other transactions, share trading and a news service, together with SEB, one of Sweden's largest banks.

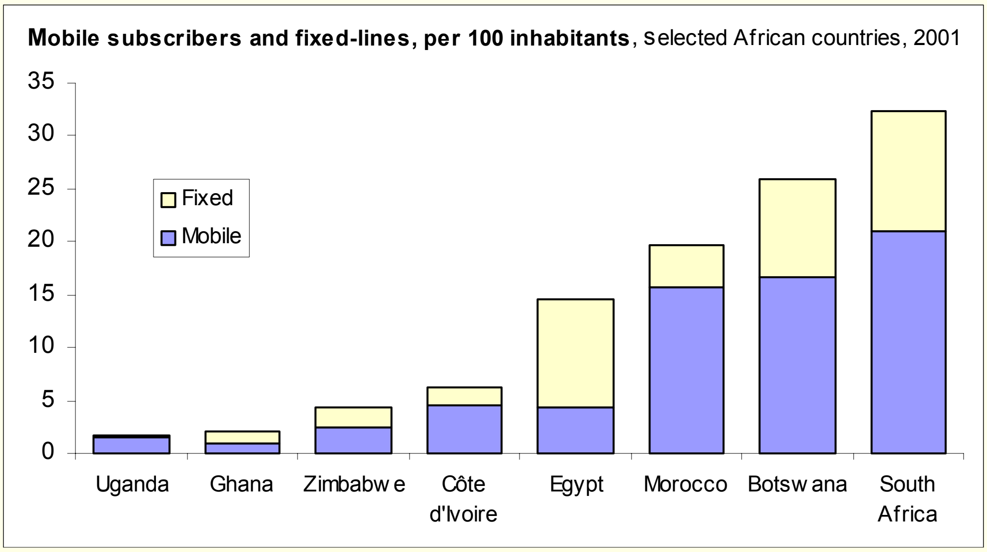
5.6 Mobile in an African context

With fixed-line infrastructure across much of Africa insufficiently developed or in disrepair, mobile networks are increasingly proving to be the most appropriate solution for the provision of telecommunication services—particularly in remote and rural areas. Figure 5.8 shows comparative mobile and fixed-line penetration rates in various African countries, clearly indicating the dominance of mobile even in the poorest economies, such as Côte d'Ivoire, Uganda and Zimbabwe, with Ghana being one of the few African exceptions. In fact, Uganda was the fist African country where mobile overtook fixed as the network with the most subscribers, closely followed by Côte d'Ivoire and Zimbabwe. The African market's potential for cellular mobile is evident from these examples, and from the significant progress made in mobile growth over the past few years. At year-end 1999 there were almost six million mobile subscribers in the Africa region. By year-end 2001 the figure had risen to 23 million, an estimated 80 per cent of which were prepaid subscriptions.[37] However, it should not be overlooked that more than eight million of the total number of subscribers in Africa are located in South Africa. The number of GSM networks in Africa also represents a relatively high proportion of all networks, with over 95 per cent of African networks now deploying GSM technology, compared to a world average of 70 per cent. In the longer term, it is expected that whereas mobile subscriber growth in developed countries will peak and start declining by 2004, growth in developing economies, including most of Africa, will go on increasing during that period.

The only operators south of the Sahara that are set to deploy general packet radio services (GPRS) during 2002 are the South African operators, MTN and Vodacom. Elsewhere in Africa, operators are concentrating on the burgeoning voice markets. The lack of computers is an obvious reason behind this trend. However, short message service (SMS) has been catching on in many African countries.

Figure 5.8: Africa—a mobile continent

Mobile and fixed-line telephone penetration (per 100 inhabitants) in selected African countries, year-end 2001



Source: ITU World Telecommunication Indicators Database.

5.6.1 The importance of local content development

In many African countries, there has been an increase in the number of companies providing specialized Web content development and hosting in response to the rising demand for such services. For example, Ghanaweb, a Web-based Ghanaian content developer, launched a WAP service offering news and other local information to mobile subscribers.[38]

The World Bank Information Development Unit[39] is also involved in numerous ICT development projects in Africa. In Ghana, it has sponsored a mobile Internet project to design, deploy and operate a Computerized Mobile Bank (CMB) for susu (informal workers private savings scheme) operators and small-to-medium enterprises over a period of 18 months. The objective of this activity is to determine the extent using new technologies to which CMB can expand the outreach of formal banking institutions and reduce the transaction costs of providing complete banking services to informal bankers. Such initiatives might, in future, be integrated into a domestic 3G network for those living in rural areas.

While initiatives of this kind are already making their mark, the lack of local content and skills shortage for content development in Africa remain an important obstacle to growth in Internet use. Location-specific content development will therefore be one of the critical success factors for the take-up of mobile data services.

5.6.2 Policy and regulatory needs

The 3G story in other countries shows that active policy measures will be necessary if African countries are to successfully develop 3G services, services which, in a largely rural population with relatively underdeveloped infrastructures, will be all the more valuable in providing access to information and communications.

Affordability of services is of paramount importance for the take-off of new mobile services, but in the less developed economies of Africa, 3G communications will be affordable and attractive only to a small elite of wealthy and technologically savvy individuals and companies. 3G handsets and services may initially be out of reach of the majority of current 2G subscribers, and may be a totally unrealistic prospect for many segments of the population. The level of market competition and the position of the incumbent operators have typically contributed to keeping costs high.

Further to this is the issue of timing: political changes, economic conditions and technological uncertainties have made 3G deployment uncertain in most African countries. It has been frequently reiterated that delays in 3G deployment will only serve to widen the digital divide.

Cheaper prices will of course result from the increasing demand for high bandwidth for data services, as more systems are networked around the country, driving improved and cheaper connectivity. In this way, private sector initiative will eventually prompt governments to take relevant policy measures, but examples of countries in other world regions have also shown that the more proactive a government is, the better the results in terms of mobile and Internet growth, the more affordable the services are to users, and the greater access populations have to information and communications.

5.6.3 Education and literacy

One of the difficulties is the identification of a "killer application" for mobile data services in Africa. As illustrated by the case of the Philippines, SMS, which sprung from first and second-generation technologies, has a great deal to offer in developing environments. However, any moves towards Internet-based services will be contingent upon further development of locally relevant content, and on education and literacy levels. While the overall literacy rate many African countries ranges widely, actual breakdown of figures usually show a strong gender divide in access to Internet content and text-based communications. In Ghana for example, overall literacy stands at some 64 per cent, representing 70 per cent for men, against just 51 per cent for women. In the African context, raising access to education will be important to cover this social divide, and to maximize the market for SMS and future data services.

5.6.4 Ghana

Ghana has one of the poorest economies in the world, with a per capita income of US$ 390 in 2001. It has a fixed-line telephone penetration of 1.16 lines per 100 inhabitants, and a mobile penetration of 0.93 subscribers per 100 inhabitants (see Figure 5.8 for a comparative cross-section of African economies). Ghana has four mobile operators. Millicom Ghana, a subsidiary of Millicom International, UK/Luxembourg, which started its operations in 1991 and was the first cellular network operator, using the brand name Mobitel. The second operator, ScanCom, started operating in October 1996 using GSM 900 technology. ONEtouch is the cellular arm of the incumbent operator, Ghana Telecom, also uses GSM technology, and offers prepaid and post-paid services, including SMS. It also plans to introduce CDMA systems into the network and to change its remaining analogue exchanges to digital. Finally, CelTel, owned by Kludjeson International, started its operations in Ghana in 1993 using AMPS technology. Ghana has had full fixed-line Internet connectivity since 1993.

5.6.5 Mobile data services in Ghana

SMS messaging

Although SMS initially took time to catch on in Ghana, its use has become a very popular means of communication in recent years, proving particularly popular with prepaid customers. Mobitel offers free e-mail services on its network. Spacefon, on the other hand, introduced the use of SMS into the mobile industry. According to estimates, SMS messages sent in Ghana have grown from 22'000 to over 130'000 in 2000.[40] The rise of SMS in Ghana has been fuelled by many factors. These include the growth of prepaid services, the development of WAP, SMS roaming, interconnection between operators and the different services available to users.

Third-generation in Ghana

The Ghanaian telecommunications regulator, the National Communication Authority, recently announced its intention to award Ghana Telecom, the former State-run monopoly operator, a 3G licence, and a frequency has already been reserved for the company's 3G operations. The decision to reserve a licence for Ghana Telecom has raised some doubts as to the transparency and design of the decision-making process, and as to whether industry stakeholders were properly consulted. The tentative approach towards opening up the market may be based on the need to allow timing of market readiness and network development.

The choice of winner of the contract to manage Ghana Telecom will have a decisive influence on the deployment of a future 3G network in Ghana. Until now, government policy and politics have strongly determined the growth and direction of the telecoms market. But difficulties are bound to arise in the deployment of 3G unless the capacities of the national regulator are strengthened as an independent overseer of the industry. Notwithstanding this, the private sector and operators have been initiating and sponsoring new projects which could have a positive effect on the sector's transition to a future 3G environment.

Beyond the governmental policy issues with regard to licensing, one of the biggest factors discouraging operators from introducing 3G in Ghana is the low level of economic activity and the low-level domestic economy. Despite being the eighth biggest cellular market in Africa, Ghana may have some way to go before introducing 3G onto the local mobile market—particularly given that only few individuals and corporate entities may be able to subscribe to 3G. However, the progress made in other African countries in encouraging the substitution of fixed-line communications—for which the necessary infrastructure is so often lacking—through mobile, could serve as inspiration in Ghana.

5.7 Conclusions

5.7.1 Lessons for a new generation

Of the countries studied, and of those that chose to award 3G licences early on, Japan and Korea were the first to forge ahead with deploying fully-fledged 3G services commercially. The experience of Japan and Korea would suggest the huge potential of the mobile Internet. However, the high hopes held for mobile services have been somewhat dampened by the slump of recent years in the telecommunication sector as a whole, as well as evidence that some mobile markets are reaching saturation. Many of the operators in the countries that have yet to initiate 3G deployment are taking a more gradual, or cautious approach, concentrating their efforts on new multimedia-type applications over existing second-generation platforms, with many choosing to upgrade their systems to support higher data transmission speeds needed for images. This approach may be a useful way to "test the waters" for 3G, or to exploit more fully the potential of 2.5G technologies without the need to invest heavily in new 3G networks. Even where appetites for mobile multimedia services have been whetted, the real test of mobile Internet services is still to come.

In many less developed countries, mobile telephony has been a real boon to extending universal access, forgoing the need to pump financial resources into fixed-line infrastructure, and offering low-cost access to communications in rural areas. Latin American countries like Chile and Venezuela have actively harnessed this potential, and their example of proactive regulatory and government policy-making could serve as useful models for other less developed countries. An evident key to the success of mobile data services such as SMS, as opposed to purely voice services, is the use of prepaid schemes, as exemplified *par excellence* in the case of the Philippines, but also borne out elsewhere. SMS has been the unexpected "killer application" that has sometimes—ironically—filled a gap that needed filling, but which may have effectively delayed 3G licensing. The "SMS phenomenon" shows that hitting on the elusive "killer application" for the mobile Internet may be a key factor in its success.

Experience has shown that licensing needs to be carefully timed and priced to ensure network development and healthy competition—and that there is no "one-size-fits-all" model for 3G licensing. The licensing process needs careful regulation with a view to the introduction of competition, to stimulate network development, expand the market and achieve economies of scale. The cases of Hong Kong and China highlight the importance of the licensing process and of regulatory approaches to 3G, showing above all that competition stimulates growth.

The experience of Japan in particular (see Box 5.1) shows that operators and regulators alike need to be aware of the demand-driven need for roaming and interconnectivity, which is becoming increasingly important as mobile technologies and applications converge, and as the market becomes increasingly global. Another sign of these times of convergence, is the practice of optimizing investments by sharing infrastructure, for example by operators with the most developed networks leasing space on transmission masts, thereby encouraging market entry by smaller players, and expediting network roll-out. As the example of Sweden shows however, such arrangements are subject to conflicts of interest between competitors, public environmental and pricing concerns, and regulatory prerogatives, which call for some foresight on the part of regulators if legal wrangling is not to further delay the deployment of 3G services.

One observation to made on the basis of different countries' experience worldwide, is that while mobile has its own obstacles to diffusion, the Internet has perhaps even greater ones. Obstacles to dial-up Internet usage include insufficient fixed-line infrastructure, (as illustrated by the case of Venezuela where Internet diffusion has been slow), limited bandwidth availability and lack of financial resources. The mobile Internet could offer a means to overcome these problems, but even the mobile Internet will still remain inaccessible to many unless locally-relevant content exists, language barriers are lifted, and literacy levels are raised, implying a determined effort on the part of governments. Thailand is one example of a country where the low level of knowledge of English has been an obstacle to Internet use, contrasting on one hand with

Singapore, where English is widely understood, and on the other hand with Korea, where efforts to develop Internet content in the indigenous language, Hangeul, and the availability of handsets that support the language characters, have been highly successful. The positive promotion of Internet development by governments does make a difference. In Chile, where the Government has been proactive in fostering creativity, training opportunities, content and e-government initiatives, Chileans have become versed in using the Web, and the production of locally relevant content has been stimulated.

Drawing different country cases together not only enables practical insights and lessons to be drawn, but also gives a larger sense of the human implications of new technologies such as the mobile Internet. The inborn need to communicate of all humans across the globe drives them to do so in ever-growing series of diverse, creative and essentially different ways. The mobile Internet is an exciting new platform for communication, but we should not expect it to be tied to the social or cultural norms of any one group of people. This may make the task harder, but marketing strategies need to be designed taking on board what makes us different—as individuals, as local communities, and as peoples. After all, those very differences are what give us our passion for communication.

1 For the purpose of clarity, Hong Kong, China is hereinafter referred to as "Hong Kong".

2 The full case studies are available at: http://www.itu.int/osg/spu/casestudies/index.html. The choice of countries selected in no way implies a greater level of regulatory, technical or other advancement over countries not mentioned, but is intended to provide as wide and varied a range of examples as possible, while reflecting different regional contexts. Also, the scope of each country section in this chapter may vary according to the particular focus on a given theme. For statistical information on m-readiness in over 200 economies worldwide, refer to the annex to this report.

For the purposes of the present report, some of the case study material has been updated to reflect new developments since the studies were first carried out, for which the original authors' contributions are gratefully acknowledged. The authors concerned are: Chris Addy-Nayo (study on Ghana); Martin Hilbert (study on Chile and Venezuela); Staffan Hultén (study on Sweden), and Xu Yan (study on China and Hong Kong, China).

3 The case studies, as well as a number of workshops and symposia, publications on CD-ROM, and telecommunication indicators, are carried out by the ITU Strategy and Policy Unit (SPU), often in collaboration with the Telecommunication Data and Statistics Unit (TDS) of the ITU Telecommunication Development Bureau. Further information about the ITU New Initiatives Programme, themes covered, and publications produced, is available at: http://www.itu.int/osg/spu/.

4 In March 2001, DoCoMo's ARPU stood at: JPY 7'770 for voice calls and JPY 880 for i-mode. In March 2002, the corresponding ARPU was JPY 6'940 for voice calls, and JPY 1'540 for i-mode. The increase in ARPU for i-mode over that period makes up for the decrease in voice call ARPU. See NTT DoCoMo website at http://www.docomo.co.jp/.

5 By the end of March 2002, the coverage area only comprised the centre of three major urban areas. As of April 2002, the FOMA network covered about 60 per cent of the population.

6 In addition to extension of coverage, DoCoMo plans to introduce a "Dual Network Service", enabling subscribers to use their FOMA handsets in the coverage areas, while being able to use their 2G handsets using the same phone number outside those coverage areas.

7 This decision was taken in March 2002 by the 3rd Generation Partnership Project, a collaboration to produce globally applicable technical specifications and technical reports for a W-CDMA system. See http://www.3gpp.org/.

8 For NTT DoCoMo's PHS services, data transmission increased from 58 per cent in March 2001 to 72.5 per cent in March 2002. NTT DoCoMo website at http://www.docomo.co.jp/.

9 *Report on business models for next-generation mobile phones*; MPHPT, Japan.

10 DoCoMo plans to develop a system whereby users can access other ISPs directly by 2003. Similarly, KDDI plans to open its mobile "EZweb" network on a case-by-case basis, but has yet to confirm a date. J-Phone has yet to declare an open network strategy, but is considering this possibility.

11 CDMA 1x, which is not strictly speaking a third-generation technology but which offers high transmission speeds of up to 2.4 Mbit/s, was accepted by ITU in 2002 as one of the IMT-2000 family of standards.

12 OECD "The development of broadband access in OECD countries", 29 October 2002, available at http://www.oecd.org/pdf/M00020000/M00020255.pdf.

13 Year-end 2001 figures, ITU World Telecommunication Indicators Database.

14 See ITU case study: "The e-City: Singapore Internet Case Study", ITU, 2001.

15 See the IDA media release of 3 June 2002 at: http://www.ida.gov.sg/. The round of 3G licensing, held in April 2001, was due to be conducted by auction, but this was aborted in the absence of other contenders. The licences were therefore sold by the IDA to the three incumbent mobile operators, for US$ 55'280'000 apiece. See also http://www.3gnewsroom.com/.

16 See for example "SingTel Mobile reviews 3G strategy" of 14 June 2002, at http://welcome.singtel.com/news/.

17 See IDA press release of 11 April 2002 at http://www.ida.gov.sg/Website/IDAhome.nsf/Home?OpenForm.

18 Figures reported by the Korea Network Information Center (KRNIC). See news article of 15 January 2002, at http://www.nic.or.kr/.

[19] *2001 Statistical Report of Telecommunications Development*, Ministry of Information Industry, 2002.

[20] See: Bing Zhang, "Understanding China's Telecommunications Policymaking and Reforms: A Tale of Transition toward Liberalization", *Telematics and Infomatics*, No. 19, 2002, 331-349, at: http://www.elsevier.com/locate/tele.

[21] *China Mobile (HK) Annual Report* 2001.

[22] Ibid.

[23] Lu, T.J., "The Development of Mobile Commerce in China", *Proceeding of Asia-Pacific Mobile Communications Symposium*, 2000, pp. 100-110.

[24] See diagram showing the relationships between the various standards and evolution paths shown in Chapter two of this report.

[25] Wang, F., "A great stride towards 3G's future", *Datang Group Newsletter*, 1 April 2001.

[26] Interview with ZTE of 26 April 2001.

[27] *ITU World Telecommunication Indicators Database*.

[28] Ibid.

[29] See: "The country we want" at http://www.gobiernodechile.cl/.

[30] The introduction of EDGE is considered by some local analysts to be a lucrative alternative for mobile operators who are reluctant to move straight to "pure" 3G.

[31] *Perspective*, Pyramid Research, Latin America, 17 July 2002.

[32] Familiar factors seem to underly the poor performance of WAP, including poor content provision and scarcity of terminals, as well as an as yet underdeveloped culture of Web usage.

[33] *Comparative Assessment of the Licensing Regimes for 3G Mobile Communications in the European Union and their Impact on the Mobile Communications Sector*, European Commission, Directorate-General Information Society, Final Report, 25 June, 2002.

[34] Ibid.

[35] See ITU Case study on Sweden for details of the various consortia established in Sweden, at http://www.itu.int/osg/spu/casestudies/index.html.

[36] NMT stands for "Nordic Mobile Telephony".

[37] Figures from African cellular statistics at: http://www.cellular.co.za/stats/stats-africa.htm.

[38] See: http://www.ghanaweb.com/GhanaHomePage/NewsArchive/wap.php.

[39] See: http://www.infodev.org/.

[40] See a selection of African cellular statistics at: http://www.cellular.co.za/stats/stats-africa.htm.

6 CHAPTER SIX: CONCLUSIONS—TOWARDS A MOBILE INFORMATION SOCIETY

6.1 A mixed blessing?

In this report we have looked at the ways in which the mobile revolution—past, present and future—is changing the way we live and work. Mobile phones are already pervasive in all major developed economies and in an increasing number of developing ones too. But with the advent of the mobile Internet, wireless gadgets are set to invade new areas of personal life and work. This new generation of gadgets will make new services and applications possible, but may also threaten traditional values of privacy and courtesy.

In the preceding chapters, we have examined the technological breakthroughs that have enabled the mobile Internet to blossom. We have looked at the commercial promise of the mobile Internet market and the challenges it poses to policy-makers and regulators. We have also examined individual country examples of how high-speed mobile services have been licensed and how the market has started to grow. In this final chapter, we look ahead to the future; towards the mobile information society.

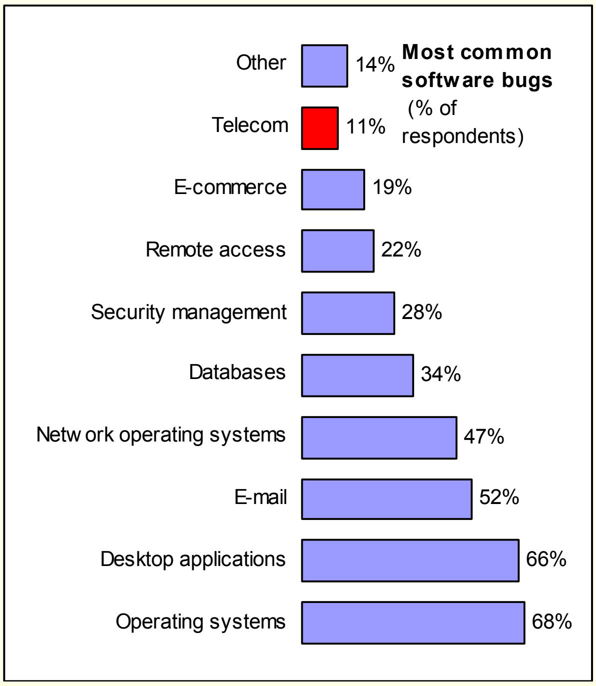
No technology is ever problem-free. In the days before the automobile, there were fewer deaths on the roads. Before the advent of television, people spent more time reading and conversing. Before aeroplanes were flown commercially, there was no hijacking. On the other hand, the sheer grinding tasks of day-to-day living have been taken off the shoulders of those to whom the heaviest burden traditionally fell: workers and women. All technology has its downsides then, but the net effect is generally positive. Technological progress enriches and facilitates our lives and, on the whole, we would not choose to live without it.

The mobile Internet holds the same mix of promises and inconveniences. Consider the following contradictions:

- Having a mobile phone is supposed to make a person feel safer, but in the United Kingdom, for instance, more than 700'000 mobile phones were stolen in 2001 and, in cities like London, it is estimated that mobile phone theft accounts for more than half of all street crime.[1]
- Having a wireless navigation system is supposed to make car driving easier, but when drivers are distracted, the likelihood of a serious accident is increased.
- Bringing easy-to-use e-mail to mobile phones will make them more useful, but e-mail also brings junk mail and spam, which are often unwelcome.
- Internet-enabled wireless gadgets will be much more useful than today's mobile phones, but as they adopt more sophisticated operating systems and functionality, they will also become likely to crash (see Figure 6.1). Mobile data users may find it much harder to fix bugs, especially if content providers and network operators blame one another for the problem.
- The location positioning functions of mobile phones will make it easier for parents to track their children's whereabouts. But do teenagers want this?
- An intelligent fridge might order the family's grocery shopping on the basis of their normal shopping preferences and which slots in the fridge are empty. But who will remember to cancel the order when the family leaves for vacation?
- Being in constant touch by mobile phone and e-mail with work colleagues is good for teamwork, but not necessarily for personal productivity.
- Most people would like a mobile phone, but few want to live next to a mobile transmission mast.

The growth of many consumer goods shows a characteristic pattern of modest but steady increase up to a certain point, at which a critical threshold is crossed and consumers find they "can't live without it". Thereafter, growth is rapid. Reaching this threshold point is particularly important for networked services where the utility of the service grows in line with the total number of users who can call and be called. In the case of the mobile Internet, the tipping point at which it becomes a "must have" is just as likely to be culturally and socially defined as economically predictable. That is because the mobile Internet will make new demands on individual lifestyles and work patterns. Thus, the initial "resistance" to adopting the mobile Internet may be much stronger than for either mobile phones or for the Internet separately.

Figure 6.1: Software bugs

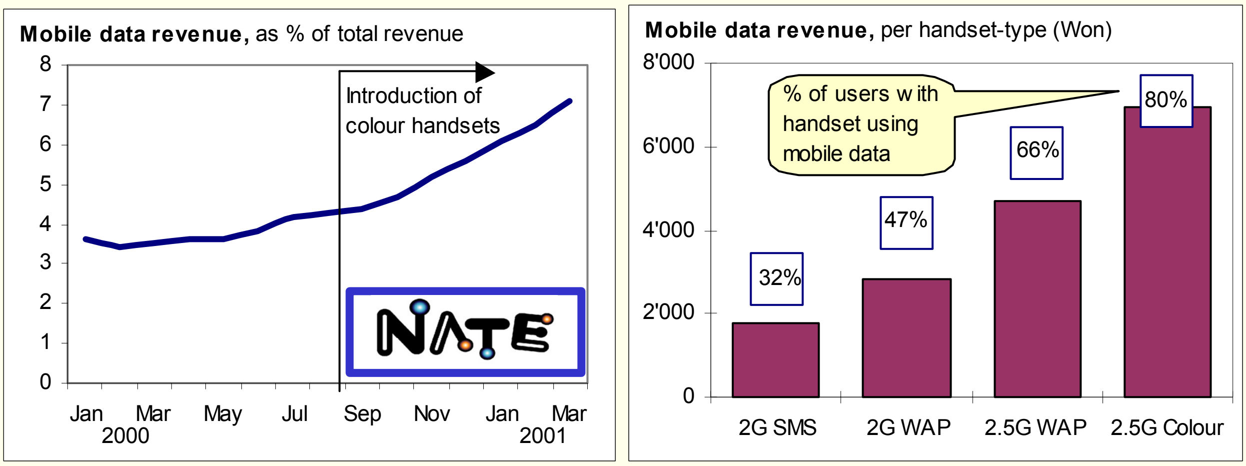


Source: Economist Technology Quaterly, 20 June 2002. See http://www.economist.com/science/tq/index.cfm.

In this chapter we examine what the Internet will mean for lifestyles and work patterns, beginning with a look at how location-based services will operate (see section 6.2) and how this will impact upon privacy and data protection concerns. Section 6.3 looks at early experiences in those markets that have currently advanced the furthest in mobile data applications, such as Korea and Japan, and the role that teenagers are playing in driving market demand. In section 6.4, we examine what the future holds, in terms of "pervasive computing". Finally, in section 6.5, we examine what the mobile information society will mean for the developing world. Throughout the chapter, mini-case studies are used to illustrate real-life examples.

Figure 6.2: Growing the mobile data market

SK Telecom's revenue from mobile data, as a percentage of total data (Jan 2001 – March 2002) and by type of handset, March 2002 (in Korean Won)



Note: US$ 1 = 1'230 Korean Won.
Source: SK Telecom.

6.2 Location-based services

6.2.1 How it works

Consider these cases:

- A skier, trapped in an avalanche, is located and rescued thanks to her mobile phone.
- A former prisoner, on release from prison, is tagged to provide evidence that he is not re-offending.
- A long-distance goods vehicle driver carries a device that reports her position to headquarters so that clients can track the progress of their shipments.

These are all examples of a location-finding technology that has been around for a number of years. Although there are many variants, the technology mainly uses global positioning system (GPS) satellites[2] to pinpoint a user's location to within a few metres or less. The first GPS satellite was launched in 1978, and by 1994 a complete global system of 24 satellites was in orbit. The original users were principally in the US military, or were scientists. But the user base has progressively widened as the technology has become declassified (accuracy limitations were removed in May 2002) and as GPS receivers have become much cheaper (as little as US$ 100).

It may well be that the level of accuracy that GPS gives—essential for scientific experiments, for instance—is simply not necessary for most potential consumer applications. Today's mobile cellular system needs to know certain information about the subscriber, for instance which cell they are located in, in order to complete the call. By using a triangulation between cellular masts (a service sometimes called "automatic location identification", or ALI), it is possible to track a subscriber to within 100 metres or so. This level of accuracy is adequate, for instance, for emergency services to arrive on the scene to respond to an emergency call (see Box 6.1).[3] This approach is sometimes called a "network-based solution" as opposed to the "handset-based solution" which GPS terminals provide (see discussion in section 2.5.4).

Location information by itself—a set of longitude and latitude coordinates—is of only limited use. It becomes useful when combined with other information, such as geographical data, a city-map for instance, and historical data, such as the path that has been followed when walking in the woods. The most common commercial application is in-car navigation systems, but positioning capability can be built into a wide variety of devices. Many applications are scientific in nature, but there is also a growing consumer market. The basic functions of GPS cover location-finding, navigation, tracking, mapping and precision timing.

GPS functions can be integrated into many different devices. The hope is that, with mobile Internet, location-based services (LBS) can be brought to the mass market, at a reasonable price. Integrating the location-finding facilities of GPS, the information search and retrieval functions of the Internet, and the mobility features of mobile phones should, in theory, create a whole new potential market. For instance, enhanced call ID would enable the receiving party to know not only who is calling but also from where they are calling. The only problem is that no one is really sure what applications users will want and what they will be willing to pay for.

6.2.2 Social concerns over location-based services

The range of possible applications for location-specific information is wide and diverse. One can imagine, for instance, using location-specific devices to track the location of any object that might be stolen (e.g. cars, works of art, etc.). Similarly, location-specific devices could be built into the airbags of cars to generate emergency calls automatically in the case of an accident. This service is already available in Japan. These types of application should help make the world a safer place.

However, it is also easy to see how the combination of location-specific data with personal data can infringe on civil liberties and personal privacy. By tracking when and where a person makes and receives calls on a mobile phone over a period of time, it is possible to build up an accurate picture of that person's behaviour. Such information could be very useful, for instance, for law enforcement agencies in tracking criminals. But might it also be used to track political dissidents? Under what circumstances should mobile operators be obliged to monitor a particular user's behaviour? How long should they be legally required to keep records?

Most mobile operators routinely destroy such information after a few months, but in Switzerland for example, records going back for five years are kept—a boon to criminal investigators, but equally a threat to civil liberty. The mobile information society will raise new questions regarding the acceptable range of information which can be collected and stored concerning the whereabouts of individuals and who should have access to that data.

In addition to information about an individual's whereabouts that is collected without their direct knowledge, there may be other applications where a user may not wish to disclose their information. For instance, some mobile Internet services are based on the premise that a user may wish to know about good restaurants or special offers when visiting a particular town. However, this potentially useful service could become abused by peddlers of junk mail. Similarly, some service providers offer a service whereby users can identify which of their friends are in the vicinity. But such a service could equally well be used to promote prostitution.

It is likely that the new issues raised by the development of the mobile information society will form one of the main talking points at the upcoming World Summit on the Information Society (WSIS).[4] The Summit, which will be held in two phases—in Geneva, 10-12 December 2003 and in Tunis, in 2005—is being organized under the patronage of the Secretary-General of the United Nations, with the ITU playing the leading managerial role. Preliminary work for the Summit, which will be conducted through a series of Preparatory Committees (PrepComs), has already identified access to information and ICTs, data protection and information network security as key themes.

Box 6.1: Enhanced 911

The emergency services—fire, police ambulance, coastguard etc—are among the most intensive users of location-based information. They need to be able to respond rapidly to emergency calls. When those calls are made from a fixed-line network, the caller can be traced from a database, which links the number of the caller to a specific location. For calls from a mobile phone however, which is more likely to be the nearest available phone to the scene of an accident, the emergency services have needed to rely on oral descriptions of location. With the application of location-finding features, that is now changing. However, cooperation between the network provider and the emergency services provider is still required in order to locate the caller's position quickly.

Emergency call numbers (such as 911 in the United States, 999 in the United Kingdom or 118 in Switzerland) have always been available over fixed-line telephones, as a service which operators are obliged to provide free of charge to users. But now, the regulatory burden is being imposed on mobile operators too. In 1996, FCC, the US regulatory agency, introduced rules for a "Wireless E911" service. These rules oblige wireless carriers to provide "public safety answering points" (PSAPs) with information concerning the point of origin of the call. These rules were divided into two phases:

- Phase I rules require carriers, subject to certain conditions, to provide PSAPs with the telephone number of the originator of a wireless 911 call and the location of the cell site or base station receiving the call.
- Phase II rules require wireless carriers to begin providing more precise automatic location identification (ALI). The FCC requests carriers to try to achieve 95 per cent penetration of ALI-capable handsets among its subscribers by 31 December 2005, and to achieve accuracies to within 50 metres for 67 per cent of all calls and within 150 metres for 95 per cent of calls. For network-based solutions, FCC requires a lower level of accuracy but which should be achieved earlier. Carriers, however, have requested a later implementation schedule.

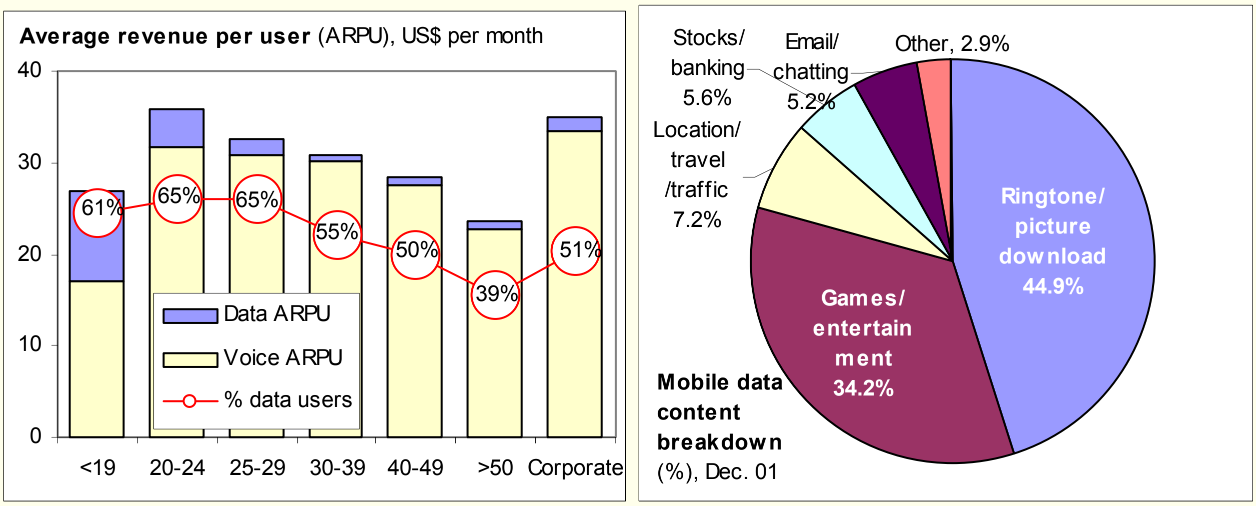
The European Commission has similar plan, the so-called E112 initiative. In February 2002, the EU appointed a Co-ordination Group on Access to Location Information by Emergency Services to develop a consensus on the introduction of E112 in Europe.

Ideally, the approaches taken to the introduction of these types of regulatory requirement should be harmonized between different countries and regions. This would assist with responding to emergency calls and it will also enable operators and manufacturers to develop a standardized offering. Measures should also ideally be technologically neutral. This would also assist in helping to enforce compliance among operators, who are increasingly active well beyond the borders of the home country in which they are regulated.

Source: FCC, European Commission.

Figure 6.3: How Koreans use mobile data

Data from SK Telecom on average revenue per user (ARPU) by age group and breakdown of content use



Note: "Other" content, in right chart, includes news/sports (2.0%), e-books/education (0.6%) and e-lottery/shopping (0.3%).
Source: SK Telecom.

In short, while location-based services offer a potentially powerful tool for enhancing a user's experience, they run into a minefield of social and personal issues that society has never previously had to deal with and where the rules of acceptable behaviour are, at best, ill-defined, and more usually non-existent. It is no coincidence that, in recent years, Hollywood films have frequently involved plotlines that turn on some aspect of new telecommunications technology (for instance, a voice-mail message provides an alibi in *Disclosure*, while e-mail plays a starring role in *You've got mail*). Future films will no doubt provide an early exploration of the moral and ethical dilemmas that location-based services will pose.

6.3 Teenagers: driving the market

Mobile phones are intrusive. They are much more demanding of our time and our attention than humble fixed-line telephones. The mobile Internet is likely to be even more demanding. Mobile data devices will require more sacrifices of our personal privacy. The price of "connectedness" could be a changing lifestyle.

Perhaps because of this, it is young people who are proving to be the most avid users of the mobile Internet in those markets, such as the Republic of Korea and Japan, where it is most advanced. In Korea, for instance, as much as a third of the money spent by teenagers on mobile phone bills is spent on mobile data (see Box 6.2). The major uses of mobile data tend to be flirtatious and frivolous, like downloading cartoon animations or "avatars" to represent the user when entering chat rooms or sending messages. Games are one of the most important market segments. In Japan, teenagers are among the most avid users of the latest craze, which is video-messaging (a type of multimedia messaging like MMS).

In the 2G world too, SMS use is driven by the overactive thumbs of young users. The difficulty for operators is that teenage users generally have less to spend than older age groups. Fortunately, while teenagers may send more text messages than they receive, they probably receive more voice messages than they send, mainly from anxious parents. Thus they are a more profitable market than their disposable incomes would suggest.

A key question for operators is whether teenagers will continue to use mobile data applications, as they get older and perhaps richer. An interesting parallel here is with the video-game market, which began mainly as teenagers and pre-teens market. As that first generation of gamers has grown up, they have continued to buy games, perhaps moving to more sophisticated and expensive ones. This augurs well for the 3G industry. On the other hand, teenagers tend to be more price-sensitive than older users and less loyal to specific carrier brands. So the theory of getting them hooked at an early age may not work so well.

If teenagers are driving the market for the mobile Internet, it may be because advertisers are ignoring other segments of the market. When was the last time an advert from a mobile-phone company featured anyone under the age of 40 in a positive role? But the "grey market" can be highly profitable, as NTT DoCoMo discovered in September 2001, when it introduced a new type of mobile handset, called *Raku-Raku* or "easy-easy". Specifically designed for older users with a bigger keypad and an easier-to-read screen, it proved an instant hit, selling over 200'000 units in the first two months.[5] Older people are living longer and more healthy lives, and are, on average, much wealthier than before, thanks to private and company pensions. But they are unlikely to match teenagers for glamour.

Korea is a significant bellwether for the rest of the mobile data industry. Data from Korea shows that mobile data ARPU (Average Revenue Per User) from CDMA 1x subscribers is more than twice the level of that from basic second generation CDMA users. For 1x subscribers with a colour handset, the level is higher still, at around 7'000 Won (US$ 5.40) per month. Furthermore, whereas only around one third of ordinary 2G handsets are used for SMS, some four-fifths of those with colour capability use data facilities (see Figure 6.2). It appears that the introduction of colour handsets, which occurred after September 2001, has been a major factor in increasing the level of mobile data ARPU. In September 2001, mobile data ARPU contributed around 4.3 per cent of total ARPU for SK Telecom, but this had grown to 7.1 per cent by March 2002. Terms like 2.5G, 3G, 1x or 1xEV-DO may seem like algebra to consumers; but colour makes a very visible difference.

6.4 Pervasive communications

In 2002, Queen Elizabeth II celebrated fifty years on the British throne. A journalist, receiving this message in some far-flung part of the Commonwealth over an imperfect line, told his readers that she was celebrating fifty years "on the phone"! A future King Charles or William may well live long enough to celebrate such an achievement. Because the mobile Internet will usher in a new concept of communication of "always-on" telephone service.

Since the days of Graham Alexander Bell we have been familiar with the concept of a telephone in every home, which is used, for an average of four three-minute calls per day. Over time, the introduction of mobile phones has meant that each individual, rather than each household, can now have a phone and the number of calls made has increased. But the mobile Internet will imply a shift to a world in which individuals may own dozens of miniaturized computer/communication devices that are continuously connected. This is the vision of ubiquitous or pervasive communications.

In the 1980s and 1990s, the microchip spread from the computer into hundreds of other devices, from computers to washing machines to cars. The average car, these days, has as much computer power as some of the early Apollo rockets. Most families in developed nations already own dozens of microchips embedded in different devices. The next stage in this process of pervasive computing is for those microchips to gain the ability to communicate and to report on their location and status. The technology to make this happen is already available—for instance, nanotechnology, cellular communications, cheap processing power, location-tracking systems—but the networks and the billing systems are not yet in place. The mobile Internet promises to make this possible.

Consider the following scenarios:

- Future medical devices may be so small that they could be swallowed to provide health status reports from inside the body, for instance on blood pressure or on the workings of a heart pacemaker.
- Miniaturized GPS chips could be located in cars to assist with road charging schemes. They could record, for instance, whenever a car uses a particular road, or crosses into a particular urban area, allowing the motorist to pay on a monthly basis rather than having to queue to pay at toll stations.
- Every valuable item we own may in future have a positioning device embedded in it, to help track it if it is lost or stolen. People may no longer invest in insurance against theft but in private security companies to trace and recover stolen goods.
- Inventory management systems will help factory-owners to track the location and quantity of spare parts by pinging out messages to "intelligent barcodes" that are added to each item that passes through the factory.

Box 6.2: Mobile data in Korea

Korea's experience provides valuable insights into the demographics of the mobile Internet marketplace (see Figures 6.2 and 6.3).

- The first key message is that it is the residential market, not the business market, which is driving usage. Although service providers like SK Telecom recognize business users as a specific market segment, only half of them use mobile data and their contribution provides just 2 per cent of total revenue.
- By contrast, teenagers are the main market drivers. Although teenagers have the second lowest (after users aged over 50) total Average Revenue Per User (ARPU) at just 33'000 Won (US$ 27) per month, more than a third of this is spent on data applications. Data ARPU diminishes sharply with age with 20-24 year-olds spending less than a half as much as teenagers, despite their greater spending power, and by the age of thirty, users are spending less than US$ 1 per month on average, on data applications.
- Study of the breakdown of content shows that those applications designed to appeal to the teenage market, such as download of ring tones or cartoon animations[6], together with games and entertainments, form more than three-quarters of the total. By contrast, information services aimed at older age groups, such as traffic information or stock prices, occupies relatively little space. Of course, viewing the market by value, rather than by volume, may produce a different picture, but most mobile content is available elsewhere (for instance, over the Internet).
- The usage breakdown contrasts markedly with that of other countries. Compare with China, for instance (see Figure 5.4 in Chapter five). There, the main mobile data application is e-mail (41 per cent) followed by stock transactions (16 per cent) and News (12 per cent). These three categories account for two-thirds of the market demand in China, but only 13 per cent in Korea. Of course, once China acquires mobile data networks that run as fast as those in Korea, then the two usage patterns may converge. The suspicion is, however, that China is more representative of mobile data usage in the wider narrowband network-based market, and that it is Korea which is a case apart.

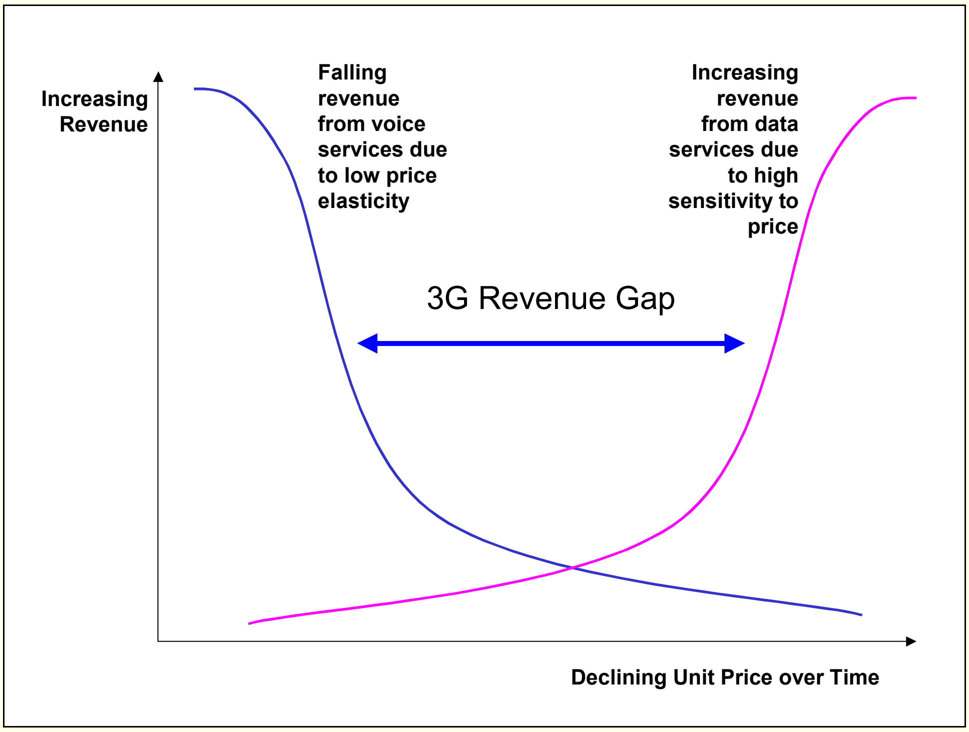
Source: ITU country case study of broadband in the Republic of Korea, to be published at: www.itu.int/casestudies.

This vision of a mobile information society, which is based on pervasive communication chips, can only be realized if we break through today's barriers of access and affordability. For instance, suppose a medical monitoring device sends information on a patient's blood pressure to a computer every five minutes to build a picture of that person's health. If the patient had to pay the price of a mobile phone call for each of those messages, then their blood pressure will most certainly go up! Unless the cost of each call is close to zero, then this type of application would never be viable.

There lies the dilemma. Pervasive computing becomes truly useful once the majority of calls are machine-to-machine, not person-to-person. The most common message delivered over 3G networks is likely to be "I am here. I am OK", or whatever the equivalent is in 1s and 0s. But to make that service viable, the price has to be so low that the service provider can only make a profit by achieving huge volumes of traffic. If data traffic is cheap, then it follows that voice traffic should also be cheap, because in a digital world it is hard to differentiate between different data streams. This experience has already been observed in the fixed-line world where IP telephony, travelling over data networks such as the Internet, has undercut the profit margins on voice traffic travelling over circuit-switched networks such as the Public Switched Telephone Network.[7] Soon, this will be repeated in the mobile world.

In the longer term, it will be data traffic that provides the majority of revenue on 3G networks. But in the early days, the business case for 3G is based squarely on more traditional voice revenues. Over time, as unit prices fall, there will be a transition away from voice to data, but it is likely that voice will get cheaper at a faster rate than data revenues will grow. That is because, while voice is relatively price inelastic (halving the price might lead to, say, a 15 per cent increase in calls) data is highly price sensitive (certain applications, like machine-to-machine communications, will only become viable once the prices fall below a certain near-zero amount). Consequently, 3G operators are likely to fall into a "revenue gap" during the time it takes for data revenue to match and overtake falling voice revenues (see Figure 6.4).

Figure 6.4: The 3G revenue gap



Source: ITU.

6.5 The mobile information society and the developing world

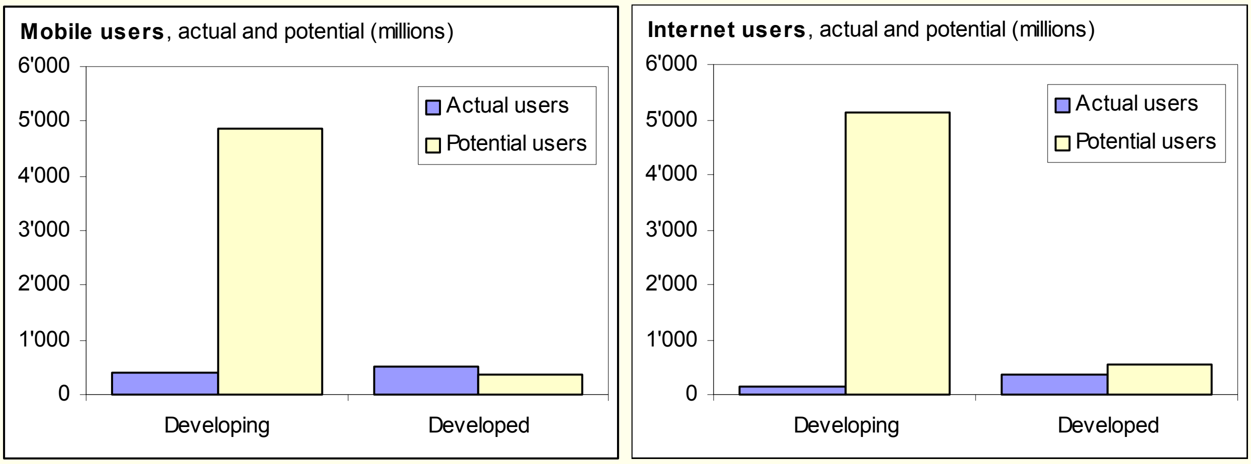
6.5.1 The developing market

Although the long-term future of the mobile Internet lies in selling lots of miniaturized communication devices to rich people, the short-term future lies in selling conventional mobile phones and Internet subscriber accounts to the not-so-rich. As the market in the developed world begins to approach saturation, interest logically turns to the developing world. Potential users may be defined as those who do not currently have a subscription. For every single potential mobile user in the high-income developed economies there are thirteen times as many in the developing world. Similarly, for every single potential Internet user in the rich countries, there are almost ten more in less wealthy countries (see Figure 6.5). Even if one takes a more restrictive definition of who a potential user might be (for instance, over the age of ten, with a family disposable income of more than US$ 5'000 per year), then there are still many times more potential users in the developing world than in the developed one. It is a simple question of demography: fewer than a billion people live in the fifty or so high income countries with an average per capita GDP of more than US$ 9'000 per year. More than 5 billion people live in economies with lower average incomes.

Which developing countries are likely to provide the most fertile ground for the development of the mobile Internet? That question is quite difficult to answer because countries that are doing well on mobile (like the Philippines, for instance) may not be doing so well on Internet. Equally, countries that are leaping ahead on Internet use (like India) may be slowed down in mobile development. Similarly, countries that have the most potential, in terms of infrastructure development, may be the most closed to foreign investment.

Figure 6.5: Spot the potential

Actual and potential users of cellular mobile and Internet, in developed and developing countries, 2001



Note: For the purposes of this chart, "developing" is defined as low, lower-middle and upper-middle income economies, and "developed" as high-income economies.
Source: ITU World Telecommunication Indicators Database.

Perhaps the best way of identifying market potential is to use a multi-variate index, which combines mobile indicators with Internet ones and which combines infrastructural indicators with measures of market openness and usage. For the purposes of this report, ITU has established at Mobile/Internet Index with a baseline of year-end 2001 (see Table 10 in the Statistical Tables). The Index reports on 26 different indicators of "readiness" for the adoption of the Mobile Internet (a full description is provided in the Methodology in the Technical Notes). Although the economies that score highest on the report, like Hong Kong, Denmark or Sweden are all high income, there are equally many low, lower-middle and upper-middle income economies that are doing much better than their relative GDP per capita would predict.

Figure 6.6 summarizes the position of the leading economies in the low and lower-middle income groups. Among low-income countries, India is probably the best positioned, ranking 56th in the world. India scores particularly well on the usage basket of indicators for which it ranks 15th in the world, mainly because of the development of offshore call centres and software outsourcers in the Bangalore area. Uganda, which is featured in Box 6.3, also scores in the top 10 low-income economies for the mobile/Internet. It ranks 76th in the world in terms of its readiness for mobile Internet. This contrasts with its GDP per capita which, even on a purchasing power parity (PPP) basis, ranks it below the top 150.

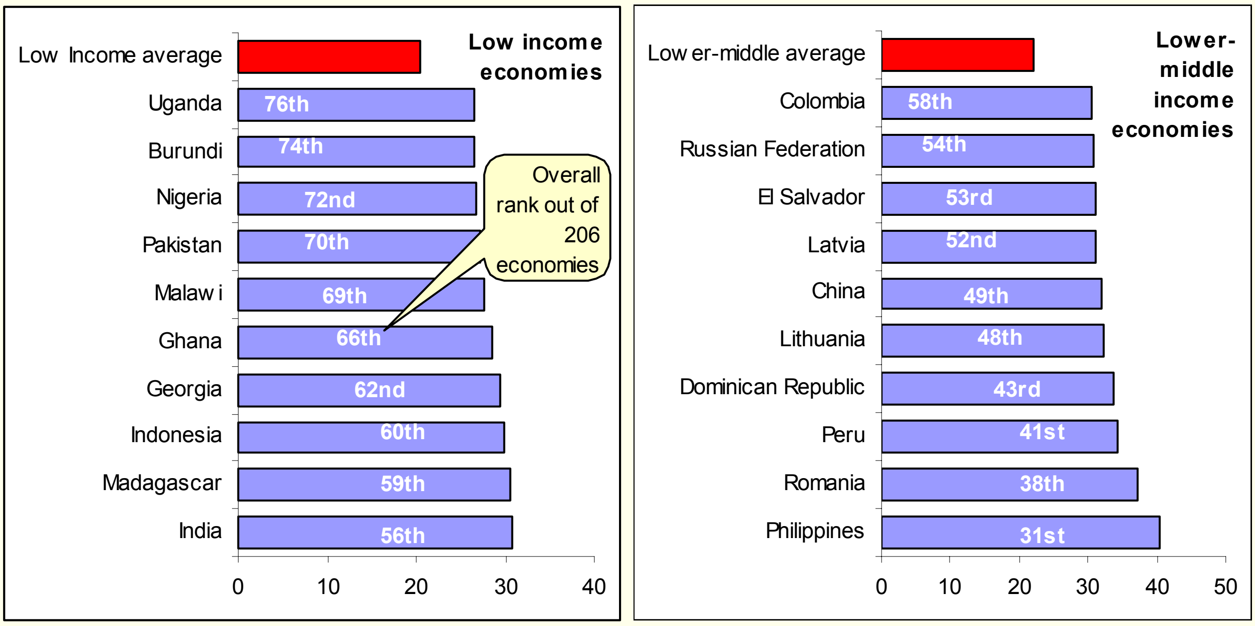
Among the lower-middle income economies, the Philippines is in the best position to be a rapid adopter of the mobile Internet, particularly because of its relatively open market structure. China also stands in a good position relative to its modest GDP per capita. Other middle-income countries that are likely to do well in adopting the mobile Internet include Romania, Peru and the Dominican Republic.

6.5.2 Mobile/fixed substitution in the developing world

Korea and Japan, which have been extensively featured in this report, may be good models for predicting market growth in Western Europe and North America. But they are unlikely to prove a good predictor of market trends in Africa, Latin America or developing Asia. The introduction of 3G mobile in the developing world is just as likely to mean 'wire-less' access to the Internet from fixed locations as much as 'mobile' access. In countries such as Uganda (see Box 6.3), which are effectively bypassing the wired stage of network evolution, the dynamics of market evolution are likely to be quite different from those in the developed world.

Figure 6.6: Which developing economies are likely to adopt the mobile Internet first?

Ranking of top ten low and lower-middle income economies on the ITU's Mobile/Internet Index



Note: The overall score represents mark (out of 100) the economy scores. The higher the mark, the better. The rank (out of 206 economies) shows where that economy falls among all economies ranked. The lower the rank, the better. For more explanation of the Mobile/Internet Index, see the Technical Notes.

Source: ITU.

Consider the following: a future consumer in a country like Uganda will go into a shop and buy a communications "device" off the shelf. It will not come with an instruction manual or a set of cables, but will instead sport bright colours and a large screen. The consumer will just need to connect the device to a power supply and then it will automatically find its local 3G or WLAN base station, and connect to available TV and radio stations (perhaps delivered by satellite), and also a local MP3 distributor. Once the connections have been made, the latest software and upgrades will be automatically downloaded and the consumer will then have a "box" providing access to the Internet, TV and radio stations and voice communication networks. It will not only provide mobile Internet services, but so much more as well. The point is that it will not be "wired" and it will not require careful study of the instruction manual or a visit from a public utility to get it up and running.

In the developed world, there has been much talk about service providers achieving "triple play", by developing combined revenue streams from television, Internet and telecommunications. But most potential users already have at least two of those services already provided and there has been no compelling reason to change to an integrated service provider. In the developing world, however, where electronic entertainment and communication services are still largely virgin territory, a company which manages to offer a "triple play" may be able overcome problems of low ARPU that make it uneconomic to provide any of these services individually. It may well be that a mobile Internet platform will prove the most suitable for providing integrated services delivery.

Already, in many parts of Africa, there is almost complete substitutability between mobile and fixed-line telephone service. In other words, even if fixed-line service were available, consumers might choose to stick with their mobile service. This could act to slow down the spread of the Internet. But it could also represent an opportunity for a different type of "Internet experience"; one which is less demanding on literacy and technical skills and which is closer in nature to watching television. Today's Internet is still user-unfriendly and offers few content services for which users are willing to pay. In a developing country environment, where the available channels for distribution of video-entertainment are often expensive, or of poor quality, an Internet-enabled device that uses the airwaves to deliver video entertainment may offer an attractive alternative.

Box 6.3: Uganda's mobile miracle

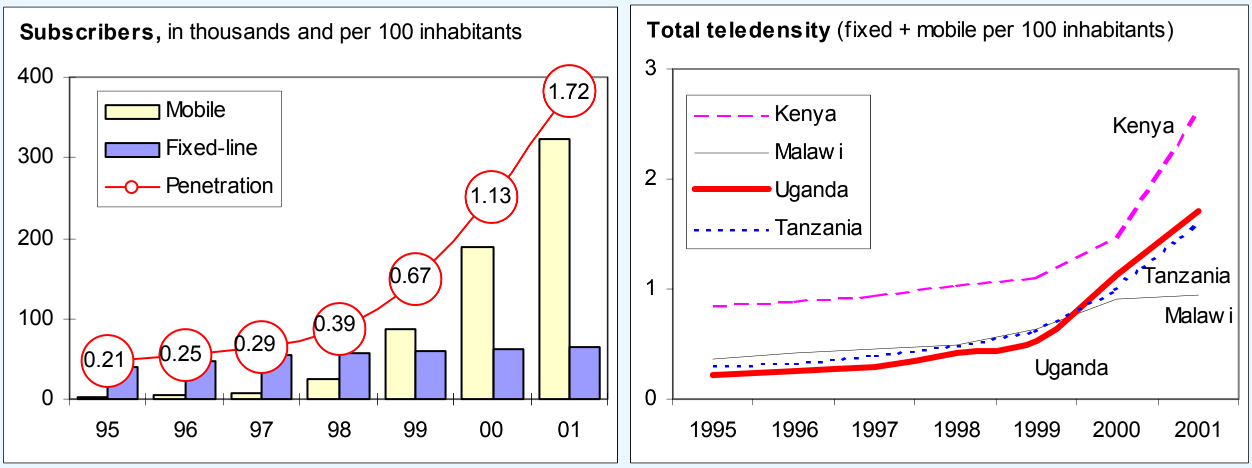
The Republic of Uganda is an agricultural country with a population of about 22 million. Over 85 per cent of its citizens live in rural areas. Uganda's gross domestic product (GDP) per capita is less than US$ 300, making it one of the world's least developed economies. It has historically had one of the lowest levels of telephone penetration in the world. However, government initiatives to boost the economy through privatization, market liberalization and foreign investment are starting to pay off. Nowhere is this more evident than the telecommunications sector, which is now one of the most liberal in Africa. Uganda licensed a private GSM mobile operator, CelTel, in May 1995 and introduced a second operator, MTN-Uganda (www.mtn.co.ug), in October 1998. The results of these changes have been dramatic. Uganda's overall telephone density rose from 0.21 telephone subscribers per 100 people in 1995, to 1.72 at the end of 2001. This liberal approach has enabled Uganda to expand its network faster than its East African neighbours, overtaking Malawi and Tanzania and closing the gap with Kenya.

This rapid growth is a direct result of MTN's entry as the second full-service operator in the market. Although MTN's licence allows it to offer all telecommunication services, including fixed telephony, it has focused on mobile. One reason is that wireless networks are quick to install. Another is the use of prepaid cards; since most Ugandans would not meet the financial criteria for subscription-based service. In a little over one year, MTN emerged as the largest network operator in Uganda surpassing not only CelTel but also the incumbent fixed operator, UTL, in terms of number of clients. In July 1999, Uganda became the first African country where there were more mobile than fixed telephone customers. MTN has not rested on its laurels. It has been aggressive in expanding the network into what Ugandan's refer as "up-country"; that is the rural part of the nation. Over 90 per cent of the urban population is now covered by mobile cellular and some 80 towns have service. What is remarkable is that the number of mobile subscribers widely exceeds earlier forecasts of a potential mobile market of only 10'000! The entry of the newly-privatized UTL into the mobile market should further spur growth.

The issuing of 3G licences is a long-way off in Uganda, but already businesses in Kampala are using wireless ISDN to access the Internet. As in many parts of Africa, installing copper networks can be slow and unreliable (copper theft is high). Thus MTN's solution, which is based on using point-to-point microwave to provide a primary rate ISDN interface to buildings within line of sight of its transmitters, is proving popular. Using local wiring to distribute the signal within buildings allows several businesses to share the costs and the bandwidth. As WLAN technology becomes more reliable and affordable, even this last leg of local wiring can be replaced.

Box Figure 6.3: Mobile outgrowing the fixed-line network in Uganda

Subscribers, to mobile and fixed-line networks in Uganda, and total teledensity in Kenya, Malawi, Tanzania and Uganda, 1995-2001



Source: ITU World Telecommunication Indicators.

But how would you bill for such a device? The most likely approach will be a sort of "prepaid" charge, for basic access, combined with "pay-per-view" for everything else. Much of the broadcast-type traffic (such as web-browsing or streaming media, as well as conventional TV and radio) will be funded through advertising. Low-bandwidth local calls and e-mail might be bundled into the pre-paid access price. But the consumer will be bombarded with opportunities for impulse buying of everything from pizza delivery to a first-run movie to a discounted international telephone call. If enough vendors from different market sectors get together, the cost of the device itself could be subsidized by usage. But here is the rub: a billing model that is based on impulse buying depends on widespread ownership of credit or debit cards, which are almost unavailable in countries like Uganda. If the 3G revolution is to reach the unwired world, then the plastic money revolution must get there first.

This report has examined the development of the mobile Internet. Most of the examples used have come from the developed North. But that reflects the fact that most current users of the mobile Internet live in those countries. In the longer term, beyond the next ten years, this picture will change. The majority of "mobile Internet" users will be in the developing world, but the services they will be using will probably not be called by that name. They will be using a combination of the airwaves as a transmission technology and Internet Protocol. But they will be using it from fixed devices as much as from mobile ones, and they will be using it for entertainment as much as for messaging. For now, "mobile Internet" is a term we use to describe an emerging niche market. But it could become the main action. In this respect, developing economies hold the greatest potential and will be the true laboratory for the "next-generation network".

[1] See: Jamie Wilson "Mobile phone thieves may face five years in jail", *The Guardian*, 4 May 2002, at: http://www.guardian.co.uk/mobile/article/0,2763,709796,00.html. The UK Government has tabled a new parliamentary bill, the "Mobile Telephones (Re-programming) Bill" which, in enacted, would make it illegal to change the International Mobile Equipment Identity (IMEI) number which identifies the handset. For information, see: http://www.parliament.the-stationery-office.co.uk/pa/ld200102/ldbills/080/en/02080x--.htm.

[2] GPS is the US system. A Russian system, GLONASS, also exists and a European system, Galileo, is planned. For a general primer on GPS, see: http://www.aero.org/publications/GPSPRIMER/.

[3] Half of around 80 million emergency calls in the EU are from mobiles. The response centres rely entirely on verbal information to discover the caller's whereabouts, but around 3.5 million callers provide inaccurate details. Ci-online, *Floating point: Lost and Found,* 1 April 2002.

[4] For more details, see the WSIS website at www.itu.int/wsis.

[5] See "Over 60 and overlooked", *The Economist*, 10 August 2002.

[6] Interestingly, the appetite of Koreans for computer animation is helping to bring North and South Korea closer together. The "mydinga" 3D computer animations (www.mydinga.com), a series of short animated films featuring a lazy cat and a cool dog, have been designed in the South (by a subsidiary of Hanaro Telecom) but subcontracted to the North, where labour is cheaper. They are designed to be downloaded onto different platforms, such as mobile phones or PC screens.

[7] IP telephony was the subject of the last in the series of ITU Internet Reports, published in December 2000. It is available for purchase, online, at http://www.itu.int/ITU-D/ict/publications/inet/2000/index.html.

Mobile Internet Statistical Annex

September 2002

INTERNATIONAL TELECOMMUNICATION UNION

CONTENTS

INTRODUCTION

Data are presented for 206 economies with populations greater than 40'000 and where sufficient data are available.

Economies are grouped by 2001 United States dollar (US$) income levels, as follows:

Low	Gross National Income (GNI) per capita of US$ 755 or less
Lower middle	US$ 756–2'995
Upper middle	US$ 2'996–9'265
High	US$ 9'266 or more

The income level classification is based on World Bank methodology whereas the Gross Domestic Product (GDP) per capita shown in Table 1 is based on the methodology described in the *Technical notes*. Economies are shown in alphabetical order within their income group in the tables. See the list of list of economies in alphabetical order and their location in the tables on page A-2.

The data cover the public telecommunications sector. Due to differing regulatory obligations for the provision of data, a complete measurement of the sector for some economies cannot be achieved. Data for major telecommunication operators covering at least 90 per cent of the market are shown for all economies. More detailed information about coverage and country specific notes together with a full time-series from 1960, 1965, 1970, 1975-2001 is contained in a CD-ROM (ITU World Telecommunication Indicators Database) available separately.

Telecommunication data are supplied by an annual questionnaire sent to telecommunication authorities and operating companies. These data are supplemented by annual reports and statistical yearbooks of telecommunication ministries, regulators, operators and industry associations. In some cases, estimates are derived from ITU background documents or other references; estimates are shown in italic. Broadcasting data are supplied by annual questionnaires sent to national broadcasting authorities or industry associations. Demographic and macro-economic data are provided by the relevant international organizations identified in the *Technical notes*.

The following signs and symbols are used in the tables:

italic	Year other than that specified or estimate.
k	Thousands (i.e., 1'000).
M	Millions (i.e., 1'000'000).
B	Billions (i.e., 1'000'000'000).
US$	United States dollars. See the *Technical notes* for how US$ figures are obtained.
%	Per cent.
–	Zero or a quantity less than half the unit shown. Also used for data items that are not applicable.
...	Data not available.
CAGR	Compound Annual Growth Rate. See the *Technical notes* for how this is computed.

The absence of any sign or symbol indicates that data are in units.

Comments and suggestions relating to the World Telecommunication Indicators should be addressed to:

Telecommunication Data and Statistics Unit
Telecommunication Development Bureau
International Telecommunication Union
Place des Nations
CH-1211 Geneva 20, Switzerland

Fax: +41 22 730 6449
E-mail: indicators@itu.int

Comments and suggestions about the report in general can be e-mailed to spumail@itu.int.

Additional information about Telecommunication Indicators can be found at the ITU's Indicators web site at http://www.itu.int/ITU-D/ict/.

LIST OF ECONOMIES

Economy	Location	Abbreviation	Region
Afghanistan	1	AFG	Asia
Albania	64	ALB	Europe
Algeria	65	DZA	Africa
Andorra	154	AND	Europe
Angola	2	AGO	Africa
Antigua & Barbuda	118	ATG	Americas
Argentina	119	ARG	Americas
Armenia	3	ARM	Asia
Aruba	155	ABW	Americas
Australia	156	AUS	Oceania
Austria	157	AUT	Europe
Azerbaijan	4	AZE	Asia
Bahamas	158	BHS	Americas
Bahrain	120	BHR	Asia
Bangladesh	5	BGD	Asia
Barbados	159	BRB	Americas
Belarus	66	BLR	Europe
Belgium	160	BEL	Europe
Belize	67	BLZ	Americas
Benin	6	BEN	Africa
Bermuda	161	BMU	Americas
Bhutan	7	BTN	Asia
Bolivia	68	BOL	Americas
Bosnia	69	BIH	Europe
Botswana	121	BWA	Africa
Brazil	122	BRA	Americas
Brunei Darussalam	162	BRN	Asia
Bulgaria	70	BGR	Europe
Burkina Faso	8	BFA	Africa
Burundi	9	BDI	Africa
Cambodia	10	KHM	Asia
Cameroon	11	CMR	Africa
Canada	163	CAN	Americas
Cape Verde	71	CPV	Africa
Central African Rep.	12	CAF	Africa
Chad	13	TCD	Africa
Chile	123	CHL	Americas
China	72	CHN	Asia
Colombia	73	COL	Americas
Comoros	14	COM	Africa
Congo	15	COG	Africa
Costa Rica	124	CRI	Americas
Côte d'Ivoire	16	CIV	Africa
Croatia	125	HRV	Europe
Cuba	74	CUB	Americas
Cyprus	164	CYP	Europe
Czech Republic	126	CZE	Europe
D.P.R. Korea	17	PRK	Asia
D.R. Congo	18	COD	Africa
Denmark	165	DNK	Europe
Djibouti	75	DJI	Africa
Dominica	127	DMA	Americas
Dominican Rep.	76	DOM	Americas
Ecuador	77	ECU	Americas
Egypt	78	EGY	Africa
El Salvador	79	SLV	Americas
Equatorial Guinea	80	GNQ	Africa
Eritrea	19	ERI	Africa
Estonia	128	EST	Europe
Ethiopia	20	ETH	Africa
Faroe Islands	166	FRO	Europe
Fiji	81	FJI	Oceania
Finland	167	FIN	Europe
France	168	FRA	Europe
French Guiana	169	GUF	Americas
French Polynesia	170	PYF	Oceania
Gabon	129	GAB	Africa
Gambia	21	GMB	Africa
Georgia	22	GEO	Asia
Germany	171	DEU	Europe
Ghana	23	GHA	Africa
Greece	172	GRC	Europe
Greenland	173	GRL	Europe
Grenada	130	GRD	Americas
Guadeloupe	131	GLP	Americas
Guam	174	GUM	Oceania
Guatemala	82	GTM	Americas
Guernsey	175	GGY	Europe
Guinea	24	GIN	Africa
Guinea-Bissau	25	GNB	Africa
Guyana	83	GUY	Americas
Haiti	26	HTI	Americas
Honduras	84	HND	Americas
Hong Kong, China	176	HKG	Asia
Hungary	132	HUN	Europe
Iceland	177	ISL	Europe
India	27	IND	Asia
Indonesia	28	IDN	Asia
Iran (I.R.)	85	IRN	Asia
Iraq	86	IRQ	Asia
Ireland	178	IRL	Europe
Israel	179	ISR	Asia
Italy	180	ITA	Europe
Jamaica	87	JAM	Americas
Japan	181	JPN	Asia
Jersey	182	JEY	Europe
Jordan	88	JOR	Asia
Kazakhstan	89	KAZ	Asia
Kenya	29	KEN	Africa
Kiribati	90	KIR	Oceania
Korea (Rep.)	133	KOR	Asia
Kuwait	183	KWT	Asia
Kyrgyzstan	30	KGZ	Asia
Lao P.D.R.	31	LAO	Asia
Latvia	91	LVA	Europe
Lebanon	134	LBN	Asia
Lesotho	32	LSO	Africa
Liberia	33	LBR	Africa
Libya	135	LBY	Africa
Lithuania	92	LTU	Europe
Luxembourg	184	LUX	Europe
Macao, China	185	MAC	Asia
Madagascar	34	MDG	Africa
Malawi	35	MWI	Africa
Malaysia	136	MYS	Asia
Maldives	93	MDV	Asia

Economy	*Location*	*Abbreviation*	*Region*
Mali	36	MLI	Africa
Malta	186	MLT	Europe
Marshall Islands	94	MHL	Oceania
Martinique	187	MTQ	Americas
Mauritania	37	MRT	Africa
Mauritius	137	MUS	Africa
Mayotte	138	MYT	Africa
Mexico	139	MEX	Americas
Micronesia	95	FSM	Oceania
Moldova	38	MDA	Europe
Mongolia	39	MNG	Asia
Morocco	96	MAR	Africa
Mozambique	40	MOZ	Africa
Myanmar	41	MMR	Asia
Namibia	97	NAM	Africa
Nepal	42	NPL	Asia
Neth. Antilles	188	ANT	Americas
Netherlands	189	NLD	Europe
New Caledonia	190	NCL	Oceania
New Zealand	191	NZL	Oceania
Nicaragua	43	NIC	Americas
Niger	44	NER	Africa
Nigeria	45	NGA	Africa
Northern Marianas	192	MNP	Oceania
Norway	193	NOR	Europe
Oman	140	OMN	Asia
Pakistan	46	PAK	Asia
Palestine	98	WBG	Asia
Panama	141	PAN	Americas
Papua New Guinea	99	PNG	Oceania
Paraguay	100	PRY	Americas
Peru	101	PER	Americas
Philippines	102	PHL	Asia
Poland	142	POL	Europe
Portugal	194	PRT	Europe
Puerto Rico	143	PRI	Americas
Qatar	195	QAT	Asia
Réunion	196	REU	Africa
Romania	103	ROM	Europe
Russia	104	RUS	Europe
Rwanda	47	RWA	Africa
S. Tomé & Principe	48	STP	Africa
Samoa	105	WSM	Oceania
Saudi Arabia	144	SAU	Asia
Senegal	49	SEN	Africa
Seychelles	145	SYC	Africa
Sierra Leone	50	SLE	Africa
Singapore	197	SGP	Asia
Slovak Republic	146	SVK	Europe
Slovenia	198	SVN	Europe
Solomon Islands	51	SLB	Oceania
Somalia	52	SOM	Africa
South Africa	147	ZAF	Africa
Spain	199	ESP	Europe
Sri Lanka	106	LKA	Asia
St. Kitts and Nevis	148	KNA	Americas
St. Lucia	149	LCA	Americas
St. Vincent	107	VCT	Americas
Sudan	53	SDN	Africa
Suriname	108	SUR	Americas
Swaziland	109	SWZ	Africa
Sweden	200	SWE	Europe
Switzerland	201	CHE	Europe
Syria	110	SYR	Asia
Taiwan, China	202	TWN	Asia
Tajikistan	54	TJK	Asia
Tanzania	55	TZA	Africa
TFYR Macedonia	111	MKD	Europe
Thailand	112	THA	Asia
Togo	56	TGO	Africa
Tonga	113	TON	Oceania
Trinidad & Tobago	150	TTO	Americas
Tunisia	114	TUN	Africa
Turkey	151	TUR	Europe
Turkmenistan	115	TKM	Asia
Uganda	57	UGA	Africa
Ukraine	58	UKR	Europe
United Arab Emirates	203	ARE	Asia
United Kingdom	204	GBR	Europe
United States	205	USA	Americas
Uruguay	152	URY	Americas
Uzbekistan	59	UZB	Asia
Vanuatu	116	VUT	Oceania
Venezuela	153	VEN	Americas
Viet Nam	60	VNM	Asia
Virgin Islands (US)	206	VIR	Americas
Yemen	61	YEM	Asia
Yugoslavia	117	YUG	Europe
Zambia	62	ZMB	Africa
Zimbabwe	63	ZWE	Africa

1. Basic Indicators

		Population		GDP		Total telephone subscribers	
		Total (M) 2001	Density (per km²) 2001	Total (B US$) 2000	per capita (US$) 2000	Total (k) 2001	per 100 inhabitants 2001
1	Afghanistan	22.47	35	*11.2*	523	29.0	0.13
2	Angola	13.53	11	*11.2*	901	166.5	1.23
3	Armenia	3.79	126	1.9	544	554.3	14.63
4	Azerbaijan	7.78	90	4.0	514	1'485.5	19.09
5	Bangladesh	131.27	912	36.4	281	1'034.0	0.79
6	Benin	6.45	57	2.2	369	184.3	2.86
7	Bhutan	0.69	15	*0.4*	665	14.0	2.03
8	Burkina Faso	12.22	45	2.2	187	132.6	1.09
9	Burundi	6.86	246	0.8	120	40.0	0.58
10	Cambodia	13.44	74	*2.1*	175	257.0	1.91
11	Cameroon	15.20	32	*9.5*	664	411.4	2.71
12	Central African Rep.	3.78	6	*1.1*	312	21.0	0.56
13	Chad	8.13	6	1.4	182	33.0	0.41
14	Comoros	0.73	390	0.2	382	8.9	1.22
15	Congo	3.11	9	3.0	1'019	172.0	5.53
16	Côte d'Ivoire	16.35	51	*11.7*	818	1'022.1	6.25
17	D.P.R. Korea	24.47	200	*10.3*	440	1'100.0	4.50
18	D.R. Congo	52.52	22	...	...	170.0	0.32
19	Eritrea	3.81	41	*0.7*	191	32.0	0.84
20	Ethiopia	64.46	53	*6.3*	106	337.5	0.52
21	Gambia	1.34	125	...	...	78.0	5.84
22	Georgia	5.47	78	*2.9*	526	1'162.6	21.25
23	Ghana	20.93	88	*6.9*	372	435.9	2.08
24	Guinea	8.02	33	5.1	677	81.2	1.01
25	Guinea-Bissau	1.23	34	*0.3*	238	12.0	0.98
26	Haiti	8.27	298	3.8	461	171.5	2.07
27	India	1'027.02	324	*454.5*	455	41'162.9	4.01
28	Indonesia	209.17	109	153.3	743	13'252.2	6.34
29	Kenya	31.29	54	*10.6*	360	813.1	2.60
30	Kyrgyzstan	4.99	25	*1.2*	255	*385.1*	*7.89*
31	Lao P.D.R.	5.64	24	1.7	315	82.2	1.46
32	Lesotho	2.16	71	0.9	418	*43.8*	*2.03*
33	Liberia	3.11	28	...	...	8.8	0.28
34	Madagascar	16.44	28	3.9	243	205.9	1.25
35	Malawi	11.57	123	1.6	152	109.8	0.95
36	Mali	11.68	9	2.5	225	95.2	0.82
37	Mauritania	2.75	3	*0.9*	368	*26.1*	*0.98*
38	Moldova	4.39	130	1.3	294	886.1	20.18
39	Mongolia	2.56	2	*0.9*	364	318.0	12.43
40	Mozambique	20.19	26	*4.0*	205	259.3	1.28
41	Myanmar	48.36	71	*6.6*	147	295.0	0.61
42	Nepal	23.59	167	5.3	230	315.3	1.34
43	Nicaragua	5.22	43	2.4	473	*248.8*	*4.90*
44	Niger	11.23	9	*1.7*	171	23.5	0.21
45	Nigeria	116.93	127	39.4	346	830.0	0.71
46	Pakistan	144.97	180	60.1	425	4'200.0	2.90
47	Rwanda	7.95	302	1.8	236	86.5	1.09
48	S. Tomé & Principe	0.15	156	-	358	5.4	3.63
49	Senegal	9.66	49	*4.8*	512	628.0	6.50
50	Sierra Leone	4.87	67	0.6	131	49.6	1.02
51	Solomon Islands	0.46	16	0.2	556	8.4	1.80
52	Somalia	10.05	16	...	...	*35.0*	*0.36*
53	Sudan	31.81	13	*10.2*	364	558.0	1.75
54	Tajikistan	6.13	43	*1.1*	178	224.6	3.66
55	Tanzania	35.97	38	9.0	257	575.4	1.60
56	Togo	4.66	82	1.3	282	143.1	3.07
57	Uganda	22.53	93	5.5	250	386.5	1.72
58	Ukraine	50.30	83	*30.8*	608	12'894.2	25.64
59	Uzbekistan	25.26	56	*16.4*	676	1'725.7	6.83
60	Viet Nam	81.12	246	31.3	393	4'301.1	5.30
61	Yemen	19.11	101	*6.7*	384	575.2	3.01
62	Zambia	10.65	14	*3.9*	463	183.7	1.72
63	Zimbabwe	13.65	35	*5.6*	487	582.4	4.27
	Low Income	**2'493.89**	**75**	**1'017.9**	**434**	**95'670.4**	**3.84**

1. Basic Indicators

		Population		GDP		Total telephone subscribers	
		Total (M) 2001	Density (per km²) 2001	Total (B US$) 2000	per capita (US$) 2000	Total (k) 2001	per 100 inhabitants 2001
64	Albania	3.97	138	3.7	940	547.5	13.79
65	Algeria	31.14	13	*47.7*	1'613	1'980.0	6.36
66	Belarus	10.25	49	8.3	814	2'996.2	29.23
67	Belize	0.24	11	0.7	3'066	63.4	26.00
68	Bolivia	8.27	8	8.3	1'011	1'258.8	15.21
69	Bosnia	4.07	80	*4.5*	1'178	683.4	16.80
70	Bulgaria	8.11	73	12.0	1'473	4'463.9	55.06
71	Cape Verde	0.44	108	0.6	1'286	93.8	21.48
72	China	1'296.14	135	1'079.8	834	323'846.0	24.99
73	Colombia	42.80	38	82.9	1'958	10'565.3	24.68
74	Cuba	11.24	98	*15.7*	1'406	580.7	5.17
75	Djibouti	0.64	29	0.5	846	12.9	2.01
76	Dominican Rep.	8.67	179	19.7	2'299	2'225.2	25.67
77	Ecuador	12.88	28	13.6	1'076	2'194.9	17.04
78	Egypt	64.55	65	97.0	1'528	9'443.8	14.63
79	El Salvador	6.40	299	13.2	2'105	1'398.0	21.84
80	Equatorial Guinea	0.47	17	*0.5*	1'290	21.9	4.66
81	Fiji	0.82	45	*1.8*	2'259	166.4	20.24
82	Guatemala	11.69	107	19.1	1'674	1'890.0	16.17
83	Guyana	0.87	4	*0.7*	881	155.2	17.84
84	Honduras	6.57	59	5.9	915	547.3	8.33
85	Iran (I.R.)	64.54	39	329.9	5'182	12'072.0	18.70
86	Iraq	23.59	54	...	...	675.0	2.86
87	Jamaica	2.60	227	7.5	2'917	1'212.6	46.68
88	Jordan	5.18	54	8.3	1'653	1'405.5	27.12
89	Kazakhstan	16.09	6	*15.8*	973	*2'031.5*	*12.52*
90	Kiribati	0.08	117	-	590	*3.7*	*4.51*
91	Latvia	2.35	37	7.1	2'930	1'381.6	58.77
92	Lithuania	3.68	56	11.2	3'042	2'083.7	56.61
93	Maldives	0.27	906	*0.2*	763	45.7	16.92
94	Marshall Islands	0.07	38	*0.1*	1'577	4.7	6.68
95	Micronesia	0.12	87	0.2	2'000	10.0	8.33
96	Morocco	30.43	46	32.9	1'160	5'963.1	19.60
97	Namibia	1.79	2	*3.5*	2'040	217.4	12.16
98	Palestine	3.31	550	...	...	556.9	16.82
99	Papua New Guinea	4.92	11	*3.4*	727	*73.4*	*1.53*
100	Paraguay	5.64	14	7.5	1'363	1'438.8	25.52
101	Peru	26.09	20	53.9	2'101	3'567.3	13.67
102	Philippines	77.13	257	75.2	983	13'668.0	17.72
103	Romania	22.39	94	36.7	1'636	7'954.0	35.52
104	Russia	146.76	9	251.1	1'709	41'260.0	28.11
105	Samoa	0.18	63	0.2	1'306	13.0	7.22
106	Sri Lanka	19.10	291	16.3	862	1'548.0	8.10
107	St. Vincent	0.11	288	*0.3*	2'441	*27.3*	*24.04*
108	Suriname	0.44	3	*0.8*	1'921	161.4	36.69
109	Swaziland	1.02	59	*1.3*	1'353	98.0	9.61
110	Syria	16.61	89	19.2	1'185	2'007.6	12.09
111	TFYR Macedonia	2.04	79	*3.4*	1'705	761.8	37.27
112	Thailand	61.25	119	121.9	2'012	13'523.5	22.08
113	Tonga	0.10	141	*0.2*	1'589	*9.2*	*9.40*
114	Tunisia	9.70	59	19.7	2'050	1'445.4	14.90
115	Turkmenistan	4.84	10	*2.5*	582	*373.9*	*8.39*
116	Vanuatu	0.20	14	*0.2*	1'273	7.1	3.54
117	Yugoslavia	10.68	105	*11.3*	1'067	4'441.7	41.59
	Lower Middle Income	**2'093.54**	**47**	**2'478.3**	**1'206**	**485'177.5**	**23.18**

1. Basic Indicators

		Population		GDP		Total telephone subscribers	
		Total (M) 2001	*Density (per km²) 2001*	*Total (B US$) 2000*	*per capita (US$) 2000*	*Total (k) 2001*	*per 100 inhabitants 2001*
118	Antigua & Barbuda	0.08	175	*0.7*	8'721	62.3	80.42
119	Argentina	37.49	13	285.0	7'697	15'082.9	40.24
120	Bahrain	0.70	994	7.9	11'518	473.4	67.15
121	Botswana	1.68	3	4.9	3'008	*350.3*	*21.32*
122	Brazil	171.83	20	595.5	3'507	66'176.5	38.51
123	Chile	15.50	21	70.5	4'609	8'974.9	57.92
124	Costa Rica	4.11	81	4.6	1'148	1'256.3	30.54
125	Croatia	4.66	82	19.0	4'253	3'455.0	74.22
126	Czech Republic	10.27	130	50.8	4'931	10'615.0	103.32
127	Dominica	0.08	107	*0.3*	3'391	*23.9*	*30.98*
128	Estonia	1.43	32	5.0	3'455	1'154.8	80.75
129	Gabon	1.26	5	*4.7*	3'999	295.3	23.40
130	Grenada	0.10	290	*0.3*	3'635	39.2	39.16
131	Guadeloupe	0.46	270	...	...	*374.7*	*82.18*
132	Hungary	9.97	107	45.6	4'561	8'698.0	87.22
133	Korea (Rep.)	47.74	485	457.2	9'666	51'770.3	108.44
134	Lebanon	3.56	342	*16.1*	4'980	*1'424.5*	*40.74*
135	Libya	5.58	3	*32.5*	5'944	660.0	11.83
136	Malaysia	23.80	71	89.3	3'838	11'866.0	49.86
137	Mauritius	1.20	643	4.6	3'881	606.8	50.56
138	Mayotte	0.14	381	...	...	10.0	6.98
139	Mexico	100.37	51	574.2	5'807	35'530.0	35.40
140	Oman	2.62	10	*15.8*	6'418	559.8	21.34
141	Panama	2.90	37	*9.6*	3'394	1'030.0	35.53
142	Poland	38.63	124	157.6	4'078	21'450.0	55.53
143	Puerto Rico	3.95	441	*34.8*	9'020	2'540.6	64.29
144	Saudi Arabia	22.32	9	173.1	8'009	5'761.6	25.81
145	Seychelles	0.08	198	*0.6*	7'349	65.5	81.87
146	Slovak Republic	5.40	110	19.1	3'540	3'703.6	68.55
147	South Africa	43.79	37	125.9	2'882	14'166.0	32.35
148	St. Kitts and Nevis	0.05	176	*0.3*	7'759	*23.1*	*59.99*
149	St. Lucia	0.16	254	0.7	4'495	*51.4*	*32.95*
150	Trinidad & Tobago	1.30	254	*6.1*	4'726	537.2	41.33
151	Turkey	66.28	85	203.1	3'111	38'900.9	58.70
152	Uruguay	3.36	18	20.1	6'009	1'470.9	43.76
153	Venezuela	24.63	27	120.5	4'985	9'248.2	37.55
	Upper Middle Income	**657.48**	**28**	**3'156.0**	**4'868**	**318'408.9**	**48.44**

1. Basic Indicators

		Population		GDP		Total telephone subscribers	
		Total (M) 2001	Density (per km²) 2001	Total (B US$) 2000	per capita (US$) 2000	Total (k) 2001	per 100 inhabitants 2001
154	Andorra	0.08	172	1.2	16'990	*57.8*	*74.05*
155	Aruba	0.11	549	1.5	17'109	90.1	85.03
156	Australia	19.34	3	381.2	19'897	21'229.0	109.77
157	Austria	8.14	97	188.9	23'266	10'375.9	127.47
158	Bahamas	0.31	22	3.1	11'001	183.9	59.69
159	Barbados	0.27	623	*2.5*	9'247	*152.3*	*56.93*
160	Belgium	10.29	337	225.7	22'212	12'764.0	124.02
161	Bermuda	0.06	1'196	*2.1*	33'469	69.6	107.79
162	Brunei Darussalam	0.34	58	*4.3*	13'724	*175.5*	*53.46*
163	Canada	30.01	3	708.7	23'806	30'243.2	100.79
164	Cyprus	0.69	75	8.8	12'993	749.3	108.68
165	Denmark	5.37	125	162.4	30'470	7'836.1	146.00
166	Faroe Islands	0.05	32	*1.1*	24'102	*41.9*	*93.16*
167	Finland	5.20	14	120.8	23'338	6'889.0	132.61
168	France	59.34	109	1'280.2	21'738	69'955.2	117.88
169	French Guiana	0.19	2	...	...	126.3	66.48
170	French Polynesia	0.24	60	*3.7*	15'920	119.6	50.46
171	Germany	82.36	231	1'864.5	22'666	108'525.0	131.77
172	Greece	10.60	80	110.1	10'423	13'569.7	128.06
173	Greenland	0.06	-	...	...	43.0	76.60
174	Guam	0.17	378	*3.1*	18'644	*107.5*	*63.99*
175	Guernsey	0.06	966	*1.8*	29'574	86.5	137.72
176	Hongkong, China	6.76	6'365	163.2	24'249	9'673.9	143.12
177	Iceland	0.29	3	8.5	30'301	425.9	148.41
178	Ireland	3.84	56	94.9	25'067	4'660.0	121.39
179	Israel	6.51	294	110.3	17'586	8'360.0	128.46
180	Italy	58.02	193	1'070.8	18'689	76'001.0	131.00
181	Japan	127.33	337	*4'348.8*	34'337	150'819.2	118.44
182	Jersey	0.09	752	...	...	135.3	155.24
183	Kuwait	1.97	81	37.4	19'529	961.6	48.79
184	Luxembourg	0.45	173	18.9	42'743	782.4	175.03
185	Macao, China	0.45	18'824	6.2	14'170	370.9	82.80
186	Malta	0.39	1'241	3.5	9'068	346.5	88.40
187	Martinique	0.40	363	...	...	458.1	114.53
188	Neth. Antilles	0.22	272	...	...	*94.0*	*44.16*
189	Netherlands	16.11	391	367.5	22'987	21'900.0	135.98
190	New Caledonia	0.22	12	*3.0*	14'670	*101.0*	*46.89*
191	New Zealand	3.89	14	50.3	13'127	4'250.6	109.27
192	Northern Marianas	0.05	105	...	...	*24.0*	*45.25*
193	Norway	4.53	14	159.4	35'548	6'999.0	154.57
194	Portugal	10.30	112	104.6	10'436	12'374.9	120.11
195	Qatar	0.61	53	14.5	24'183	346.2	56.76
196	Réunion	0.73	291	...	...	721.1	98.65
197	Singapore	4.13	6'051	92.5	23'015	4'939.1	119.56
198	Slovenia	2.00	99	18.1	9'108	2'315.4	116.06
199	Spain	40.43	80	556.2	13'863	43'921.2	108.64
200	Sweden	8.91	20	227.4	25'603	13'627.0	152.94
201	Switzerland	7.22	175	241.0	33'454	10'409.0	144.17
202	Taiwan, China	22.41	623	307.8	13'888	34'479.9	153.89
203	United Arab Emirates	2.65	32	*46.5*	19'750	2'962.2	111.66
204	United Kingdom	60.08	245	1'416.1	23'694	82'352.0	137.08
205	United States	284.80	30	9'872.9	35'082	317'000.0	111.31
206	Virgin Islands (US)	0.12	348	...	...	*103.3*	*85.27*
	High Income	**909.13**	**27**	**24'416.1**	**27'161**	**1'095'305.2**	**120.48**
	WORLD	**6'154.04**	**45**	**31'068.3**	**5'224**	**1'994'561.9**	**32.42**
	Africa	**812.60**	**27**	**548.0**	**776**	**45'139.0**	**5.56**
	Americas	**840.84**	**21**	**12'569.9**	**15'173**	**518'649.5**	**61.69**
	Asia	**3'669.26**	**119**	**8'368.3**	**2'334**	**729'171.6**	**19.87**
	Europe	**800.49**	**31**	**9'134.4**	**11'463**	**675'474.3**	**84.38**
	Oceania	**30.86**	**4**	**447.7**	**14'798**	**26'127.6**	**84.97**

Note: For data comparability and coverage, see the technical notes.
Figures in italics are estimates or refer to years other than those specified.

Source: ITU.

2. Information Technology

		Internet				Estimated PCs	
		Hosts Total 2001	Hosts per 10'000 inhab. 2001	Users (k) 2001	Users per 10'000 inhab. 2001	Total (k) 2001	per 100 inhab. 2001
1	Afghanistan	4	-	...	...	...	...
2	Angola	8	0.01	60	44.35	17	0.13
3	Armenia	2'361	6.23	*50*	*142.05*	30	0.79
4	Azerbaijan	1'314	1.69	25	32.13	...	...
5	Bangladesh	3	-	150	11.43	250	0.19
6	Benin	500	0.78	25	38.78	11	0.17
7	Bhutan	1'136	16.46	3	36.23	4	0.58
8	Burkina Faso	704	0.58	21	17.18	17	0.14
9	Burundi	1	-	6	8.75	...	...
10	Cambodia	623	0.46	10	7.44	20	0.15
11	Cameroon	390	0.26	45	29.60	60	0.39
12	Central African Rep.	7	0.02	2	5.29	7	0.19
13	Chad	1	-	4	4.92	12	0.15
14	Comoros	11	0.15	3	34.39	4	0.55
15	Congo	42	0.14	*1*	*1.75*	12	0.39
16	Côte d'Ivoire	3'131	1.92	70	42.82	100	0.61
17	D.P.R. Korea	-	-	...	...	...	...
18	D.R. Congo	115	0.02	6	1.14	...	...
19	Eritrea	10	0.03	10	26.21	7	0.18
20	Ethiopia	43	0.01	25	3.88	75	0.12
21	Gambia	120	0.90	18	134.63	17	1.27
22	Georgia	2'081	3.80	25	45.70	...	...
23	Ghana	235	0.11	41	19.36	70	0.33
24	Guinea	245	0.31	15	18.70	32	0.40
25	Guinea-Bissau	77	0.63	4	32.60	...	...
26	Haiti	-	-	30	36.28	...	...
27	India	82'979	0.81	7'000	68.16	6'000	0.58
28	Indonesia	45'660	2.18	4'000	191.23	2'300	1.10
29	Kenya	2'702	0.86	500	159.78	175	0.56
30	Kyrgyzstan	4'558	9.14	*52*	*105.74*	...	...
31	Lao P.D.R.	165	0.29	10	17.73	16	0.28
32	Lesotho	60	0.28	5	23.15	...	...
33	Liberia	10	0.03	1	3.22	...	...
34	Madagascar	234	0.14	35	21.29	40	0.24
35	Malawi	22	0.02	20	17.28	13	0.11
36	Mali	87	0.07	30	25.69	14	0.12
37	Mauritania	113	0.41	7	25.48	27	0.98
38	Moldova	1'756	4.00	60	136.67	70	1.59
39	Mongolia	151	0.59	40	156.31	35	1.37
40	Mozambique	16	0.01	15	7.43	70	0.35
41	Myanmar	2	-	10	2.07	55	0.11
42	Nepal	1'513	0.64	60	25.43	80	0.34
43	Nicaragua	2'194	4.20	*50*	*98.54*	50	0.96
44	Niger	176	0.16	12	10.69	6	0.05
45	Nigeria	723	0.06	*200*	*17.57*	800	0.68
46	Pakistan	11'319	0.78	500	34.49	600	0.41
47	Rwanda	1'133	1.43	20	25.16	...	...
48	S. Tomé & Principe	927	61.80	9	600.00	...	...
49	Senegal	*1'836*	*1.93*	100	103.50	180	1.86
50	Sierra Leone	278	0.57	7	14.37	...	...
51	Solomon Islands	390	8.42	2	43.33	22	4.75
52	Somalia	4	-	1	1.00	...	...
53	Sudan	-	-	56	17.61	115	0.36
54	Tajikistan	299	0.49	3	5.22	...	...
55	Tanzania	1'478	0.41	300	83.41	120	0.33
56	Togo	220	0.47	50	107.37	100	2.15
57	Uganda	293	0.13	60	26.64	70	0.31
58	Ukraine	58'235	11.58	600	119.29	920	1.83
59	Uzbekistan	213	0.08	150	59.39	...	...
60	Viet Nam	487	0.06	400	49.31	800	0.99
61	Yemen	80	0.04	17	8.89	37	0.19
62	Zambia	1'095	1.03	25	23.48	75	0.70
63	Zimbabwe	3'494	2.56	100	73.26	165	1.21
	Low Income	**238'064**	**0.95**	**15'153.8**	**62.03**	**13'700**	**0.60**

2. Information Technology

		Internet				Estimated PCs	
		Hosts Total 2001	*Hosts per 10'000 inhab. 2001*	*Users (k) 2001*	*Users per 10'000 inhab. 2001*	*Total (k) 2001*	*per 100 inhab. 2001*
64	Albania	187	0.47	10	25.19	30	0.76
65	Algeria	665	0.21	60	19.27	220	0.71
66	Belarus	3'287	3.21	422	411.87	...	...
67	Belize	333	13.65	18	737.70	33	13.52
68	Bolivia	1'522	1.84	*120*	*146.19*	170	2.05
69	Bosnia	3'248	7.99	45	110.65	...	...
70	Bulgaria	26'926	33.21	605	746.27	*361*	*4.43*
71	Cape Verde	34	0.78	12	274.60	30	6.86
72	China	89'357	0.69	33'700	260.00	25'000	1.93
73	Colombia	57'419	13.41	1'154	269.61	1'800	4.21
74	Cuba	878	0.78	120	106.79	220	1.96
75	Djibouti	-	-	3	51.32	7	1.09
76	Dominican Rep.	41'761	48.17	186	214.53	...	...
77	Ecuador	3'383	2.63	328	254.43	300	2.33
78	Egypt	1'802	0.28	600	92.95	1'000	1.55
79	El Salvador	510	0.80	*50*	*79.67*	140	2.19
80	Equatorial Guinea	6	0.13	1	19.15	3	0.53
81	Fiji	668	8.13	15	182.48	50	6.08
82	Guatemala	6'630	5.67	200	171.13	150	1.28
83	Guyana	20	0.23	95	1'091.95	23	2.64
84	Honduras	322	0.49	*40*	*61.68*	80	1.22
85	Iran (I.R.)	2'466	0.38	402	62.29	4'500	6.97
86	Iraq	-	-	...	...	...	...
87	Jamaica	1'436	5.53	100	384.91	130	5.00
88	Jordan	2'185	4.22	212	409.11	170	3.28
89	Kazakhstan	10'947	6.80	*100*	*61.64*	...	...
90	Kiribati	23	2.88	2	250.00	2	2.50
91	Latvia	25'003	106.35	170	723.10	360	15.31
92	Lithuania	35'155	95.50	250	679.16	260	7.06
93	Maldives	-	-	10	370.37	6	2.22
94	Marshall Islands	3	0.43	1	128.57	4	5.00
95	Micronesia	653	54.42	*4*	*337.84*	...	...
96	Morocco	2'454	0.81	400	131.45	400	1.31
97	Namibia	4'632	25.91	45	251.68	65	3.64
98	Palestine	...	...	60	181.21	...	...
99	Papua New Guinea	439	0.89	*135*	*280.71*	300	6.10
100	Paraguay	2'704	4.80	60	106.44	80	1.42
101	Peru	13'504	5.18	3'000	1'149.73	1'250	4.79
102	Philippines	30'851	4.00	2'000	259.30	1'700	2.20
103	Romania	46'283	20.67	1'000	446.63	800	3.57
104	Russia	354'339	24.14	4'300	293.00	7'300	4.97
105	Samoa	5'351	297.28	3	166.67	1	0.67
106	Sri Lanka	2'286	1.20	150	78.52	150	0.79
107	St. Vincent	3	0.27	*4*	*308.57*	13	11.61
108	Suriname	59	1.34	15	330.00	...	...
109	Swaziland	1'142	11.20	14	137.25	...	...
110	Syria	9	0.01	60	36.12	270	1.63
111	TFYR Macedonia	2'594	12.69	70	342.47	...	...
112	Thailand	71'995	11.75	3'536	577.32	1'700	2.78
113	Tonga	20'587	2'090.05	*1*	*101.76*	...	...
114	Tunisia	218	0.22	400	412.37	230	2.37
115	Turkmenistan	1'620	3.35	8	16.55	...	...
116	Vanuatu	358	17.81	6	273.63	...	...
117	Yugoslavia	15'664	14.67	600	561.80	250	2.34
	Lower Middle Income	**893'921**	**4.28**	**54'900.5**	**265.26**	**49'558**	**2.45**

2. Information Technology

		Internet				Estimated PCs	
		Hosts Total 2001	Hosts per 10'000 inhab. 2001	Users (k) 2001	Users per 10'000 inhab. 2001	Total (k) 2001	per 100 inhab. 2001
118	Antigua & Barbuda	786	101.52	*5*	*652.03*	...	...
119	Argentina	465'359	124.14	3'000	800.28	2'000	5.34
120	Bahrain	1'718	24.37	140	1'988.65	100	14.18
121	Botswana	1'273	7.57	50	297.47	65	3.87
122	Brazil	1'644'575	95.71	8'000	465.58	10'800	6.29
123	Chile	122'727	79.20	3'102	2'001.99	1'300	8.39
124	Costa Rica	8'551	20.79	384	933.63	700	17.02
125	Croatia	21'988	47.24	*250*	*558.91*	400	8.59
126	Czech Republic	215'525	209.78	1'400	1'362.66	*1'250*	*12.14*
127	Dominica	223	27.88	*6*	*777.77*	6	7.50
128	Estonia	51'040	356.92	430	3'004.59	250	17.48
129	Gabon	69	0.55	17	134.71	15	1.19
130	Grenada	12	1.20	5	520.00	13	13.00
131	Guadeloupe	461	10.02	*8*	*175.44*	100	21.74
132	Hungary	167'585	168.04	1'480	1'484.01	1'000	10.03
133	Korea (Rep.)	439'859	92.14	24'380	5'106.83	12'000	25.14
134	Lebanon	7'101	19.97	*300*	*858.00*	200	5.62
135	Libya	70	0.13	20	35.84	...	...
136	Malaysia	74'007	31.10	5'700	2'394.96	3'000	12.61
137	Mauritius	3'126	26.05	158	1'316.67	130	10.83
138	Mayotte	-	-	...	...	...	...
139	Mexico	918'288	91.49	3'636	362.23	6'900	6.87
140	Oman	4'678	17.83	120	457.49	85	3.24
141	Panama	7'825	26.99	*90*	*316.99*	110	3.79
142	Poland	489'895	126.82	3'800	983.72	3'300	8.54
143	Puerto Rico	1'584	4.01	600	1'518.22	...	...
144	Saudi Arabia	11'422	5.12	300	134.40	1'400	6.27
145	Seychelles	262	32.75	9	1'125.00	12	15.00
146	Slovak Republic	72'557	134.29	*650*	*1'203.26*	800	14.81
147	South Africa	238'462	54.45	3'068	700.58	3'000	6.85
148	St. Kitts and Nevis	3	0.65	*2*	*516.10*	8	17.45
149	St. Lucia	17	1.09	*3*	*195.18*	23	14.68
150	Trinidad & Tobago	6'872	52.86	120	923.08	90	6.92
151	Turkey	106'556	16.08	2'500	377.22	2'700	4.07
152	Uruguay	70'892	210.93	400	1'190.12	370	11.01
153	Venezuela	22'614	9.18	1'300	527.77	1'300	5.28
	Upper Middle Income	**5'177'982**	**78.76**	**65'432.9**	**995.91**	**53'427**	**8.25**

2. Information Technology

		Internet				Estimated PCs	
		Hosts Total 2001	*Hosts per 10'000 inhab. 2001*	*Users (k) 2001*	*Users per 10'000 inhab. 2001*	*Total (k) 2001*	*per 100 inhab. 2001*
154	Andorra	3'200	400.70	*7*	*897.44*	...	...
155	Aruba	923	87.08	24	2'264.15	...	...
156	Australia	2'288'584	1'183.40	7'200	3'723.05	10'000	51.71
157	Austria	326'016	400.51	2'600	3'194.10	*2'270*	*27.95*
158	Bahamas	28	0.91	17	549.45	...	...
159	Barbados	130	4.85	*10*	*373.83*	25	9.33
160	Belgium	351'970	341.98	2'881	2'799.26	*3'500*	*34.45*
161	Bermuda	5'161	798.92	*25*	*3'901.37*	32	49.54
162	Brunei Darussalam	8'707	259.91	35	1'044.78	25	7.46
163	Canada	2'890'273	963.20	13'500	4'498.94	*12'000*	*40.31*
164	Cyprus	2'090	30.31	150	2'175.58	170	24.66
165	Denmark	561'056	1'045.38	2'900	5'403.39	*2'300*	*43.15*
166	Faroe Islands	1'614	358.23	*3*	*672.65*	...	...
167	Finland	886'916	1'707.25	2'235	4'302.83	2'200	42.35
168	France	788'897	132.94	15'653	2'637.72	20'000	33.70
169	French Guiana	120	6.32	*2*	*114.93*	27	14.21
170	French Polynesia	1'726	72.83	16	675.11	...	...
171	Germany	2'426'202	294.58	30'000	3'642.54	*27'640*	*33.60*
172	Greece	143'240	135.18	1'400	1'321.25	860	8.12
173	Greenland	2'583	460.51	20	3'565.70	...	...
174	Guam	148	8.71	*5*	*304.06*	...	...
175	Guernsey	1'517	241.56	*20*	*3'189.79*	...	...
176	Hongkong, China	387'672	573.52	2'601	3'848.36	2'600	38.46
177	Iceland	54'668	1'904.81	195	6'794.43	120	41.81
178	Ireland	128'092	333.67	895	2'331.40	1'500	39.07
179	Israel	143'678	220.77	1'500	2'304.86	1'600	24.59
180	Italy	680'461	117.28	16'400	2'826.71	11'300	19.48
181	Japan	7'118'333	559.03	55'930	4'392.39	44'400	34.87
182	Jersey	1'577	180.88	*8*	*921.87*	...	...
183	Kuwait	3'437	17.44	200	1'014.71	260	13.19
184	Luxembourg	13'965	312.42	110	2'460.85	230	51.45
185	Macao, China	189	4.22	101	2'254.46	80	17.86
186	Malta	8'733	222.78	99	2'525.51	90	22.96
187	Martinique	343	8.57	*5*	*127.46*	52	13.00
188	Neth. Antilles	119	5.47	*2*	*93.14*	...	...
189	Netherlands	2'632'137	1'634.33	7'900	4'905.22	6'900	42.84
190	New Caledonia	4'711	214.14	*24*	*1'114.77*	...	...
191	New Zealand	408'290	1'049.59	1'092	2'806.98	1'500	38.56
192	Northern Marianas	13	2.60	...	...	...	...
193	Norway	305'107	673.82	2'700	5'962.90	2'300	50.80
194	Portugal	246'534	239.28	2'500	2'426.48	1'210	11.74
195	Qatar	127	2.08	40	655.74	100	16.39
196	Réunion	-	-	*130*	*1'859.80*	43	5.88
197	Singapore	197'959	479.18	1'500	3'630.91	2'100	50.83
198	Slovenia	29'558	148.16	600	3'007.52	550	27.57
199	Spain	538'655	133.24	7'388	1'827.45	6'800	16.82
200	Sweden	735'200	825.14	4'600	5'162.74	5'000	56.12
201	Switzerland	527'592	730.74	2'223	3'078.95	*3'600*	*49.97*
202	Taiwan, China	1'712'539	764.34	7'820	3'490.20	5'000	22.32
203	United Arab Emirates	76'546	288.53	900	3'392.39	420	15.83
204	United Kingdom	2'230'976	371.37	24'000	3'995.01	22'000	36.62
205	United States	106'193'339	3'728.74	142'823	5'014.91	178'000	62.50
206	Virgin Islands (US)	2'468	205.67	*12*	*1'003.22*	...	...
	High Income	**135'074'119**	**1'485.75**	**363'001.5**	**3'993.38**	**378'804**	**41.77**
	WORLD	**141'384'086**	**229.90**	**498'488.6**	**820.04**	**495'489**	**8.44**
	Africa	**274'756**	**3.38**	**6'894.7**	**85.21**	**7'631**	**1.06**
	Americas	**112'496'371**	**1'337.90**	**182'649.7**	**2'173.59**	**218'295**	**26.67**
	Asia	**10'554'636**	**28.80**	**154'309.8**	**428.83**	**117'093**	**3.32**
	Europe	**15'326'379**	**191.46**	**146'129.1**	**1'825.93**	**140'591**	**17.94**
	Oceania	**2'731'944**	**885.26**	**8'505.3**	**2'771.58**	**11'879**	**39.91**

Note: For data comparability and coverage, see the technical notes.
Figures in italics are estimates or refer to years other than those specified.

Source: ITU (Internet host data: ISC, RIPE).

3. Internet Users

		Estimated Internet users (k) 1995	1996	1997	1998	1999	2000	2001	Users per 10'000 inhabitants 2001	CAGR (%) '95-'01	Change (%) '00-'01
1	Afghanistan	…	…	…	…	…	…	…	…	…	…
2	Angola	…	-	1	3	10	30	60	44.4	259.4	100.0
3	Armenia	2	3	4	4	30	50	…	*142.1*	96.7	…
4	Azerbaijan	-	1	2	3	8	12	25	32.1	132.1	108.3
5	Bangladesh	…	…	1	5	50	100	150	11.4	250.0	50.0
6	Benin	…	-	2	3	10	15	25	38.8	201.7	66.7
7	Bhutan	…	…	…	…	1	2	3	36.2	123.6	66.7
8	Burkina Faso	…	-	2	5	7	10	21	17.2	191.4	110.0
9	Burundi	-	-	1	1	3	5	6	8.7	160.5	20.0
10	Cambodia	…	…	1	2	4	6	10	7.4	94.4	66.7
11	Cameroon	…	…	1	2	20	40	45	29.6	159.0	12.5
12	Central African Rep.	…	-	-	-	1	2	2	5.3	102.3	33.3
13	Chad	…	…	-	-	1	3	4	4.9	199.1	33.3
14	Comoros	…	…	-	-	1	2	3	34.4	132.1	66.7
15	Congo	…	-	-	-	1	…	…	*1.8*	…	…
16	Côte d'Ivoire	-	1	3	10	20	40	70	42.8	264.2	75.0
17	D.P.R. Korea	…	…	…	…	…	…	…	…	…	…
18	D.R. Congo	…	-	-	-	1	3	6	1.1	160.5	100.0
19	Eritrea	-	-	-	-	1	5	10	26.2	140.3	100.0
20	Ethiopia	-	1	3	6	8	10	25	3.9	268.4	150.0
21	Gambia	-	-	1	3	9	12	18	134.6	137.6	50.0
22	Georgia	1	2	3	5	20	23	25	45.7	86.2	8.7
23	Ghana	-	1	5	6	20	30	41	19.4	196.2	35.1
24	Guinea	-	-	-	1	5	8	15	18.7	158.7	87.5
25	Guinea-Bissau	…	…	-	-	2	3	4	32.6	111.5	33.3
26	Haiti	…	1	…	2	6	20	30	36.3	146.6	50.0
27	India	250	450	700	1 400	2 800	5 500	7 000	68.2	74.3	27.3
28	Indonesia	50	110	384	510	900	2 000	4 000	191.2	107.6	100.0
29	Kenya	-	3	10	15	35	200	500	159.8	268.4	150.0
30	Kyrgyzstan	…	…	…	4	10	52	…	*105.7*	284.0	…
31	Lao P.D.R.	…	…	…	1	2	6	10	17.7	171.4	66.7
32	Lesotho	…	-	-	-	1	4	5	23.1	151.2	25.0
33	Liberia	…	…	-	-	-	1	1	3.2	77.8	100.0
34	Madagascar	…	1	2	9	25	30	35	21.3	133.9	16.7
35	Malawi	…	…	1	2	10	15	20	17.3	151.5	33.3
36	Mali	…	-	1	2	6	19	30	25.7	172.4	59.5
37	Mauritania	…	…	-	1	3	5	7	25.5	189.3	40.0
38	Moldova	-	-	1	11	25	53	60	136.7	171.4	14.1
39	Mongolia	-	-	3	3	12	30	40	156.3	141.8	33.3
40	Mozambique	…	1	2	4	10	12	15	7.4	97.4	25.0
41	Myanmar	…	…	…	…	1	7	10	2.1	347.2	42.9
42	Nepal	-	1	5	15	35	50	60	25.4	158.7	20.0
43	Nicaragua	1	4	10	15	20	50	…	98.5	104.4	…
44	Niger	…	-	-	-	3	4	12	10.7	160.5	200.0
45	Nigeria	…	10	20	30	100	200	…	*17.6*	111.5	…
46	Pakistan	-	4	38	62	80	134	500	34.5	282.4	273.5
47	Rwanda	…	-	-	1	5	5	20	25.2	231.4	300.0
48	S. Tomé & Principe	…	…	…	-	1	7	9	600.0	182.3	38.5
49	Senegal	-	1	3	8	30	40	100	103.5	244.3	150.0
50	Sierra Leone	-	-	-	1	2	5	7	14.4	133.9	40.0
51	Solomon Islands	-	1	2	2	2	2	2	43.3	67.8	0.3
52	Somalia	-	-	-	-	-	1	1	1.0	115.4	100.0
53	Sudan	-	-	1	2	5	30	56	17.6	199.1	86.7
54	Tajikistan	…	…	…	…	2	3	3	5.2	26.5	6.7
55	Tanzania	…	1	3	3	25	115	300	83.4	259.4	160.9
56	Togo	-	1	10	15	30	40	50	107.4	151.2	25.0
57	Uganda	1	1	2	15	25	40	60	26.6	115.4	50.0
58	Ukraine	22	50	100	150	200	350	600	119.3	73.5	71.4
59	Uzbekistan	-	1	3	5	8	120	150	59.4	174.6	25.0
60	Viet Nam	…	-	3	10	100	200	400	49.3	425.3	100.0
61	Yemen	…	-	3	4	10	15	17	8.9	179.3	13.3
62	Zambia	1	1	1	3	15	20	25	23.5	77.5	25.0
63	Zimbabwe	1	2	4	10	20	50	100	73.3	119.3	100.0
	Low Income	**328**	**650**	**1 336**	**2 370**	**4 793**	**9 842**	**14 802**	**53.8**	**88.7**	**50.4**

3. Internet Users

		Estimated Internet users (k)							Users per 10'000 inhabitants	CAGR (%) '95-'01	Change (%) '00-'01
		1995	1996	1997	1998	1999	2000	2001	2001		
64	Albania	-	1	2	2	3	4	10	25.2	74.8	185.7
65	Algeria	1	1	1	2	20	50	60	19.3	122.1	20.0
66	Belarus	-	3	5	8	50	182	422	411.9	234.8	131.5
67	Belize	-	2	3	5	10	15	18	737.7	137.6	20.0
68	Bolivia	5	15	35	50	80	120	…	*146.2*	88.8	…
69	Bosnia	…	1	2	5	7	40	45	110.6	146.0	12.5
70	Bulgaria	10	60	100	150	235	430	605	746.3	98.1	40.7
71	Cape Verde	…	…	1	2	5	8	12	274.6	86.1	50.0
72	China	60	160	400	2 100	8 900	22 500	33 700	260.0	187.2	49.8
73	Colombia	69	123	208	433	664	878	1 154	269.6	60.1	31.4
74	Cuba	-	4	8	25	35	60	120	106.8	378.5	100.0
75	Djibouti	-	-	1	1	1	1	3	51.3	79.1	135.7
76	Dominican Rep.	1	6	12	20	96	159	186	214.5	125.9	17.0
77	Ecuador	5	10	13	15	100	180	328	254.4	100.8	82.1
78	Egypt	20	40	60	100	200	450	600	93.0	76.3	33.3
79	El Salvador	…	3	10	30	40	50	…	79.7	108.9	…
80	Equatorial Guinea	…	…	-	-	1	1	1	19.1	45.6	28.6
81	Fiji	-	1	2	5	8	12	15	182.5	144.6	25.0
82	Guatemala	-	2	10	50	65	80	200	171.1	195.6	150.0
83	Guyana	…	1	1	2	28	52	95	1 092.0	185.6	82.7
84	Honduras	2	3	10	18	20	40	…	*61.7*	81.1	…
85	Iran (I.R.)	3	10	30	65	100	250	402	62.3	131.7	60.8
86	Iraq	…	…	…	…	…	…	…	…	…	…
87	Jamaica	3	15	20	50	60	80	100	384.9	82.6	25.0
88	Jordan	1	2	27	61	120	127	212	409.1	144.2	66.5
89	Kazakhstan	2	5	10	20	70	100	…	*61.6*	123.3	…
90	Kiribati	…	…	…	1	1	2	2	250.0	…	33.3
91	Latvia	…	20	50	80	105	150	170	723.1	53.4	13.3
92	Lithuania	…	10	35	70	103	225	250	679.2	90.4	11.1
93	Maldives	-	1	1	2	3	6	10	370.4	77.0	66.7
94	Marshall Islands	-	-	…	…	1	1	1	128.6	116.3	12.5
95	Micronesia	…	-	1	2	3	4	…	*337.8*	…	…
96	Morocco	1	2	6	40	50	200	400	131.4	171.4	100.0
97	Namibia	-	-	1	5	6	30	45	251.7	172.5	50.0
98	Palestine	…	…	…	…	…	35	60	181.2	71.4	71.4
99	Papua New Guinea	…	-	…	66	75	135	…	*280.7*	…	…
100	Paraguay	…	1	5	10	20	40	60	106.4	126.8	50.0
101	Peru	8	60	100	900	1 500	2 500	3 000	1 149.7	168.5	20.0
102	Philippines	20	40	100	823	1 090	1 540	2 000	259.3	115.4	29.9
103	Romania	17	50	100	500	600	800	1 000	446.6	97.2	25.0
104	Russia	220	400	700	1 200	1 500	3 100	4 300	293.0	64.1	38.7
105	Samoa	…	…	-	-	1	1	3	166.7	77.8	200.0
106	Sri Lanka	1	10	30	55	65	122	150	78.5	130.5	23.5
107	St. Vincent	-	1	1	2	3	4	…	*308.6*	60.9	…
108	Suriname	1	1	4	8	9	12	15	330.0	75.3	24.0
109	Swaziland	-	1	1	1	5	10	14	137.3	234.5	40.0
110	Syria	-	-	5	10	20	30	60	36.1	86.1	100.0
111	TFYR Macedonia	1	2	10	20	30	50	70	342.5	110.7	40.0
112	Thailand	55	135	375	500	1 300	2 300	3 536	556.1	100.2	53.7
113	Tonga	-	-	1	1	1	…	…	*101.8*	…	…
114	Tunisia	1	3	4	10	150	250	400	412.4	171.4	60.0
115	Turkmenistan	…	…	…	…	2	6	8	16.5	100.0	33.3
116	Vanuatu	…	-	-	1	1	4	6	273.6	122.9	37.5
117	Yugoslavia	…	20	50	65	80	400	600	561.8	97.4	50.0
	Lower Middle Income	**505**	**1 218**	**2 549**	**7 588**	**17 638**	**37 824**	**54 447**	**286.0**	**118.2**	**43.9**

3. Internet Users

		Estimated Internet users (k)							Users per 10'000 inhabitants	CAGR (%) '95-'01	Change (%) '00-'01
		1995	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2001*		
118	Antigua & Barbuda	2	2	3	3	4	5	…	*652.0*	27.2	…
119	Argentina	30	50	100	200	500	2 500	3 000	800.3	115.4	20.0
120	Bahrain	2	5	10	20	30	40	140	1 988.7	103.1	250.5
121	Botswana	1	3	5	10	19	25	…	*152.2*	90.4	…
122	Brazil	170	740	1 310	2 500	3 500	5 000	8 000	465.6	90.0	60.0
123	Chile	50	100	157	250	625	2 537	3 102	2 002.0	99.0	22.3
124	Costa Rica	15	30	60	100	150	228	384	933.6	72.6	68.4
125	Croatia	24	40	80	150	200	250	…	*558.9*	59.8	…
126	Czech Republic	150	200	300	400	700	1 000	1 400	1 362.7	45.1	40.0
127	Dominica	-	1	…	2	2	6	…	*777.8*		…
128	Estonia	40	50	80	150	200	392	430	3 004.6	48.5	9.7
129	Gabon	…	-	1	2	3	15	17	134.7	135.8	13.3
130	Grenada	-	-	1	2	3	4	5	520.0	76.9	26.4
131	Guadeloupe	…	-	1	2	4	8	…	*175.4*	…	…
132	Hungary	70	100	200	400	600	715	1 480	1 484.0	66.3	107.0
133	Korea (Rep.)	366	731	1 634	3 103	10 860	19 040	24 380	5 106.8	101.3	28.0
134	Lebanon	3	5	45	100	200	300	…	*858.0*	160.5	…
135	Libya	…	…	…	…	7	10	20	35.8	69.0	100.0
136	Malaysia	40	200	600	1 500	2 500	3 700	5 700	2 395.0	128.5	54.1
137	Mauritius	…	2	6	30	55	87	158	1 316.7	137.3	81.6
138	Mayotte	…	…	…	…	…	…	…	…	…	…
139	Mexico	94	187	596	1 222	1 822	2 712	3 636	362.2	83.9	34.0
140	Oman	…	…	10	20	50	90	120	457.5	86.1	33.3
141	Panama	2	6	15	30	45	90	…	*317.0*	126.8	…
142	Poland	250	500	800	1 581	2 100	2 800	3 800	983.7	57.4	35.7
143	Puerto Rico	5	10	50	100	200	400	600	1 518.2	122.1	50.0
144	Saudi Arabia	2	5	10	20	100	200	300	134.4	130.5	50.0
145	Seychelles	…	1	1	2	5	6	9	1 125.0	78.3	50.0
146	Slovak Republic	28	100	190	500	600	650	…	*1 203.3*	87.6	…
147	South Africa	460	618	800	1 266	1 820	2 400	3 068	700.6	37.2	27.8
148	St. Kitts and Nevis	…	1	1	2	2	…	…	*516.1*	…	…
149	St. Lucia	-	1	2	2	3	…	…	*195.2*	…	…
150	Trinidad & Tobago	2	5	15	35	75	100	120	923.1	97.9	20.0
151	Turkey	50	120	300	450	1 500	2 000	2 500	377.2	91.9	25.0
152	Uruguay	10	60	110	230	330	370	400	1 190.1	84.9	8.1
153	Venezuela	27	56	90	185	525	950	1 300	527.8	90.7	36.8
	Upper Middle Income	**1 891**	**3 928**	**7 581**	**14 568**	**29 339**	**48 630**	**64 069**	**1 007.3**	**79.9**	**31.7**

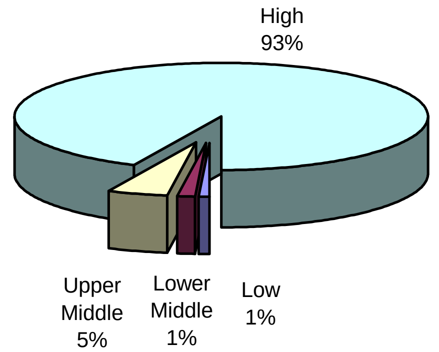
3. Internet Users

		Estimated Internet users (k)							*Users per 10'000 inhabitants*	*CAGR (%)*	*Change (%)*
		1995	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2001*	*'95-'01*	*'00-'01*
154	Andorra	…	1	2	5	5	7	…	*897.4*	62.7	…
155	Aruba	…	2	…	…	4	14	24	2 264.2	…	71.4
156	Australia	500	600	1 600	4 200	5 600	6 600	7 200	3 723.0	56.0	9.1
157	Austria	150	250	360	710	1 250	2 100	2 600	3 194.1	60.9	23.8
158	Bahamas	3	5	4	7	11	13	17	549.4	35.8	28.9
159	Barbados	-	1	2	5	6	10	…	*373.8*	77.8	…
160	Belgium	100	300	500	800	1 200	2 326	2 881	2 799.3	75.1	23.8
161	Bermuda	4	10	15	20	25	…	…	*3 901.4*	…	…
162	Brunei Darussalam	3	10	15	20	25	30	35	1 044.8	50.6	16.7
163	Canada	1 220	2 000	4 500	7 500	11 000	12 700	13 500	4 352.7	49.3	6.3
164	Cyprus	3	5	33	68	88	120	150	2 175.6	91.9	25.0
165	Denmark	200	300	600	1 000	1 500	1 950	2 400	4 471.8	51.3	23.1
166	Faroe Islands	…	1	1	2	3	…	…	*672.7*	…	…
167	Finland	710	860	1 000	1 311	1 667	1 927	2 235	4 302.8	21.1	16.0
168	France	950	1 500	2 500	3 700	5 370	8 500	15 653	2 637.7	59.5	84.2
169	French Guiana	…	1	1	2	2	…	…	*114.9*	…	…
170	French Polynesia	…	-	-	3	8	15	16	675.1	140.2	6.7
171	Germany	1 500	2 500	5 500	8 100	14 400	24 000	30 000	3 642.5	64.8	25.0
172	Greece	80	150	200	350	750	1 000	1 400	1 321.3	61.1	40.0
173	Greenland	-	1	4	8	12	18	20	3 565.7	195.6	12.1
174	Guam	1	2	3	4	5	…	…	*304.1*	…	…
175	Guernsey	…	1	2	5	10	20	…	*3 189.8*	111.5	…
176	Hong Kong, China	200	300	675	947	2 430	2 601	3 100	4 586.1	57.9	19.2
177	Iceland	30	40	75	100	150	168	195	6 794.4	36.6	16.1
178	Ireland	40	80	150	300	679	784	895	2 331.4	67.9	14.2
179	Israel	50	120	250	600	800	1 270	1 500	2 304.9	76.3	18.1
180	Italy	300	585	1 300	2 600	8 200	13 200	19 250	3 317.9	100.1	45.8
181	Japan	2 000	5 500	11 550	16 940	27 060	37 200	57 900	4 547.1	75.2	55.6
182	Jersey	…	1	3	4	6	8	…	*921.9*	68.2	…
183	Kuwait	4	15	40	60	100	150	200	1 014.7	96.3	33.3
184	Luxembourg	7	23	30	50	75	100	…	2 266.0	72.7	…
185	Macao, China	1	3	10	30	40	60	101	2 254.5	110.7	68.3
186	Malta	1	4	15	25	30	51	99	2 525.5	121.0	94.1
187	Martinique	…	…	…	2	5	…	…	*127.5*	…	…
188	Neth. Antilles	…	1	…	…	2	…	…	*93.1*	…	…
189	Netherlands	600	900	1 000	1 600	3 000	3 900	5 300	3 291.7	43.8	35.9
190	New Caledonia	-	1	2	4	12	24	…	*1 114.8*	163.2	…
191	New Zealand	180	300	550	600	700	830	1 092	2 807.0	35.0	31.6
192	Northern Marianas	…	…	…	…	…	…	…	…	…	…
193	Norway	280	800	1 300	1 600	2 000	2 200	2 700	5 962.9	45.9	22.7
194	Portugal	90	230	270	500	1 000	2 500	3 600	3 494.1	84.9	44.0
195	Qatar	1	5	17	20	24	30	40	655.7	84.9	33.3
196	Réunion	…	…	…	9	10	130	…	*1 859.8*	…	…
197	Singapore	100	300	500	750	950	1 300	1 500	3 630.9	57.0	15.4
198	Slovenia	57	100	150	200	250	300	600	3 007.5	48.0	100.0
199	Spain	150	526	1 100	1 733	2 830	5 388	7 388	1 827.4	91.5	37.1
200	Sweden	450	800	2 100	2 961	3 666	4 048	4 600	5 162.7	47.3	13.6
201	Switzerland	250	322	548	1 200	1 761	2 134	2 917	4 040.2	50.6	36.7
202	Taiwan,China	250	603	1 660	3 010	4 800	6 260	7 820	3 490.2	77.5	24.9
203	United Arab Emirates	3	10	90	200	400	735	900	3 392.4	166.7	22.4
204	United Kingdom	1 100	2 400	4 310	8 000	12 500	18 000	24 000	3 995.0	67.2	33.3
205	United States	25 000	45 000	60 000	84 587	102 000	124 000	142 823	4 995.1	33.7	15.2
206	Virgin Islands (US)	3	5	8	10	12	…	…	*1 003.2*	…	…
	High Income	**36 569**	**67 472**	**104 545**	**156 461**	**218 433**	**288 721**	**366 651**	**2 634.4**	**46.8**	**27.0**
	WORLD	**39 293**	**73 268**	**116 011**	**180 987**	**270 203**	**385 018**	**499 969**	**824.8**	**52.8**	**29.9**
	Africa	**532**	**784**	**1 150**	**1 995**	**3 713**	**6 526**	**9 371**	**13.3**	**61.3**	**43.6**
	Americas	**29 230**	**54 884**	**80 485**	**119 960**	**162 457**	**215 188**	**262 163**	**101.0**	**44.1**	**21.8**
	Asia	**115**	**283**	**604**	**1 004**	**1 975**	**3 321**	**5 484**	**97.5**	**90.4**	**65.1**
	Europe	**8 671**	**16 294**	**31 195**	**52 083**	**93 625**	**149 457**	**210 958**	**219.7**	**70.2**	**41.1**
	Oceania	**744**	**1 023**	**2 576**	**5 945**	**8 433**	**10 525**	**11 994**	**91.7**	**58.9**	**14.0**

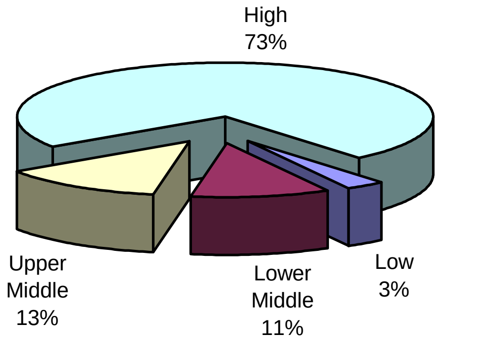
Note: CAGR values are calculated from the most recent year available to 2001.

4. Internet Usage Charts

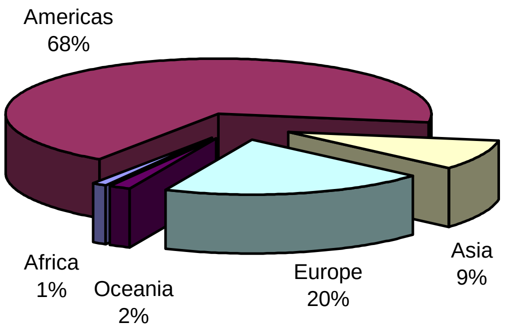
Internet users 1995, by income



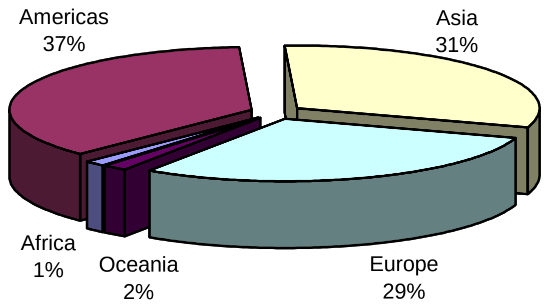
Internet users 2001, by income



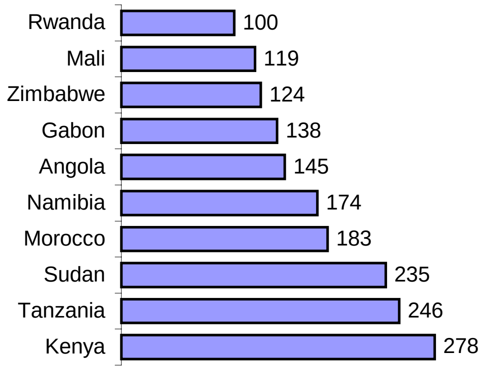
Internet users 1995, by region



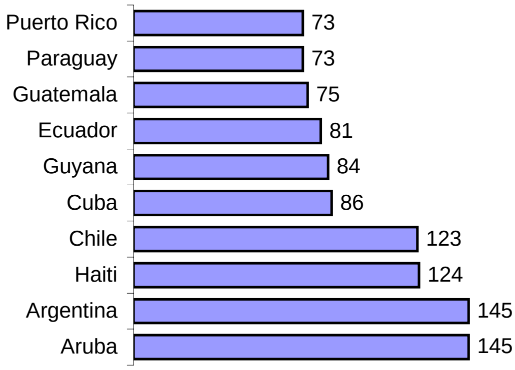
Internet users 2001, by region



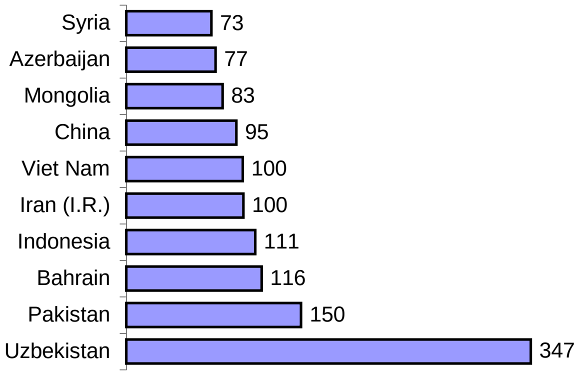
Internet user growth 99-01, top 10, %: Africa



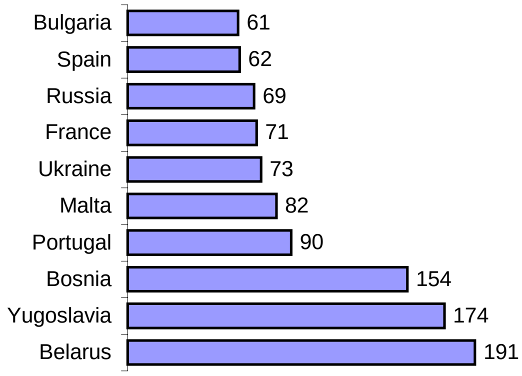
Internet user growth 99-01, top 10, %: Americas



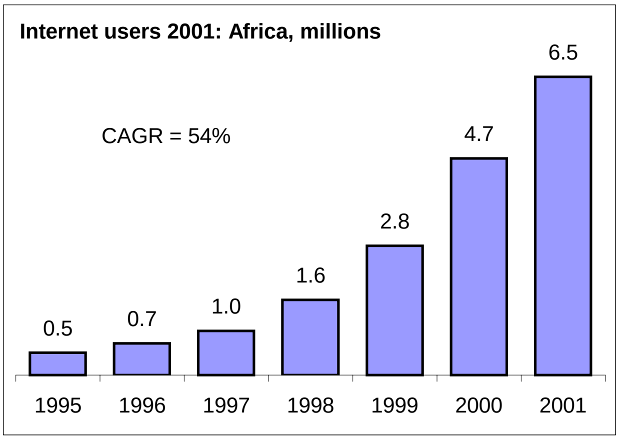
Internet user growth 99-01, top 10, %: Asia/Pacific

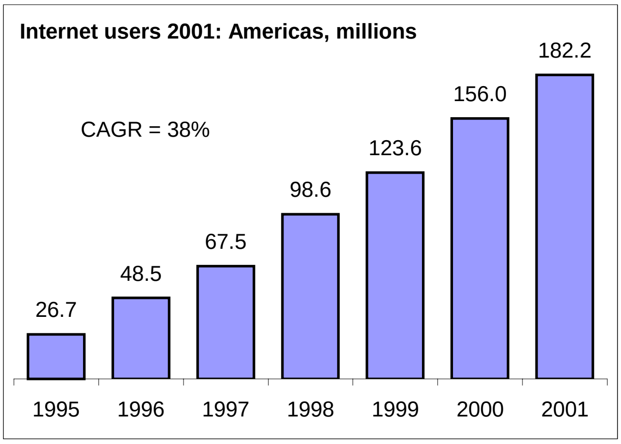


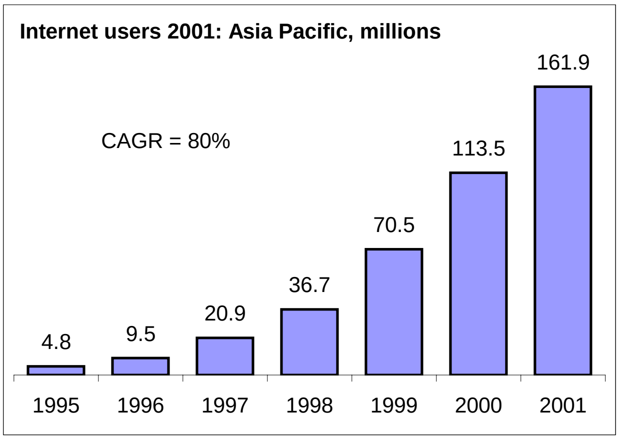
Internet user growth 99-01, top 10, %: Europe

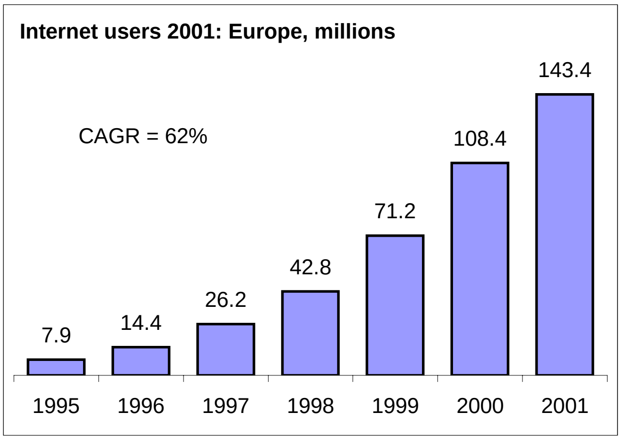


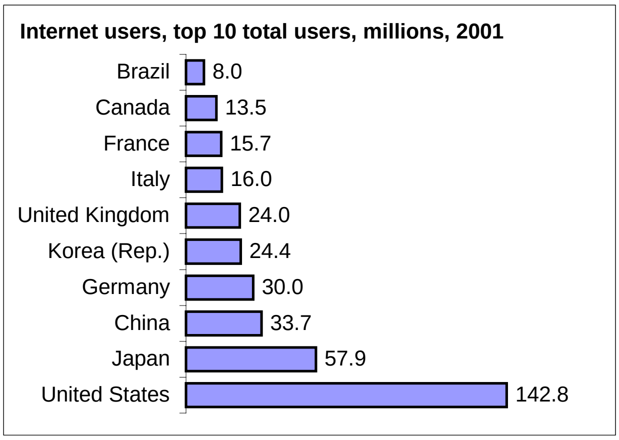
4. Internet Usage Charts

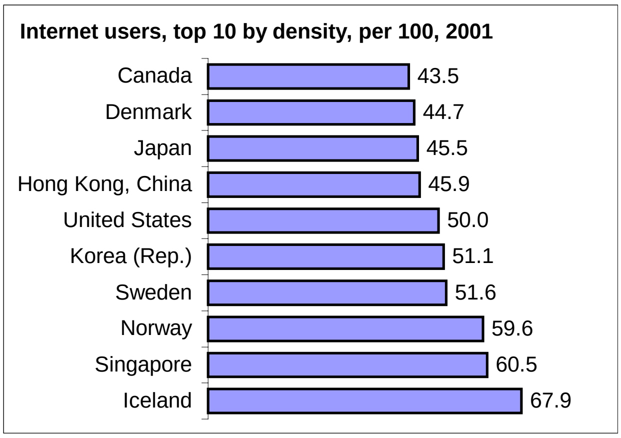












5. Secure Servers and ISPs

		Secure servers			Internet service providers		
		Total	*per million inhabitants*		*Total*	*per million inhabitants*	
		2001	*2000*	*2001*	*2001*	*2000*	*2001*
1	Afghanistan	-	…	-	-	0.18	-
2	Angola	-	…	-	2	0.15	0.15
3	Armenia	3	0.28	0.79	10	1.70	2.64
4	Azerbaijan	1	0.13	0.13	8	0.78	1.03
5	Bangladesh	2	0.01	0.02	10	0.05	0.08
6	Benin	-	0.16	-	3	0.33	0.47
7	Bhutan	-	…	-	1	1.48	1.45
8	Burkina Faso	-	…	-	1	0.08	0.08
9	Burundi	-	…	-	-	…	-
10	Cambodia	1	-	0.07	2	0.08	0.15
11	Cameroon	-	…	-	5	0.33	0.33
12	Central African Rep.	-	…	-	1	0.28	0.26
13	Chad	-	…	-	1	0.13	0.12
14	Comoros	-	…	-	1	1.44	1.38
15	Congo	-	…	-	1	…	0.32
16	Côte d'Ivoire	2	…	0.12	2	0.14	0.12
17	D.P.R. Korea	-	…	-	-	0.04	-
18	D.R. Congo	3	…	…	1	…	-
19	Eritrea	-	…	-	-	…	-
20	Ethiopia	1	0.02	0.02	1	0.02	0.02
21	Gambia	-	…	-	2	0.77	1.50
22	Georgia	9	1.46	1.65	10	1.83	1.83
23	Ghana	1	0.05	0.05	6	0.15	0.29
24	Guinea	-	…	-	3	0.38	0.37
25	Guinea-Bissau	-	…	-	2	0.83	1.63
26	Haiti	-	-	-	6	0.61	0.73
27	India	156	0.07	0.15	61	0.04	0.06
28	Indonesia	66	0.16	0.31	45	0.15	0.21
29	Kenya	-	-	-	12	0.20	0.38
30	Kyrgyzstan	2	0.20	0.40	6	1.23	1.20
31	Lao P.D.R.	1	…	0.18	1	0.18	0.18
32	Lesotho	-	…	-	2	0.46	0.93
33	Liberia	-	…	-	2	…	0.64
34	Madagascar	1	…	0.06	3	0.25	0.18
35	Malawi	1	…	0.09	4	0.19	0.35
36	Mali	-	…	-	2	0.18	0.17
37	Mauritania	1	…	0.36	1	0.38	0.36
38	Moldova	6	0.23	1.37	10	2.28	2.28
39	Mongolia	1	0.42	0.39	6	1.26	2.34
40	Mozambique	-	…	-	4	0.05	0.20
41	Myanmar	-	…	-	1	0.04	0.02
42	Nepal	-	…	-	6	0.13	0.25
43	Nicaragua	5	0.99	0.96	8	1.38	1.53
44	Niger	-	…	-	1	0.19	0.09
45	Nigeria	-	0.01	-	14	0.07	0.12
46	Pakistan	7	0.04	0.05	18	0.10	0.12
47	Rwanda	-	0.13	-	3	0.26	0.38
48	S. Tomé & Principe	-	…	-	1	6.72	6.67
49	Senegal	-	…	-	1	0.21	0.10
50	Sierra Leone	1	0.21	0.21	1	0.21	0.21
51	Solomon Islands	-	…	-	1	2.29	2.16
52	Somalia	1	…	0.10	-	…	-
53	Sudan	1	…	0.03	2	0.03	0.06
54	Tajikistan	-	…	-	3	0.33	0.49
55	Tanzania	2	…	0.06	6	0.11	0.17
56	Togo	-	…	-	2	0.43	0.43
57	Uganda	1	…	0.04	4	0.14	0.18
58	Ukraine	66	0.73	1.31	161	1.98	3.20
59	Uzbekistan	1	0.04	0.04	6	0.28	0.24
60	Viet Nam	2	0.03	0.02	2	0.04	0.02
61	Yemen	-	…	-	1	0.05	0.05
62	Zambia	-	…	-	4	0.29	0.38
63	Zimbabwe	4	-	0.29	5	0.30	0.37
	Low Income	**349**	**0.27**	**0.33**	**489**	**0.60**	**0.73**

5. Secure Servers and ISPs

		Secure servers			Internet service providers		
		Total	per million inhabitants		Total	per million inhabitants	
		2001	2000	2001	2001	2000	2001
64	Albania	2	0.26	0.50	5	1.02	1.26
65	Algeria	-	…	-	4	0.06	0.13
66	Belarus	19	0.49	1.85	18	0.78	1.76
67	Belize	7	29.14	28.69	2	4.16	8.20
68	Bolivia	9	0.61	1.09	3	0.49	0.36
69	Bosnia	-	…	-	9	1.51	2.21
70	Bulgaria	25	1.84	3.08	58	5.28	7.15
71	Cape Verde	-	…	-	1	2.30	2.29
72	China	173	0.07	0.13	59	0.02	0.05
73	Colombia	69	1.02	1.61	31	0.71	0.72
74	Cuba	2	0.18	0.18	3	0.36	0.27
75	Djibouti	-	…	-	1	1.57	1.56
76	Dominican Rep.	8	0.47	0.92	4	0.47	0.46
77	Ecuador	13	0.55	1.01	14	0.95	1.09
78	Egypt	11	0.06	0.17	19	0.25	0.29
79	El Salvador	12	0.96	1.88	9	1.27	1.41
80	Equatorial Guinea	-	…	-	-	2.21	-
81	Fiji	3	4.92	3.65	2	1.23	2.43
82	Guatemala	25	0.88	2.14	9	0.61	0.77
83	Guyana	-	…	-	1	1.16	1.15
84	Honduras	5	0.46	0.76	5	0.77	0.76
85	Iran (I.R.)	2	…	0.03	11	0.17	0.17
86	Iraq	-	…	-	-	…	-
87	Jamaica	4	1.55	1.54	10	4.27	3.85
88	Jordan	5	0.40	0.96	10	1.79	1.93
89	Kazakhstan	12	1.05	0.75	14	0.68	0.87
90	Kiribati	-	…	-	-	…	-
91	Latvia	46	11.55	19.57	30	9.08	12.76
92	Lithuania	47	8.12	12.77	17	3.52	4.62
93	Maldives	-	…	-	1	3.72	3.70
94	Marshall Islands	-	…	-	2	14.68	28.57
95	Micronesia	1	…	8.33	1	8.45	8.33
96	Morocco	6	0.04	0.20	1	0.07	0.03
97	Namibia	3	1.14	1.68	5	2.28	2.80
98	Palestine	-	…	-	4	0.63	1.21
99	Papua New Guinea	-	…	-	1	0.21	0.20
100	Paraguay	4	0.55	0.71	8	1.27	1.42
101	Peru	52	0.74	1.99	13	0.27	0.50
102	Philippines	72	0.46	0.93	51	0.46	0.66
103	Romania	61	1.34	2.72	88	2.67	3.93
104	Russia	397	1.39	2.71	327	1.63	2.23
105	Samoa	1	5.55	5.56	2	11.10	11.11
106	Sri Lanka	7	0.16	0.37	12	0.32	0.63
107	St. Vincent	4	26.45	35.71	-	8.82	-
108	Suriname	-	…	-	2	2.30	4.55
109	Swaziland	1	0.99	0.98	4	3.97	3.92
110	Syria	1	0.06	0.06	2	0.19	0.12
111	TFYR Macedonia	-	…	-	7	2.96	3.42
112	Thailand	134	1.34	2.11	47	0.63	0.74
113	Tonga	2	30.50	20.30	1	…	10.15
114	Tunisia	3	0.21	0.31	1	0.10	0.10
115	Turkmenistan	-	…	-	2	0.45	0.41
116	Vanuatu	6	10.16	29.85	1	…	4.98
117	Yugoslavia	11	0.56	1.03	18	1.32	1.69
	Lower Middle Income	**1 265**	**3.95**	**5.10**	**950**	**2.30**	**3.08**

5. Secure Servers and ISPs

		Secure servers			Internet service providers		
		Total	per million inhabitants		Total	per million inhabitants	
		2001	2000	2001	2001	2000	2001
118	Antigua & Barbuda	26	260.81	330.39	4	65.20	50.83
119	Argentina	231	3.38	6.16	81	1.89	2.16
120	Bahrain	7	7.30	9.93	2	2.92	2.84
121	Botswana	-	…	-	-	1.23	-
122	Brazil	1 081	3.23	6.29	17	0.09	0.10
123	Chile	134	3.79	8.65	42	2.03	2.71
124	Costa Rica	88	10.69	21.40	8	1.74	1.95
125	Croatia	87	6.93	18.69	9	1.56	1.93
126	Czech Republic	370	17.78	36.01	41	2.82	3.99
127	Dominica	7	25.93	87.50	3	25.93	37.50
128	Estonia	91	40.30	63.64	11	6.95	7.69
129	Gabon	1	0.82	0.79	2	2.45	1.58
130	Grenada	8	74.13	80.00	2	10.59	20.00
131	Guadeloupe	-	…	-	3	4.39	6.52
132	Hungary	169	9.30	16.95	72	5.50	7.22
133	Korea (Rep.)	447	4.44	9.36	270	1.67	5.66
134	Lebanon	24	2.57	6.75	11	3.15	3.09
135	Libya	-	…	-	2	0.18	0.36
136	Malaysia	115	3.44	4.83	21	0.69	0.88
137	Mauritius	17	7.54	14.17	2	2.51	1.67
138	Mayotte	-	…	-	-	…	-
139	Mexico	256	1.16	2.55	92	0.80	0.92
140	Oman	-	0.39	-	2	0.79	0.76
141	Panama	51	7.04	17.59	13	3.87	4.48
142	Poland	635	6.57	16.44	118	1.71	3.05
143	Puerto Rico	76	9.71	19.23	21	6.39	5.31
144	Saudi Arabia	24	0.32	1.08	9	0.23	0.40
145	Seychelles	5	12.33	62.50	1	…	12.50
146	Slovak Republic	99	11.11	18.32	33	4.07	6.11
147	South Africa	563	6.62	12.86	28	0.69	0.64
148	St. Kitts and Nevis	13	337.47	309.52	2	51.92	47.62
149	St. Lucia	5	6.41	31.25	1	6.41	6.25
150	Trinidad & Tobago	10	6.18	7.69	4	3.09	3.08
151	Turkey	288	1.96	4.35	81	0.90	1.22
152	Uruguay	43	5.99	12.79	9	1.50	2.68
153	Venezuela	108	2.81	4.38	17	0.74	0.69
	Upper Middle Income	**5 079**	**28.08**	**40.07**	**1 034**	**6.66**	**7.48**

5. Secure Servers and ISPs

		Secure servers			Internet service providers		
		Total	per million inhabitants		Total	per million inhabitants	
		2001	2000	2001	2001	2000	2001
154	Andorra	8	64.10	100.17	1	12.82	12.52
155	Aruba	9	29.26	84.91	1	9.75	9.43
156	Australia	3 567	102.68	184.45	235	6.47	12.15
157	Austria	864	50.49	106.14	114	11.21	14.00
158	Bahamas	25	39.44	81.17	5	23.01	16.23
159	Barbados	19	48.60	70.90	3	11.22	11.19
160	Belgium	329	14.17	31.97	66	6.30	6.41
161	Bermuda	36	356.79	557.28	6	77.56	92.88
162	Brunei Darussalam	1	6.09	2.99	2	6.09	5.97
163	Canada	6 507	143.84	209.80	275	6.67	8.87
164	Cyprus	50	29.81	73.86	13	14.90	19.20
165	Denmark	481	35.65	89.62	50	7.50	9.32
166	Faroe Islands	1	-	22.20	2	44.44	44.39
167	Finland	654	58.15	125.89	54	8.69	10.39
168	France	1 557	11.12	26.24	221	3.16	3.72
169	French Guiana	-	…	-	-	…	-
170	French Polynesia	9	17.14	37.97	1	8.57	4.22
171	Germany	6 817	44.06	82.77	481	4.50	5.84
172	Greece	156	7.48	14.72	77	5.96	7.27
173	Greenland	1	-	17.83	1	17.86	17.83
174	Guam	7	47.62	41.18	6	41.67	35.29
175	Guernsey	1	…	…	-	…	-
176	Hong Kong, China	541	46.64	80.04	141	17.53	20.86
177	Iceland	97	142.35	337.98	6	21.35	20.91
178	Ireland	437	57.83	113.83	34	6.87	8.86
179	Israel	285	30.62	43.79	66	8.77	10.14
180	Italy	1 102	10.23	18.99	256	3.14	4.41
181	Japan	4 485	25.56	35.22	234	1.36	1.84
182	Jersey	-	…	-	-	…	-
183	Kuwait	6	1.57	3.04	12	3.66	6.09
184	Luxembourg	72	81.58	161.07	29	49.85	64.88
185	Macao, China	3	11.42	6.70	2	4.57	4.46
186	Malta	34	12.82	86.73	9	17.95	22.96
187	Martinique	-	-	-	2	2.53	5.00
188	Neth. Antilles	32	125.42	147.09	6	27.87	27.58
189	Netherlands	979	24.77	60.80	148	7.26	9.19
190	New Caledonia	10	23.22	45.45	4	13.93	18.18
191	New Zealand	794	80.92	204.11	44	8.88	11.31
192	Northern Marianas	1	37.72	20.00	1	37.72	20.00
193	Norway	479	44.59	105.79	54	8.47	11.93
194	Portugal	201	8.18	19.51	35	3.19	3.40
195	Qatar	2	5.01	3.28	2	3.34	3.28
196	Réunion	-	…	-	-	…	-
197	Singapore	459	63.47	111.11	47	8.46	11.38
198	Slovenia	120	35.18	60.15	18	7.04	9.02
199	Spain	1 013	12.16	25.06	138	2.22	3.41
200	Sweden	1 068	57.09	119.87	88	6.76	9.88
201	Switzerland	1 243	87.31	172.16	141	14.58	19.53
202	Taiwan, China	348	6.55	15.53	59	2.11	2.63
203	United Arab Emirates	48	9.59	18.09	5	1.92	1.88
204	United Kingdom	7 347	58.11	122.30	340	4.25	5.66
205	United States	89 527	247.57	313.11	4 915	13.95	17.19
206	Virgin Islands (US)	8	16.51	66.67	4	33.02	33.33
	High Income	**131 840**	**53.71**	**93.32**	**8 454**	**13.69**	**15.03**
	WORLD	**138 533**	**17.86**	**25.15**	**10 950**	**1.39**	**1.81**
	Africa	**629**	**2.02**	**4.75**	**177**	**0.77**	**1.01**
	Americas	**98 519**	**49.48**	**69.07**	**5 664**	**10.05**	**10.79**
	Asia	**7 453**	**6.81**	**10.04**	**1 295**	**1.84**	**2.33**
	Europe	**27 531**	**27.38**	**55.17**	**3 489**	**8.09**	**9.83**
	Oceania	**4 401**	**36.04**	**54.62**	**302**	**12.93**	**12.08**

Source: Netcraft, http://www.netcraft.com

6. Fixed Lines

		Fixed lines			*Fixed lines per 100 inhabitants*		
		(k)		*CAGR (%)*			*CAGR (%)*
		1995	*2001*	*1995-01*	*1995*	*2001*	*1995-01*
1	Afghanistan	29.0	29.0	-	0.15	0.13	-2.2
2	Angola	52.7	80.0	7.2	0.49	0.59	3.2
3	Armenia	582.8	529.3	-1.6	15.45	13.97	-1.7
4	Azerbaijan	639.5	865.5	5.2	8.49	11.13	4.6
5	Bangladesh	286.6	514.0	10.2	0.24	0.39	8.6
6	Benin	28.2	59.3	13.2	0.52	0.92	10.1
7	Bhutan	5.2	14.0	17.8	0.90	2.03	14.5
8	Burkina Faso	30.0	57.6	11.5	0.29	0.47	8.6
9	Burundi	17.3	20.0	2.5	0.29	0.29	0.2
10	Cambodia	8.5	33.5	25.6	0.08	0.25	20.1
11	Cameroon	65.6	101.4	7.5	0.49	0.67	5.2
12	Central African Rep.	8.4	10.0	3.0	0.25	0.26	0.8
13	Chad	5.3	11.0	12.8	0.08	0.14	8.2
14	Comoros	4.4	8.9	12.5	0.72	1.22	9.2
15	Congo	21.4	22.0	0.5	0.81	0.71	-2.2
16	Côte d'Ivoire	115.8	293.6	16.8	0.86	1.80	13.1
17	D.P.R. Korea	1'100.0	1'100.0	-	4.98	4.50	-1.7
18	D.R. Congo	36.0	20.0	-9.3	0.08	0.04	-11.5
19	Eritrea	17.5	32.0	10.6	0.49	0.84	9.4
20	Ethiopia	142.5	310.0	13.8	0.25	0.48	11.6
21	Gambia	19.2	35.0	10.5	1.75	2.62	6.9
22	Georgia	554.3	867.6	7.8	10.23	15.86	7.6
23	Ghana	63.1	242.1	25.1	0.37	1.16	21.0
24	Guinea	10.9	25.5	15.3	0.15	0.32	13.6
25	Guinea-Bissau	7.4	12.0	8.5	0.69	0.98	6.0
26	Haiti	60.0	80.0	4.9	0.84	0.97	2.5
27	India	11'978.0	37'950.0	21.2	1.29	3.70	19.2
28	Indonesia	3'290.9	7'949.3	15.8	1.69	3.80	14.5
29	Kenya	256.4	313.1	3.4	0.84	1.00	3.0
30	Kyrgyzstan	357.0	*376.1*	*1.0*	7.92	*7.71*	*-0.5*
31	Lao P.D.R.	16.6	52.6	21.2	0.36	0.93	17.2
32	Lesotho	17.8	*22.2*	*4.5*	0.88	*1.03*	*3.3*
33	Liberia	4.5	6.8	7.1	0.16	0.22	5.0
34	Madagascar	37.1	58.4	7.9	0.25	0.36	6.1
35	Malawi	34.3	54.1	7.9	0.37	0.47	4.1
36	Mali	17.2	49.9	19.5	0.16	0.43	17.4
37	Mauritania	9.2	*19.0*	*15.4*	0.41	*0.72*	*12.0*
38	Moldova	566.5	676.1	3.0	13.02	15.40	2.8
39	Mongolia	77.7	123.0	7.9	3.50	4.81	5.4
40	Mozambique	59.8	89.4	6.9	0.34	0.44	4.3
41	Myanmar	157.8	281.2	10.1	0.36	0.58	8.4
42	Nepal	83.7	298.1	23.6	0.41	1.26	20.6
43	Nicaragua	96.6	*158.6*	*10.4*	2.22	*3.12*	*7.1*
44	Niger	13.7	21.7	7.9	0.15	0.19	4.0
45	Nigeria	405.1	500.0	3.6	0.39	0.43	1.4
46	Pakistan	2'127.3	3'400.0	8.1	1.67	2.35	5.8
47	Rwanda	6.9	21.5	20.9	0.13	0.27	12.5
48	S. Tomé & Principe	2.5	5.4	13.8	1.97	3.63	10.7
49	Senegal	82.0	237.2	19.4	0.98	2.45	16.5
50	Sierra Leone	16.6	22.7	5.4	0.37	0.47	4.0
51	Solomon Islands	6.5	7.4	2.2	1.73	1.60	-1.3
52	Somalia	15.0	*35.0*	*18.5*	0.17	*0.35*	*16.3*
53	Sudan	75.0	453.0	34.9	0.28	1.42	30.8
54	Tajikistan	262.7	223.0	-2.7	4.50	3.63	-3.5
55	Tanzania	90.3	148.5	8.6	0.30	0.41	5.2
56	Togo	21.7	48.1	14.2	0.52	1.03	11.9
57	Uganda	39.0	63.7	8.5	0.20	0.28	5.8
58	Ukraine	8'311.0	10'669.6	4.3	16.09	21.21	4.7
59	Uzbekistan	1'544.2	1'663.0	1.2	6.81	6.58	-0.6
60	Viet Nam	775.0	3'049.9	25.7	1.05	3.76	23.7
61	Yemen	186.7	423.2	14.6	1.21	2.21	10.5
62	Zambia	76.8	85.4	1.8	0.95	0.80	-2.8
63	Zimbabwe	152.5	253.7	8.9	1.40	1.86	4.8
	Low Income	**35'183.3**	**75'183.0**	**13.5**	**1.58**	**3.02**	**11.4**

6. Fixed Lines

		Fixed lines (k) 1995	Fixed lines (k) 2001	Fixed lines CAGR (%) 1995-01	Fixed lines per 100 inhabitants 1995	Fixed lines per 100 inhabitants 2001	Fixed lines per 100 inhabitants CAGR (%) 1995-01
64	Albania	42.1	197.5	29.4	1.17	4.97	27.3
65	Algeria	1'176.3	1'880.0	8.1	4.12	6.04	6.6
66	Belarus	1'968.4	2'857.9	6.4	19.18	27.88	6.4
67	Belize	28.9	35.2	3.3	13.40	14.44	1.3
68	Bolivia	246.9	514.8	13.0	3.33	6.22	11.0
69	Bosnia	237.8	450.1	11.2	5.99	11.07	10.8
70	Bulgaria	2'562.9	2'913.9	2.2	30.47	35.94	2.8
71	Cape Verde	21.5	62.3	19.4	5.57	14.27	17.0
72	China	40'705.7	179'034.0	28.0	3.30	13.81	26.9
73	Colombia	3'872.8	7'300.0	11.1	10.05	17.05	9.2
74	Cuba	353.2	572.6	8.4	3.21	5.10	8.0
75	Djibouti	7.6	9.9	4.7	1.31	1.54	2.8
76	Dominican Rep.	582.6	955.1	8.6	7.48	11.02	6.7
77	Ecuador	697.9	1'335.8	11.4	6.09	10.37	9.3
78	Egypt	2'716.2	6'650.0	16.1	4.67	10.30	14.1
79	El Salvador	284.8	598.0	13.2	5.03	9.34	10.9
80	Equatorial Guinea	2.5	6.9	18.3	0.63	1.47	15.2
81	Fiji	64.8	90.4	5.7	8.39	11.00	4.6
82	Guatemala	286.4	756.0	17.6	2.87	6.47	14.5
83	Guyana	44.6	79.9	10.2	5.37	9.19	9.4
84	Honduras	160.8	309.7	11.5	2.70	4.71	9.7
85	Iran (I.R.)	5'090.4	10'346.8	12.5	8.60	16.03	10.9
86	Iraq	638.6	675.0	0.9	3.18	2.86	-1.7
87	Jamaica	290.3	512.6	9.9	11.61	19.73	9.2
88	Jordan	317.0	660.0	13.0	7.39	12.74	9.5
89	Kazakhstan	1'962.9	*1'834.2*	*-1.3*	11.87	*11.31*	*-1.0*
90	Kiribati	2.0	*3.4*	*10.6*	2.57	*4.03*	*9.4*
91	Latvia	704.5	724.8	0.5	27.85	30.83	1.7
92	Lithuania	941.0	1'151.7	3.4	25.35	31.29	3.6
93	Maldives	13.9	27.2	11.9	5.67	10.09	10.1
94	Marshall Islands	3.2	4.2	4.7	5.73	5.98	0.7
95	Micronesia	7.9	10.0	4.0	7.33	8.33	2.2
96	Morocco	1'128.0	1'191.3	0.9	4.24	3.92	-1.3
97	Namibia	78.5	117.4	6.9	5.06	6.57	4.4
98	Palestine	80.0	256.9	21.5	3.45	7.76	14.4
99	Papua New Guinea	43.6	*64.8*	*8.2*	1.07	*1.35*	*4.7*
100	Paraguay	166.9	288.8	9.6	3.46	5.12	6.8
101	Peru	1'109.2	2'022.3	10.5	4.71	7.75	8.6
102	Philippines	1'409.6	3'100.0	14.0	2.05	4.02	11.8
103	Romania	2'968.0	4'094.0	5.5	13.09	18.28	5.7
104	Russia	25'018.9	35'700.0	6.1	16.91	24.33	6.3
105	Samoa	7.8	10.0	4.2	4.73	5.56	2.7
106	Sri Lanka	205.9	828.0	26.1	1.14	4.33	25.0
107	St. Vincent	18.2	*24.9*	*6.4*	16.46	*21.96*	*5.9*
108	Suriname	54.1	77.4	6.1	13.21	17.58	4.9
109	Swaziland	21.1	32.0	7.2	2.32	3.14	5.1
110	Syria	958.5	1'807.6	11.2	6.77	10.88	8.2
111	TFYR Macedonia	351.0	538.5	7.4	17.85	26.35	6.7
112	Thailand	3'482.0	5'973.5	9.4	6.06	9.75	8.3
113	Tonga	6.6	*9.7*	*8.0*	6.74	*9.86*	*7.9*
114	Tunisia	521.7	1'056.2	12.5	5.82	10.89	11.0
115	Turkmenistan	320.3	387.6	3.2	7.14	8.02	1.9
116	Vanuatu	4.2	6.8	8.2	2.49	3.36	5.1
117	Yugoslavia	2'017.1	2'443.9	3.3	19.15	22.88	3.0
	Lower Middle Income	**106'008.0**	**282'591.5**	**17.8**	**5.37**	**13.50**	**16.6**

6. Fixed Lines

		Fixed lines			*Fixed lines per 100 inhabitants*		
		(k)		*CAGR (%)*			*CAGR (%)*
		1995	*2001*	*1995-01*	*1995*	*2001*	*1995-01*
118	Antigua & Barbuda	25.9	37.3	6.3	38.84	48.13	3.6
119	Argentina	5'622.5	8'108.0	6.3	16.17	21.63	5.0
120	Bahrain	140.8	173.9	3.6	24.23	24.66	0.3
121	Botswana	59.7	*150.3*	*20.3*	4.09	*9.15*	*17.5*
122	Brazil	13'263.0	37'430.8	18.9	8.51	21.78	17.0
123	Chile	1'818.0	3'581.2	12.0	12.74	23.11	10.4
124	Costa Rica	478.9	945.0	12.0	14.38	22.97	8.1
125	Croatia	1'287.1	1'700.0	4.7	28.28	36.52	4.4
126	Czech Republic	2'444.2	3'846.0	7.8	23.65	37.43	8.0
127	Dominica	17.8	23.3	4.6	24.13	29.06	3.1
128	Estonia	411.7	503.6	3.4	27.74	35.21	4.1
129	Gabon	32.0	37.2	2.6	2.98	2.95	-0.2
130	Grenada	23.2	32.8	5.9	26.02	32.75	3.9
131	Guadeloupe	165.3	*204.9*	*4.4*	38.98	*44.93*	*2.9*
132	Hungary	2'157.2	3'730.0	9.6	21.05	37.40	10.1
133	Korea (Rep.)	18'600.2	22'724.7	3.4	41.24	47.60	2.4
134	Lebanon	330.0	*681.5*	*15.6*	10.96	*19.49*	*12.2*
135	Libya	318.0	610.0	11.5	5.88	10.93	10.9
136	Malaysia	3'332.4	4'659.0	5.7	16.57	19.58	2.8
137	Mauritius	148.2	306.8	12.9	13.21	25.56	11.6
138	Mayotte	5.3	10.0	11.3	4.66	6.98	7.0
139	Mexico	8'801.0	13'773.0	7.7	9.39	13.72	6.5
140	Oman	169.9	235.3	5.6	7.87	8.97	2.2
141	Panama	303.9	430.0	6.0	11.56	14.83	4.2
142	Poland	5'728.5	11'400.0	12.2	14.84	29.51	12.1
143	Puerto Rico	1'195.9	1'329.5	1.8	32.05	33.64	0.8
144	Saudi Arabia	1'719.4	3'232.9	11.1	9.42	14.48	7.4
145	Seychelles	13.1	21.4	8.5	17.41	26.73	7.4
146	Slovak Republic	1'118.5	1'556.3	5.7	20.84	28.80	5.5
147	South Africa	4'002.2	4'925.7	3.5	10.14	11.25	1.7
148	St. Kitts and Nevis	14.4	*21.9*	*8.7*	36.32	*56.88*	*9.4*
149	St. Lucia	30.6	*48.9*	*9.8*	21.02	*31.35*	*8.3*
150	Trinidad & Tobago	209.3	311.8	6.9	16.78	23.99	6.1
151	Turkey	13'215.7	18'900.9	6.1	21.44	28.52	4.9
152	Uruguay	622.0	950.9	7.3	19.50	28.29	6.4
153	Venezuela	2'463.2	2'758.3	1.9	11.38	11.20	-0.3
	Upper Middle Income	**90'289.0**	**149'392.7**	**8.8**	**14.91**	**22.73**	**7.3**

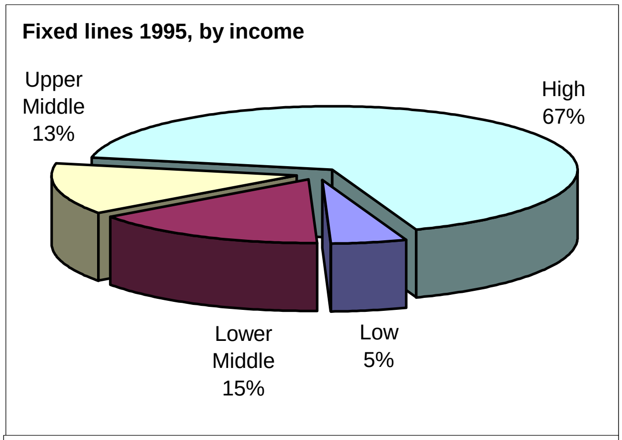
6. Fixed Lines

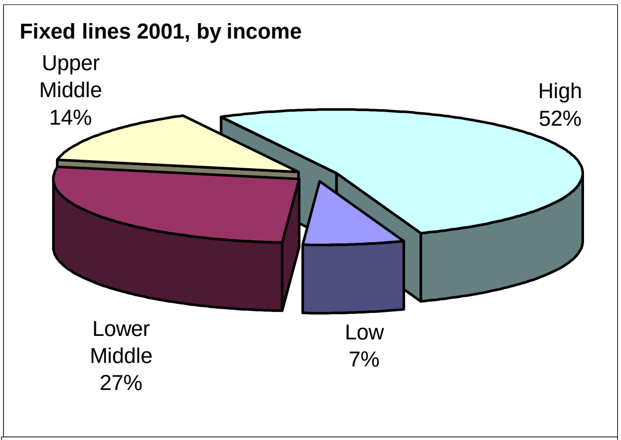
		Fixed lines (k) 1995	Fixed lines (k) 2001	CAGR (%) 1995-01	Fixed lines per 100 inhabitants 1995	Fixed lines per 100 inhabitants 2001	CAGR (%) 1995-01
154	Andorra	29.8	35.0	2.7	43.82	43.83	-
155	Aruba	27.3	37.1	5.3	33.50	35.03	0.7
156	Australia	8'900.0	10'060.0	2.1	49.25	52.02	0.9
157	Austria	3'796.9	3'810.0	0.1	47.18	46.81	-0.1
158	Bahamas	83.7	123.3	6.7	30.00	40.03	4.9
159	Barbados	90.1	*123.8*	*6.6*	34.53	*46.29*	*6.0*
160	Belgium	4'682.1	5'133.1	1.5	46.17	49.87	1.3
161	Bermuda	46.4	56.2	3.2	73.65	86.92	2.8
162	Brunei Darussalam	68.1	*80.5*	*3.4*	23.99	*24.52*	*0.4*
163	Canada	17'567.0	20'319.3	2.5	61.57	67.71	1.6
164	Cyprus	347.3	435.0	3.8	53.94	63.09	2.6
165	Denmark	3'193.4	3'882.0	3.3	61.23	72.33	2.8
166	Faroe Islands	22.2	*25.0*	*2.3*	50.52	*55.45*	*1.9*
167	Finland	2'810.0	2'845.0	0.2	54.28	54.76	0.1
168	France	32'400.0	34'032.9	0.8	56.01	57.35	0.4
169	French Guiana	41.7	51.0	3.4	27.88	26.84	-0.6
170	French Polynesia	48.7	52.6	1.3	22.12	22.19	0.1
171	Germany	42'000.0	52'280.0	3.7	51.33	63.48	3.6
172	Greece	5'162.8	5'607.7	1.4	49.40	52.92	1.2
173	Greenland	19.6	26.2	5.0	35.08	46.74	4.9
174	Guam	69.2	*80.3*	*3.0*	46.14	*47.80*	*0.7*
175	Guernsey	42.0	55.0	4.6	68.86	87.50	4.1
176	Hongkong, China	3'277.9	3'897.6	2.9	53.25	57.66	1.3
177	Iceland	148.7	190.6	4.2	55.52	66.39	3.0
178	Ireland	1'310.0	1'860.0	6.0	36.33	48.45	4.9
179	Israel	2'342.6	3'100.0	4.8	41.69	47.63	2.2
180	Italy	24'845.0	27'353.0	1.6	43.33	47.15	1.4
181	Japan	62'292.0	76'000.0	3.4	49.61	59.69	3.1
182	Jersey	59.3	73.9	3.7	68.88	84.79	3.5
183	Kuwait	382.3	472.4	3.6	22.62	23.97	1.0
184	Luxembourg	233.9	346.8	6.8	56.67	77.58	5.4
185	Macao, China	153.3	176.4	2.4	37.45	39.39	0.8
186	Malta	170.7	207.7	3.3	45.88	53.00	2.4
187	Martinique	160.9	172.0	1.1	41.68	43.00	0.5
188	Neth. Antilles	75.9	81.0	1.1	36.59	37.23	0.3
189	Netherlands	8'124.0	10'003.0	3.5	52.43	62.11	2.9
190	New Caledonia	43.7	*51.0*	*3.1*	23.64	*23.69*	-
191	New Zealand	1'719.0	1'833.6	1.1	47.34	47.14	-0.1
192	Northern Marianas	15.5	*21.0*	*6.3*	32.21	*39.59*	*4.2*
193	Norway	2'476.5	3'262.0	4.7	56.67	72.04	4.1
194	Portugal	3'642.9	4'397.4	3.2	36.72	42.68	2.5
195	Qatar	122.7	167.4	5.3	22.27	27.45	3.5
196	Réunion	218.7	300.0	5.4	33.13	41.04	3.6
197	Singapore	1'428.6	1'947.5	5.3	40.52	47.14	2.6
198	Slovenia	614.8	799.7	4.5	30.93	40.09	4.4
199	Spain	15'095.4	17'427.0	2.4	38.50	43.11	1.9
200	Sweden	6'013.0	6'585.0	1.5	68.04	73.91	1.4
201	Switzerland	4'480.0	5'183.0	2.5	63.43	71.79	2.1
202	Taiwan, China	9'174.8	12'846.9	5.8	42.96	57.34	4.9
203	United Arab Emirates	672.3	1'052.9	7.8	28.77	39.69	5.5
204	United Kingdom	29'411.4	35'326.0	3.1	50.18	58.80	2.7
205	United States	159'735.2	190'000.0	2.9	60.38	66.71	1.7
206	Virgin Islands (US)	58.3	*68.3*	*3.2*	51.20	*56.37*	*1.9*
	High Income	**459'947.6**	**544'354.1**	**2.8**	**52.73**	**59.88**	**2.1**
	WORLD	**691'427.8**	**1'051'521.4**	**7.2**	**12.16**	**17.09**	**5.8**
	Africa	**12'549.6**	**21'216.7**	**9.1**	**1.77**	**2.61**	**6.7**
	Americas	**221'295.8**	**296'641.0**	**5.0**	**28.68**	**35.29**	**3.5**
	Asia	**183'456.0**	**396'121.9**	**13.7**	**5.42**	**10.80**	**12.2**
	Europe	**263'183.7**	**325'236.6**	**3.6**	**33.27**	**40.63**	**3.4**
	Oceania	**10'942.7**	**12'305.1**	**2.0**	**38.81**	**40.02**	**0.5**

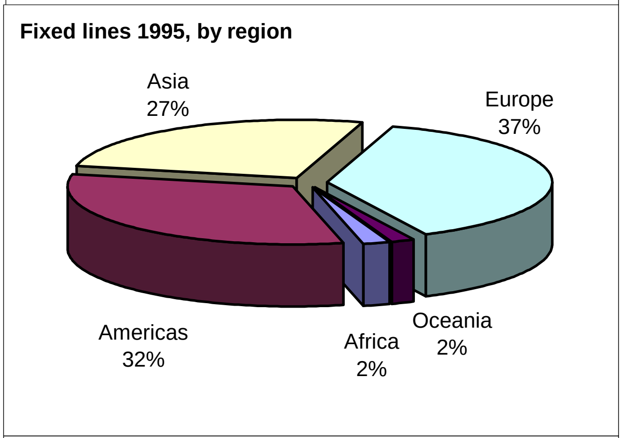
Note: For data comparability and coverage, see the technical notes.
Figures in italics are estimates or refer to years other than those specified.

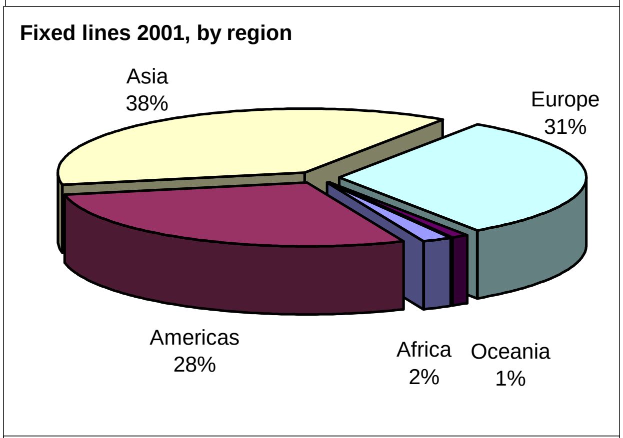
Source: ITU.

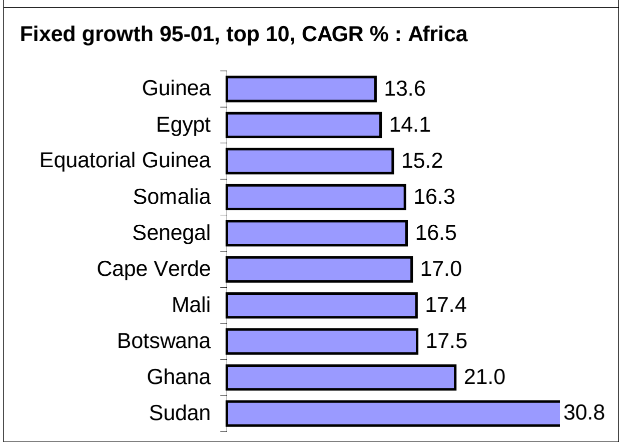
6. Fixed Lines

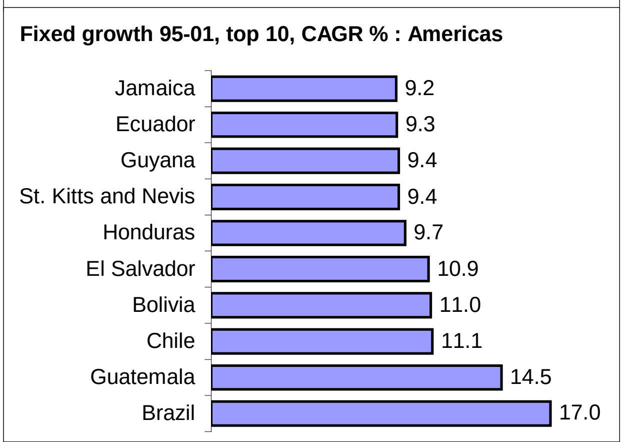


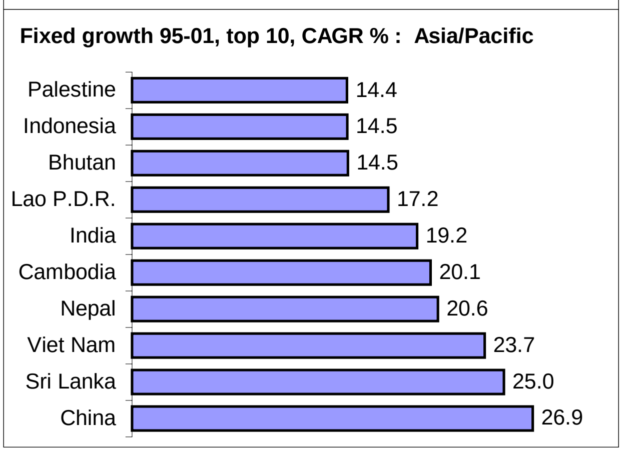


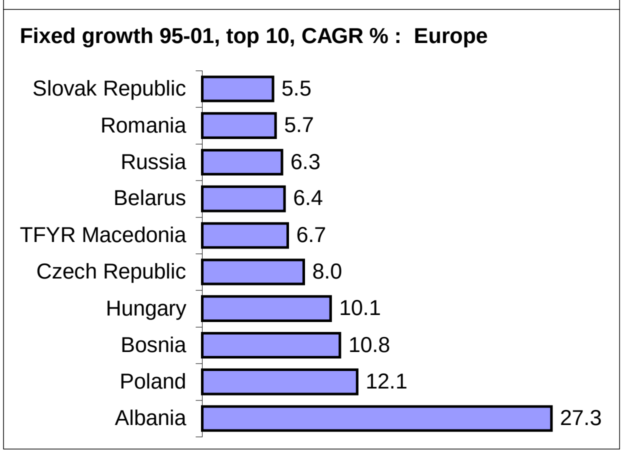




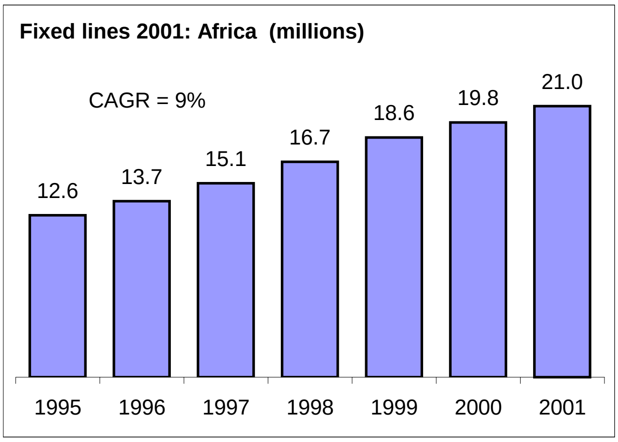


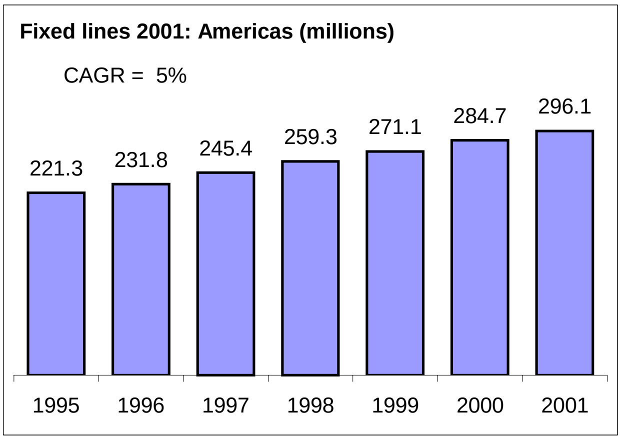


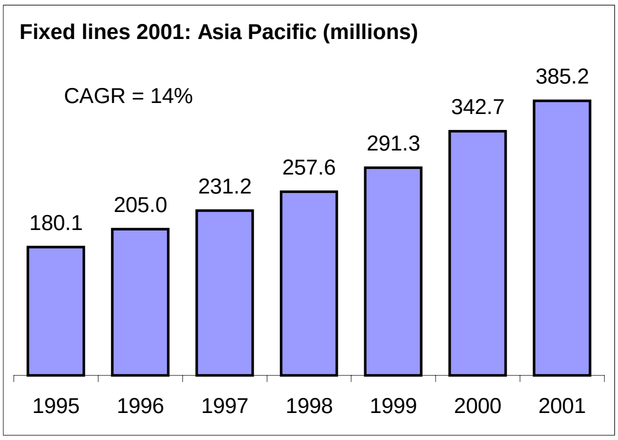


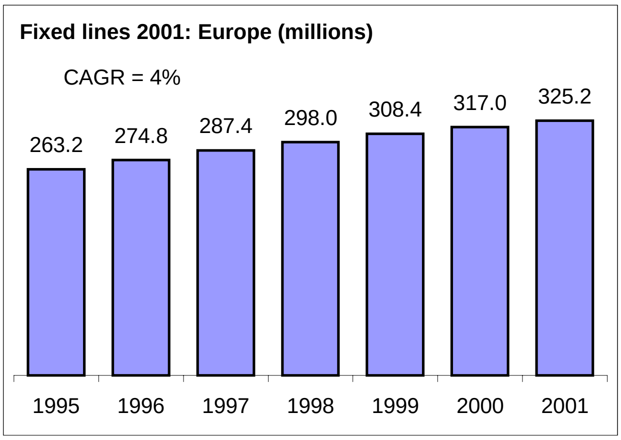


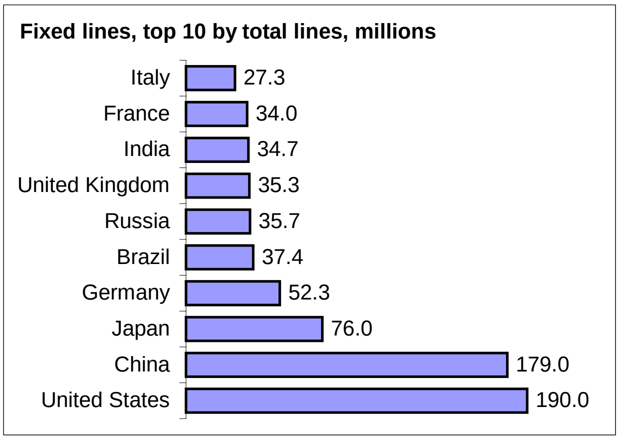
6. Fixed Lines

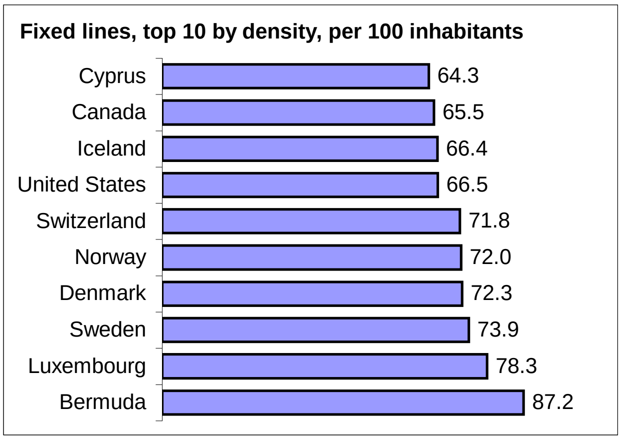












7. Mobile Subscribers

		Mobile subscribers (k)			Mobile subscribers per 100 inhabitants		
		1995	2001	CAGR (%) 1995-01	1995	2001	CAGR (%) 1995-01
1	Afghanistan	…	…	…	…	…	…
2	Angola	1.99	86.50	87.45	0.02	0.64	78.18
3	Armenia	…	25.00	…	…	0.66	…
4	Azerbaijan	6.00	620.00	116.62	0.08	7.97	115.31
5	Bangladesh	2.50	520.00	143.41	…	0.40	…
6	Benin	1.05	125.00	121.80	0.02	1.94	114.35
7	Bhutan	…	…	…	…	…	…
8	Burkina Faso	…	75.00	…	…	0.61	…
9	Burundi	0.56	20.00	81.26	0.01	0.29	75.28
10	Cambodia	14.10	223.46	58.49	0.14	1.66	51.01
11	Cameroon	2.80	310.00	119.13	0.02	2.04	116.16
12	Central African Rep.	0.04	11.00	150.99	…	0.29	…
13	Chad	…	22.00	…	…	0.27	…
14	Comoros	…	…	…	…	…	…
15	Congo	…	150.00	…	…	4.82	…
16	Côte d'Ivoire	…	728.55	…	…	4.46	…
17	D.P.R. Korea	…	…	…	…	…	…
18	D.R. Congo	8.50	150.00	61.35	0.02	0.29	56.16
19	Eritrea	…	…	…	…	…	…
20	Ethiopia	…	27.50	…	…	0.04	…
21	Gambia	1.44	43.00	76.10	0.13	3.22	70.73
22	Georgia	0.15	295.00	253.96	…	5.39	…
23	Ghana	6.20	193.77	77.48	0.04	0.93	68.94
24	Guinea	0.95	55.67	97.08	0.01	0.69	102.52
25	Guinea-Bissau	…	…	…	…	…	…
26	Haiti	…	91.50	…	…	1.11	…
27	India	76.68	6 430.81	109.22	0.01	0.63	99.48
28	Indonesia	210.64	5 302.98	71.20	0.11	2.47	67.96
29	Kenya	2.28	500.00	145.59	0.01	1.60	133.00
30	Kyrgyzstan	…	27.00	…	…	0.54	…
31	Lao P.D.R.	1.54	29.55	63.63	0.03	0.52	60.87
32	Lesotho	…	33.00	…	…	1.53	…
33	Liberia	…	2.00	…	…	0.06	…
34	Madagascar	1.30	147.50	120.03	0.01	0.90	111.69
35	Malawi	0.38	55.73	129.44	…	0.48	…
36	Mali	…	45.34	…	…	0.39	…
37	Mauritania	…	…	…	…	…	…
38	Moldova	0.01	210.00	396.61	…	4.78	…
39	Mongolia	…	195.00	…	…	7.62	…
40	Mozambique	…	169.90	…	…	0.84	…
41	Myanmar	2.77	13.80	30.73	0.01	0.03	20.09
42	Nepal	…	17.29	…	…	0.07	…
43	Nicaragua	4.40	156.00	81.25	0.10	2.99	76.18
44	Niger	…	1.85	…	…	0.02	…
45	Nigeria	13.00	330.00	71.43	0.01	0.28	74.26
46	Pakistan	40.96	800.00	64.10	0.03	0.55	62.38
47	Rwanda	…	65.00	…	…	0.82	…
48	S. Tomé & Principe	…	…	…	…	…	…
49	Senegal	0.12	390.80	283.94	…	4.04	…
50	Sierra Leone	…	26.90	…	…	0.55	…
51	Solomon Islands	0.23	0.97	27.04	0.06	0.21	23.22
52	Somalia	…	…	…	…	…	…
53	Sudan	…	105.00	…	…	0.33	…
54	Tajikistan	…	1.63	…	…	0.03	…
55	Tanzania	3.50	426.96	122.70	0.01	1.19	121.78
56	Togo	…	95.00	…	…	2.04	…
57	Uganda	1.75	322.74	138.65	0.01	1.43	128.68
58	Ukraine	14.00	2 224.60	132.73	0.03	4.42	129.82
59	Uzbekistan	3.73	62.76	60.07	0.02	0.25	52.34
60	Viet Nam	23.50	1 251.20	93.96	0.03	1.54	92.78
61	Yemen	8.25	152.00	62.52	0.05	0.80	58.74
62	Zambia	1.55	98.25	99.75	0.02	0.92	89.29
63	Zimbabwe	…	328.67	…	…	2.41	…
	Low Income	**456.89**	**23 793.17**	**93.24**	**0.04**	**1.57**	**85.59**

7. Mobile Subscribers

		Mobile subscribers (k) 1995	Mobile subscribers (k) 2001	CAGR (%) 1995-01	Mobile subscribers per 100 inhabitants 1995	2001	CAGR (%) 1995-01
64	Albania	…	350.00	…	…	8.82	…
65	Algeria	4.69	100.00	66.52	0.02	0.32	58.74
66	Belarus	5.90	138.33	69.19	0.06	1.35	68.02
67	Belize	1.55	28.19	62.22	0.72	11.55	58.81
68	Bolivia	10.00	744.00	105.08	0.13	8.99	102.60
69	Bosnia	…	233.26	…	…	5.74	…
70	Bulgaria	20.92	1 550.00	104.94	0.25	19.12	106.03
71	Cape Verde	…	31.51	…	…	7.21	…
72	China	3 629.00	144 812.00	84.86	0.29	11.17	83.77
73	Colombia	274.59	3 265.26	51.08	0.71	7.63	48.55
74	Cuba	1.94	8.08	26.85	0.02	0.07	23.22
75	Djibouti	…	3.00	…	…	0.47	…
76	Dominican Rep.	55.98	1 270.08	68.25	0.72	14.65	65.23
77	Ecuador	54.38	859.15	58.41	0.47	6.67	55.60
78	Egypt	7.37	2 793.80	169.03	0.01	4.33	175.05
79	El Salvador	13.48	800.00	97.51	0.24	12.50	93.25
80	Equatorial Guinea	…	15.00	…	…	3.19	…
81	Fiji	2.20	76.00	80.47	0.28	9.25	79.13
82	Guatemala	30.00	1 134.01	83.20	0.30	9.70	78.49
83	Guyana	1.24	75.32	98.19	0.15	8.66	96.59
84	Honduras	…	237.63	…	…	3.61	…
85	Iran (I.R.)	15.90	1 725.22	118.39	0.03	2.67	111.30
86	Iraq	…	…	…	…	…	…
87	Jamaica	45.14	700.00	57.92	1.81	26.94	56.84
88	Jordan	12.40	745.55	97.93	0.29	14.39	91.69
89	Kazakhstan	4.60	582.00	124.06	0.03	3.62	122.30
90	Kiribati	…	…	…	…	…	…
91	Latvia	15.00	656.84	87.74	0.59	27.94	90.21
92	Lithuania	14.80	932.00	99.47	0.40	25.32	99.63
93	Maldives	…	18.89	…	…	6.83	…
94	Marshall Islands	0.26	0.49	10.82	0.48	0.70	6.49
95	Micronesia	…	…	…	…	…	…
96	Morocco	29.51	4 771.74	133.41	0.11	15.68	128.56
97	Namibia	3.50	100.00	74.85	0.23	5.59	70.20
98	Palestine	20.00	300.00	57.04	0.86	9.06	48.06
99	Papua New Guinea	…	…	…	…	…	…
100	Paraguay	15.81	1 150.00	104.32	0.33	20.40	98.85
101	Peru	73.54	1 545.00	66.11	0.31	5.92	63.49
102	Philippines	493.86	10 568.00	66.62	0.72	13.70	63.39
103	Romania	9.07	3 860.00	174.27	0.04	17.24	174.84
104	Russia	88.53	5 560.00	99.37	0.06	3.79	99.56
105	Samoa	…	3.00	…	…	1.67	…
106	Sri Lanka	51.32	720.00	55.30	0.28	3.77	54.24
107	St. Vincent	0.22	…	…	0.19	…	…
108	Suriname	1.69	84.06	91.83	0.41	19.11	89.71
109	Swaziland	…	66.00	…	…	6.47	…
110	Syria	…	200.00	…	…	1.20	…
111	TFYR Macedonia	…	223.28	…	…	10.92	…
112	Thailand	1 297.83	7 550.00	34.11	2.26	11.87	31.84
113	Tonga	0.30	…	…	0.31	…	…
114	Tunisia	3.19	389.21	122.76	0.04	4.01	115.53
115	Turkmenistan	…	…	…	…	…	…
116	Vanuatu	0.12	0.35	19.37	0.07	0.17	15.94
117	Yugoslavia	…	1 997.81	…	…	18.71	…
	Lower Middle Income	**6 309.80**	**202 974.05**	**78.34**	**0.38**	**9.21**	**69.78**

7. Mobile Subscribers

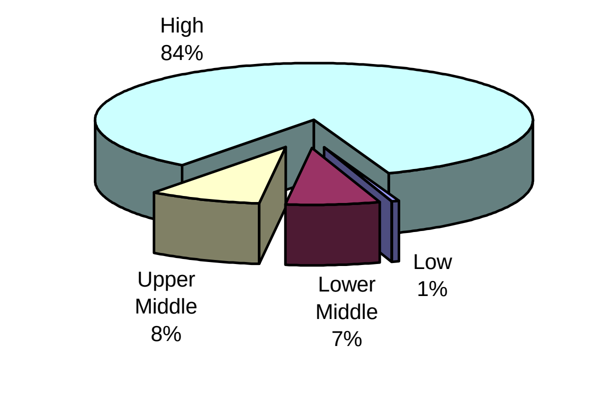
		Mobile subscribers (k)			*Mobile subscribers per 100 inhabitants*		
		1995	*2001*	*CAGR (%) 1995-01*	*1995*	*2001*	*CAGR (%) 1995-01*
118	Antigua & Barbuda	…	25.00	…	…	31.77	…
119	Argentina	340.74	6 974.94	65.39	0.98	18.61	63.34
120	Bahrain	27.60	299.59	48.80	4.75	42.49	44.08
121	Botswana	…	278.00	…	…	16.65	…
122	Brazil	1 285.53	28 745.77	67.85	0.83	16.73	64.97
123	Chile	197.31	5 271.57	72.90	1.38	34.02	70.60
124	Costa Rica	18.75	311.33	59.72	0.56	7.57	54.34
125	Croatia	33.69	1 755.00	93.26	0.74	37.70	92.54
126	Czech Republic	48.90	6 769.00	127.44	0.47	65.88	127.92
127	Dominica	…	…	…	…	…	…
128	Estonia	30.45	651.20	66.60	2.05	45.54	67.66
129	Gabon	4.00	258.09	100.27	0.37	20.45	95.17
130	Grenada	0.40	6.41	58.80	0.45	6.41	55.69
131	Guadeloupe	…	292.52	…	…	63.59	…
132	Hungary	265.00	4 968.00	62.99	2.59	49.81	63.68
133	Korea (Rep.)	1 641.29	29 045.60	61.43	3.64	60.84	59.90
134	Lebanon	120.00	…	…	3.99	…	…
135	Libya	…	50.00	…	…	0.90	…
136	Malaysia	1 005.07	7 128.00	38.61	5.00	29.95	34.76
137	Mauritius	11.74	300.00	71.64	1.05	25.00	69.61
138	Mayotte	…	…	…	…	…	…
139	Mexico	688.51	21 757.00	77.81	0.73	21.68	75.98
140	Oman	8.05	324.54	85.17	0.37	12.37	79.48
141	Panama	…	600.00	…	…	20.70	…
142	Poland	75.00	10 050.00	126.21	0.19	26.02	127.03
143	Puerto Rico	287.00	1 211.11	27.12	7.69	30.65	25.92
144	Saudi Arabia	16.01	2 528.64	132.50	0.09	11.33	123.87
145	Seychelles	0.05	44.12	209.70	0.07	55.15	203.91
146	Slovak Republic	12.32	2 147.33	136.36	0.23	39.74	136.00
147	South Africa	535.00	10 740.00	64.86	1.36	21.00	57.80
148	St. Kitts and Nevis	…	…	…	…	…	…
149	St. Lucia	1.00	…	…	0.69	…	…
150	Trinidad & Tobago	6.35	225.39	81.27	0.51	17.34	79.99
151	Turkey	437.13	20 000.00	89.12	0.71	30.18	86.81
152	Uruguay	39.90	519.99	53.40	1.25	15.47	52.09
153	Venezuela	403.8	6 489.9	58.9	1.87	26.35	55.4
	Upper Middle Income	**7 540.60**	**169 768.03**	**68.04**	**1.59**	**29.09**	**62.28**

7. Mobile Subscribers

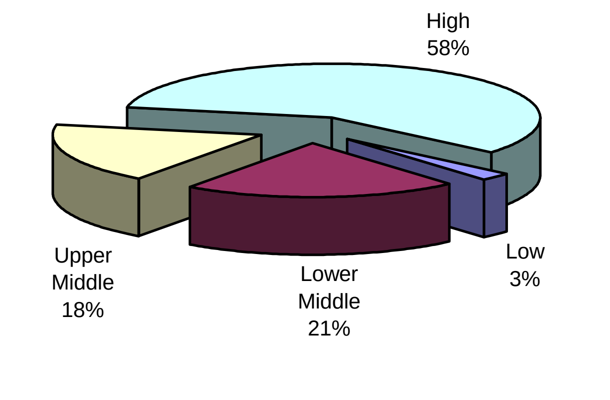
		Mobile subscribers (k) 1995	Mobile subscribers (k) 2001	CAGR (%) 1995-01	Mobile subscribers per 100 inhabitants 1995	Mobile subscribers per 100 inhabitants 2001	CAGR (%) 1995-01
154	Andorra	2.83	…	…	4.15	…	…
155	Aruba	1.72	53.00	77.10	2.11	50.00	69.48
156	Australia	2 242.00	11 169.00	30.69	12.41	57.75	29.21
157	Austria	383.54	6 565.90	60.54	4.77	80.66	60.21
158	Bahamas	4.10	60.56	56.64	1.47	19.66	54.07
159	Barbados	4.61	…	…	1.77	…	…
160	Belgium	235.26	7 690.00	78.81	2.32	74.72	78.37
161	Bermuda	6.32	13.33	13.24	10.04	20.64	12.76
162	Brunei Darussalam	35.88	…	…	12.63	…	…
163	Canada	2 589.78	9 923.90	25.09	8.82	32.00	23.96
164	Cyprus	44.45	314.36	38.54	6.90	46.43	37.40
165	Denmark	822.26	3 954.04	29.92	15.77	73.67	29.29
166	Faroe Islands	2.56	…	…	5.81	…	…
167	Finland	1 039.13	4 044.00	25.42	20.07	77.84	25.35
168	France	1 302.50	35 922.27	73.82	2.25	60.53	73.10
169	French Guiana	…	75.32	…	…	39.64	…
170	French Polynesia	1.15	67.00	96.89	0.52	28.27	94.63
171	Germany	3 725.00	56 245.00	57.21	4.55	68.29	57.06
172	Greece	273.00	7 962.00	75.45	2.61	75.14	75.07
173	Greenland	2.05	16.75	41.89	3.67	29.86	41.82
174	Guam	4.97	…	…	3.31	…	…
175	Guernsey	2.36	31.54	54.07	3.87	50.22	53.29
176	Hong Kong, China	798.37	5 776.36	39.07	12.97	85.46	36.92
177	Iceland	30.88	235.40	40.29	11.53	82.02	38.68
178	Ireland	158.00	2 800.00	61.47	4.38	72.94	59.80
179	Israel	445.46	5 260.00	50.90	7.93	80.82	47.25
180	Italy	3 923.00	48 698.00	52.17	6.84	83.94	51.87
181	Japan	11 712.14	74 819.16	36.22	9.33	58.76	35.89
182	Jersey	4.36	61.42	55.44	5.06	70.44	55.10
183	Kuwait	117.61	489.21	26.82	6.96	24.82	23.60
184	Luxembourg	26.84	432.38	58.92	6.50	96.73	56.83
185	Macao, China	35.88	194.50	32.54	8.77	43.41	30.55
186	Malta	10.79	138.79	53.07	2.90	35.40	51.74
187	Martinique	…	286.12	…	…	71.53	…
188	Neth. Antilles	11.70	…	…	5.64	…	…
189	Netherlands	539.00	11 900.00	67.49	3.48	73.91	66.41
190	New Caledonia	0.83	…	…	0.45	…	…
191	New Zealand	365.00	2 417.00	37.03	10.05	62.13	35.47
192	Northern Marianas	1.20	…	…	2.50	…	…
193	Norway	981.31	3 737.00	24.96	22.46	82.53	24.22
194	Portugal	340.85	7 977.54	69.13	3.44	77.43	68.03
195	Qatar	18.47	178.79	45.99	3.35	29.31	43.55
196	Réunion	5.50	421.10	106.06	0.83	57.61	102.72
197	Singapore	306.00	2 991.60	46.23	8.68	72.41	42.41
198	Slovenia	27.30	1 515.70	95.32	1.37	75.98	95.28
199	Spain	944.96	26 494.15	74.30	2.41	65.53	73.41
200	Sweden	2 008.00	7 042.00	23.26	22.72	79.03	23.09
201	Switzerland	447.17	5 226.00	50.64	6.33	72.38	50.10
202	Taiwan, China	772.17	21 632.98	74.27	3.62	96.55	72.85
203	United Arab Emirates	128.97	1 909.30	56.70	5.52	71.97	53.42
204	United Kingdom	5 735.79	46 282.00	41.62	9.79	78.28	41.41
205	United States	33 785.66	128 374.51	24.92	12.84	44.42	22.98
206	Virgin Islands (US)	…	…	…	…	…	…
	High Income	**76 408.62**	**551 398.95**	**39.01**	**6.77**	**62.07**	**44.67**
	WORLD	**90 715.91**	**947 934.19**	**47.86**	**1.86**	**15.61**	**42.56**
	Africa	**652.0**	**25 504.2**	**84.25**	**0.2**	**5.9**	**78.27**
	Americas	**40 257.1**	**223 366.0**	**33.05**	**2.0**	**20.8**	**47.67**
	Asia	**23 104.7**	**335 767.4**	**56.22**	**3.0**	**20.2**	**37.27**
	Europe	**24 083.9**	**349 562.9**	**56.18**	**4.9**	**49.5**	**47.22**
	Oceania	**2 618.3**	**13 733.8**	**31.81**	**2.8**	**20.0**	**39.07**

7. Mobile Subscribers

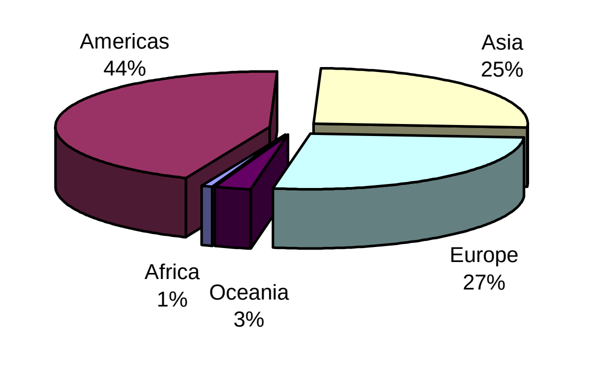
Mobile subscribers 1995, by income



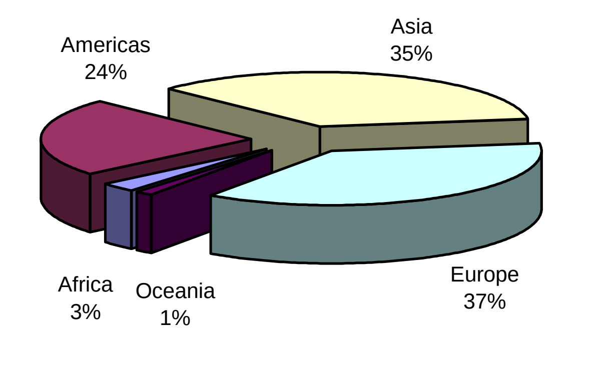
Mobile subscribers 2001, by income



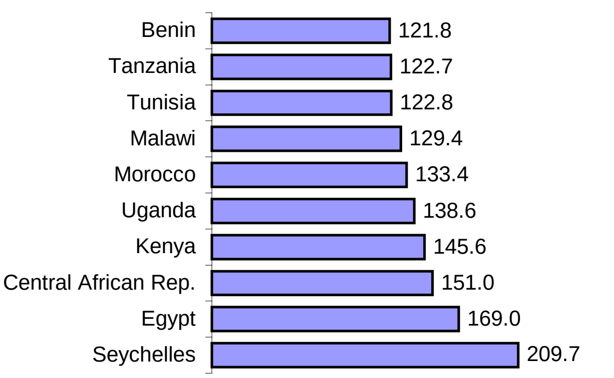
Mobile subscribers 1995, by region



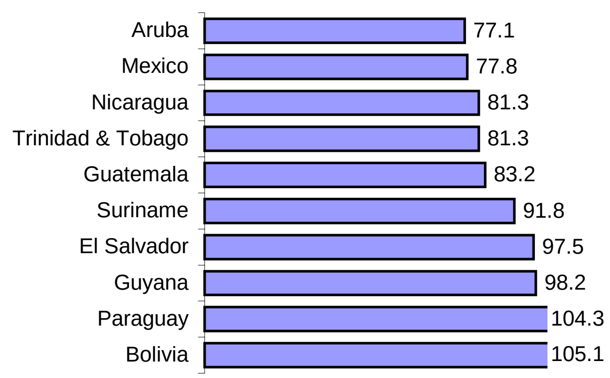
Mobile subscribers 2001, by region



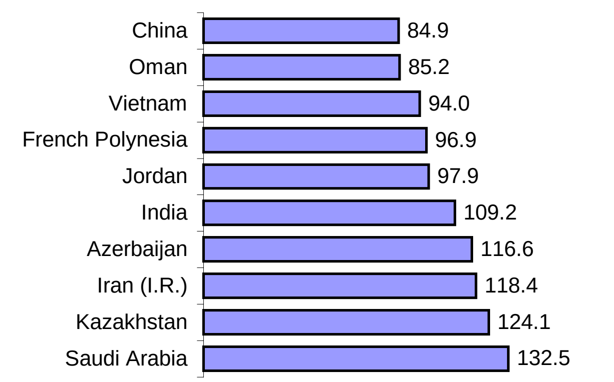
Mobile growth 95-01, top 10, CAGR % : Africa



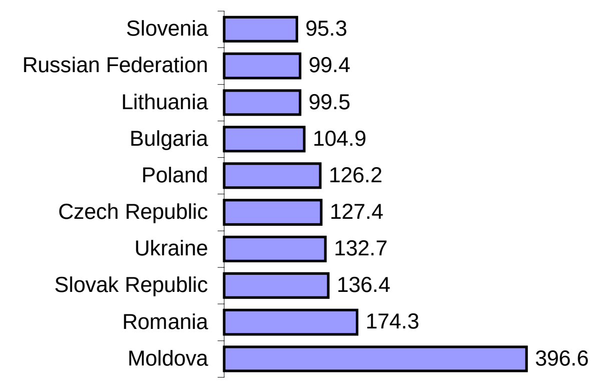
Mobile growth 95-01, top 10, CAGR % : Americas



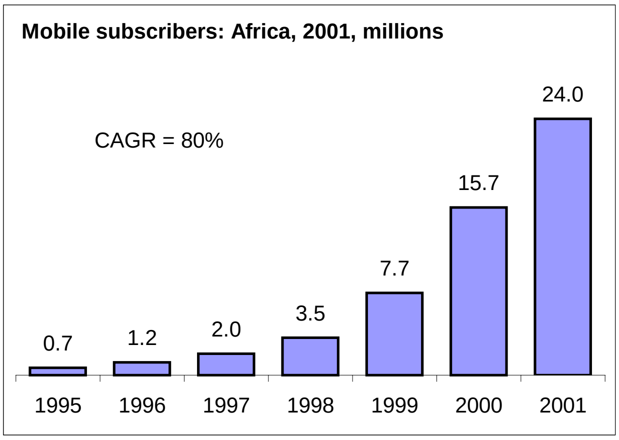
Mobile growth 95-01, top 10, CAGR % : Asia/Pacific

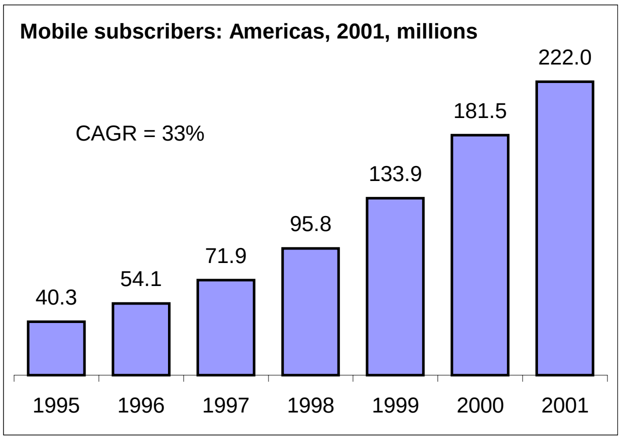


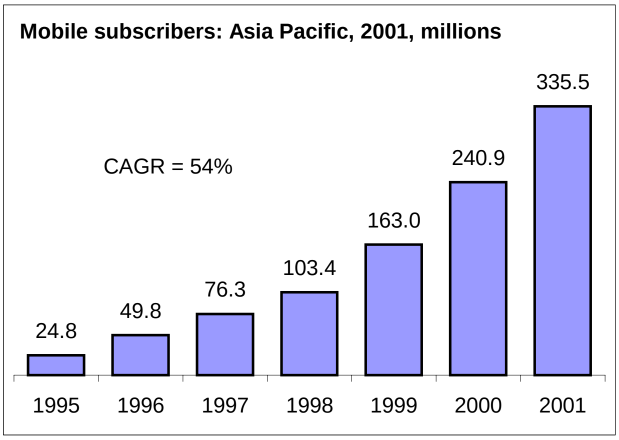
Mobile growth 95-01, top 10, CAGR % : Europe

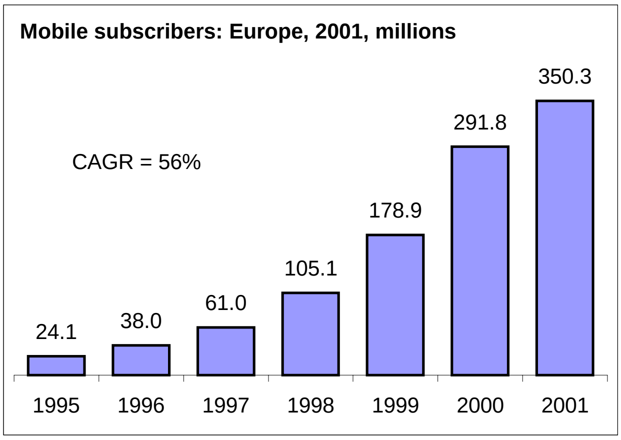


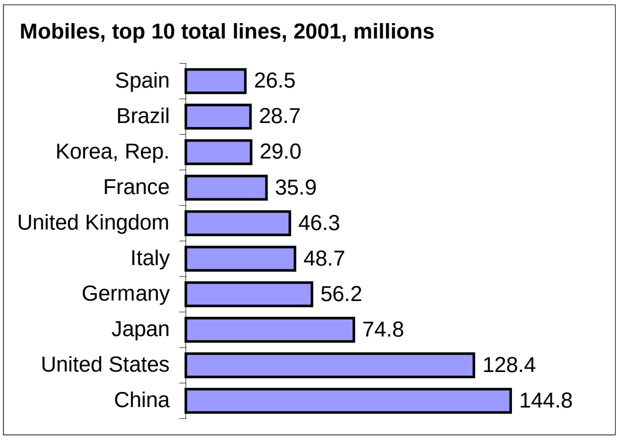
7. Mobile Subscribers

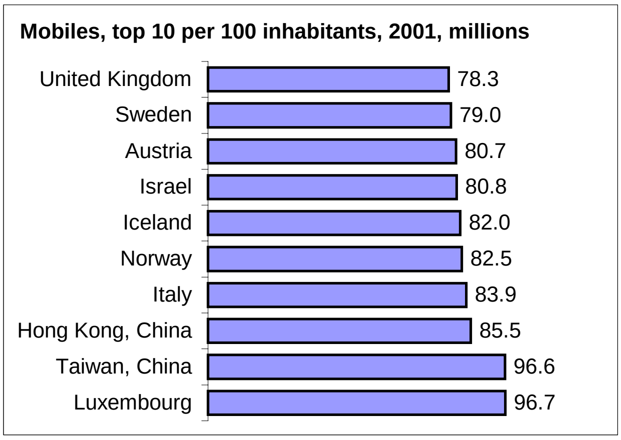












8. Network Penetration

		Fixed lines		Mobile subscribers		Internet users		Ratios		
		per 100	rank	per 100	rank	per 100	rank	Mobile /Fixed	Mobile /Internet	Internet /Fixed
		2001		2001		2001		2001	2001	2001
1	Afghanistan	0.13	205	…	…	...	…	…	…	…
2	Angola	0.59	183	0.64	147	0.44	153	1.08	1.44	0.75
3	Armenia	13.97	100	0.66	146	*1.42*	120	0.05	0.46	0.10
4	Azerbaijan	11.13	107	7.97	94	0.32	164	0.72	24.80	0.03
5	Bangladesh	0.39	193	0.40	156	0.11	187	1.01	3.47	0.29
6	Benin	0.92	177	1.94	126	0.39	156	2.11	5.00	0.42
7	Bhutan	2.03	160	…	…	0.36	158	…	…	0.18
8	Burkina Faso	0.47	186	0.61	149	0.17	184	1.30	3.57	0.36
9	Burundi	0.29	197	0.29	160	0.09	190	1.00	3.33	0.30
10	Cambodia	0.25	201	1.66	128	0.07	191	6.67	22.35	0.30
11	Cameroon	0.67	182	2.04	125	0.30	165	3.06	6.89	0.44
12	Central African Rep.	0.26	200	0.29	161	0.05	193	1.10	5.50	0.20
13	Chad	0.14	204	0.27	164	0.05	195	2.00	5.50	0.36
14	Comoros	1.22	169	…	…	0.34	162	…	…	0.28
15	Congo	0.71	181	4.82	107	*0.02*	199	6.82	241.08	0.03
16	Côte d'Ivoire	1.80	162	4.46	109	0.43	155	2.48	10.41	0.24
17	D.P.R. Korea	4.50	141	…	…	...	…	…	…	…
18	D.R. Congo	0.04	206	0.29	162	0.01	200	7.50	25.00	0.30
19	Eritrea	0.84	178	…	…	0.26	167	…	…	0.31
20	Ethiopia	0.48	185	0.04	171	0.04	196	0.09	1.10	0.08
21	Gambia	2.62	156	3.22	118	1.35	124	1.23	2.39	0.51
22	Georgia	15.86	94	5.39	106	0.46	152	0.34	11.80	0.03
23	Ghana	1.16	170	0.93	137	0.19	176	0.80	4.78	0.17
24	Guinea	0.32	196	0.69	145	0.19	179	2.18	3.71	0.59
25	Guinea-Bissau	0.98	174	…	…	0.33	163	…	…	0.33
26	Haiti	0.97	175	1.11	136	0.36	157	1.14	3.05	0.38
27	India	3.70	148	0.63	148	0.68	145	0.17	0.92	0.18
28	Indonesia	3.80	146	2.47	122	1.91	110	0.65	1.29	0.50
29	Kenya	1.00	173	1.60	129	1.60	116	1.60	1.00	1.60
30	Kyrgyzstan	*7.71*	127	0.54	152	*1.06*	135	0.07	0.51	0.14
31	Lao P.D.R.	0.93	176	0.52	153	0.18	181	0.56	2.95	0.19
32	Lesotho	*1.03*	172	1.53	131	0.23	174	1.48	6.60	0.22
33	Liberia	0.22	202	0.06	170	0.03	197	0.29	2.00	0.15
34	Madagascar	0.36	194	0.90	139	0.21	175	2.53	4.21	0.60
35	Malawi	0.47	187	0.48	154	0.17	183	1.03	2.79	0.37
36	Mali	0.43	191	0.39	157	0.26	168	0.91	1.51	0.60
37	Mauritania	*0.72*	180	…	…	0.25	169	…	…	0.35
38	Moldova	15.40	95	4.78	108	1.37	122	0.31	3.50	0.09
39	Mongolia	4.81	139	7.62	96	1.56	117	1.59	4.88	0.33
40	Mozambique	0.44	189	0.84	141	0.07	192	1.90	11.33	0.17
41	Myanmar	0.58	184	0.03	172	0.02	198	0.05	1.38	0.04
42	Nepal	1.26	168	0.07	168	0.25	170	0.06	0.29	0.20
43	Nicaragua	*3.12*	153	2.99	120	*0.99*	138	0.96	3.02	0.32
44	Niger	0.19	203	0.02	174	0.11	188	0.09	0.15	0.55
45	Nigeria	0.43	190	0.28	163	*0.18*	180	0.66	1.57	0.42
46	Pakistan	2.35	158	0.55	151	0.34	161	0.24	1.60	0.15
47	Rwanda	0.27	199	0.82	142	0.25	172	3.02	3.25	0.93
48	S. Tomé & Principe	3.63	150	…	…	6.00	73	…	…	1.65
49	Senegal	2.45	157	4.04	112	1.03	136	1.65	3.91	0.42
50	Sierra Leone	0.47	188	0.55	150	0.14	186	1.18	3.84	0.31
51	Solomon Islands	1.60	163	0.21	166	0.43	154	0.13	0.48	0.27
52	Somalia	*0.35*	195	…	…	0.01	201	…	…	0.03
53	Sudan	1.42	166	0.33	158	0.18	182	0.23	1.88	0.12
54	Tajikistan	3.63	149	0.03	173	0.05	194	0.01	0.51	0.01
55	Tanzania	0.41	192	1.19	135	0.83	141	2.88	1.42	2.02
56	Togo	1.03	171	2.04	124	1.07	132	1.98	1.90	1.04
57	Uganda	0.28	198	1.43	132	0.27	166	5.06	5.38	0.94
58	Ukraine	21.21	86	4.42	110	1.19	129	0.21	3.71	0.06
59	Uzbekistan	6.58	129	0.25	165	0.59	149	0.04	0.42	0.09
60	Viet Nam	3.76	147	1.54	130	0.49	151	0.41	3.13	0.13
61	Yemen	2.21	159	0.80	143	0.09	189	0.36	8.94	0.04
62	Zambia	0.80	179	0.92	138	0.23	173	1.15	3.93	0.29
63	Zimbabwe	1.86	161	2.41	123	0.73	144	1.30	3.29	0.39
	Low Income	**3.02**		**1.57**		**0.62**		**0.52**	**2.53**	**0.21**

8. Network Penetration

		Fixed lines		Mobile subscribers		Internet users		Ratios		
		per 100	rank	per 100	rank	per 100	rank	Mobile /Fixed	Mobile /Internet	Internet /Fixed
		2001		2001		2001		2001	2001	2001
64	Albania	4.97	138	8.82	92	0.25	171	1.77	35.00	0.05
65	Algeria	6.04	133	0.32	159	0.19	177	0.05	1.67	0.03
66	Belarus	27.88	67	1.35	133	4.12	85	0.05	0.33	0.15
67	Belize	14.44	98	11.55	84	7.38	65	0.80	1.57	0.51
68	Bolivia	6.22	132	8.99	91	*1.46*	119	1.45	6.16	0.23
69	Bosnia	11.07	108	5.74	104	1.11	131	0.52	5.18	0.10
70	Bulgaria	35.94	54	19.12	68	7.46	64	0.53	2.56	0.21
71	Cape Verde	14.27	99	7.21	98	2.75	100	0.51	2.63	0.19
72	China	13.81	101	11.17	86	2.60	103	0.81	4.30	0.19
73	Colombia	17.05	92	7.63	95	2.70	102	0.45	2.83	0.16
74	Cuba	5.10	137	0.07	169	1.07	133	0.01	0.07	0.21
75	Djibouti	1.54	164	0.47	155	0.51	150	0.30	0.91	0.33
76	Dominican Rep.	11.02	109	14.65	78	2.15	108	1.33	6.83	0.19
77	Ecuador	10.37	114	6.67	100	2.54	105	0.64	2.62	0.25
78	Egypt	10.30	115	4.33	111	0.93	140	0.42	4.66	0.09
79	El Salvador	9.34	119	12.50	81	*0.80*	142	1.34	15.63	0.09
80	Equatorial Guinea	1.47	165	3.19	119	0.19	178	2.17	16.67	0.13
81	Fiji	11.00	110	9.25	89	1.82	111	0.84	5.07	0.17
82	Guatemala	6.47	131	9.70	88	1.71	114	1.50	5.67	0.26
83	Guyana	9.19	120	8.66	93	10.92	52	0.94	0.79	1.19
84	Honduras	4.71	140	3.61	117	*0.62*	147	0.77	5.83	0.13
85	Iran (I.R.)	16.03	93	2.67	121	0.62	146	0.17	4.29	0.04
86	Iraq	2.86	155	…	…	...	…	…	…	…
87	Jamaica	19.73	88	26.94	55	3.85	87	1.37	7.00	0.20
88	Jordan	12.74	103	14.39	79	4.09	86	1.13	3.52	0.32
89	Kazakhstan	*11.31*	104	3.62	116	*0.62*	147	0.32	5.83	0.05
90	Kiribati	*4.03*	143	…	…	2.50	107	…	…	0.62
91	Latvia	30.83	61	27.94	54	7.23	66	0.91	3.86	0.23
92	Lithuania	31.29	60	25.32	58	6.79	68	0.81	3.73	0.22
93	Maldives	10.09	116	6.83	99	3.70	90	0.68	1.84	0.37
94	Marshall Islands	5.98	134	0.70	144	1.29	127	0.12	0.54	0.22
95	Micronesia	8.33	123	…	…	*3.38*	93	…	…	0.41
96	Morocco	3.92	145	15.68	76	1.31	126	4.01	11.93	0.34
97	Namibia	6.57	130	5.59	105	2.52	106	0.85	2.22	0.38
98	Palestine	7.76	125	9.06	90	1.81	112	1.17	5.00	0.23
99	Papua New Guinea	*1.35*	167	…	…	*2.81*	99	…	…	2.08
100	Paraguay	5.12	136	20.40	66	1.06	134	3.98	19.17	0.21
101	Peru	7.75	126	5.92	103	11.50	49	0.76	0.52	1.48
102	Philippines	4.02	144	13.70	80	2.59	104	3.41	5.28	0.65
103	Romania	18.28	90	17.24	73	4.47	83	0.94	3.86	0.24
104	Russia	24.33	75	3.79	114	2.93	98	0.16	1.29	0.12
105	Samoa	5.56	135	1.67	127	1.67	115	0.30	1.00	0.30
106	Sri Lanka	4.33	142	3.77	115	0.79	143	0.87	4.80	0.18
107	St. Vincent	*21.96*	83	…	…	*3.09*	96	…	…	0.14
108	Suriname	17.58	91	19.11	69	3.30	94	1.09	5.79	0.19
109	Swaziland	3.14	152	6.47	101	1.37	121	2.06	4.71	0.44
110	Syria	10.88	113	1.20	134	0.36	159	0.11	3.33	0.03
111	TFYR Macedonia	26.35	70	10.92	87	3.42	92	0.41	3.19	0.13
112	Thailand	9.39	118	11.87	83	5.56	76	1.26	2.14	0.59
113	Tonga	*9.86*	117	…	…	*1.02*	137	…	…	0.10
114	Tunisia	10.89	112	4.01	113	4.12	84	0.37	0.97	0.38
115	Turkmenistan	8.02	124	…	…	0.17	185	…	…	0.02
116	Vanuatu	3.36	151	0.17	167	2.74	101	0.05	0.06	0.81
117	Yugoslavia	22.88	81	18.71	70	5.62	74	0.82	3.33	0.25
	Lower Middle Income	**13.48**		**9.21**		**2.65**		**0.68**	**3.48**	**0.20**

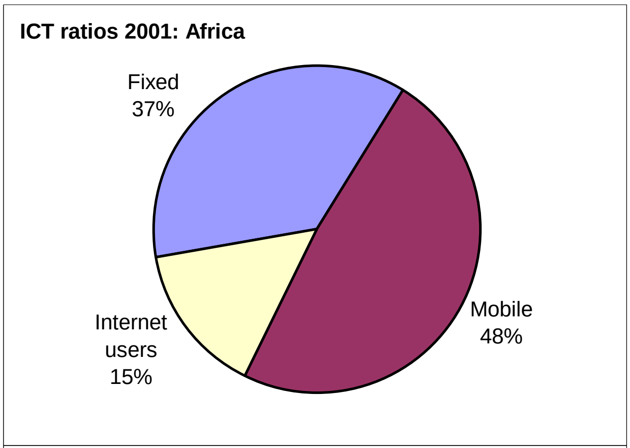
8. Network Penetration

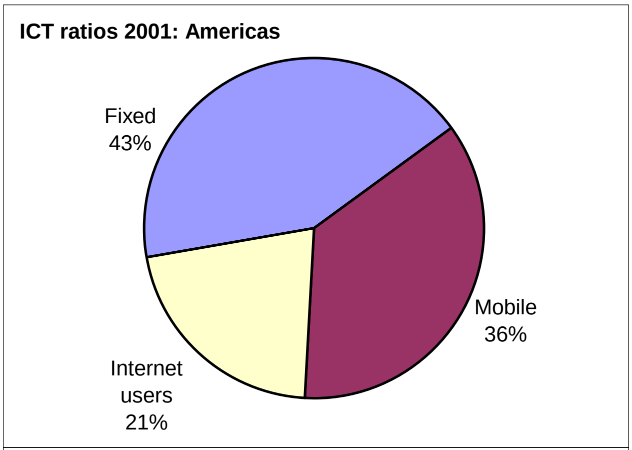
		Fixed lines		Mobile subscribers		Internet users		Ratios		
		per 100	rank	per 100	rank	per 100	rank	Mobile /Fixed	Mobile /Internet	Internet /Fixed
		2001		2001		2001		2001	2001	2001
118	Antigua & Barbuda	48.13	29	31.77	47	*6.52*	72	0.66	4.87	0.14
119	Argentina	21.63	85	18.61	71	8.00	62	0.86	2.32	0.37
120	Bahrain	24.66	73	42.49	41	19.89	39	1.72	2.14	0.81
121	Botswana	*9.15*	121	16.65	75	*1.52*	118	1.82	10.95	0.17
122	Brazil	21.78	84	16.73	74	4.66	81	0.77	3.59	0.21
123	Chile	23.90	78	34.02	45	20.02	38	1.42	1.70	0.84
124	Costa Rica	22.97	80	7.57	97	9.34	57	0.33	0.81	0.41
125	Croatia	36.52	53	37.70	43	*5.59*	75	1.03	6.74	0.15
126	Czech Republic	37.43	50	65.88	25	13.63	44	1.76	4.84	0.36
127	Dominica	29.06	63	…	…	*7.78*	63	…	…	0.27
128	Estonia	35.21	55	45.54	38	30.05	26	1.29	1.52	0.85
129	Gabon	2.95	154	20.45	65	1.35	123	6.93	15.18	0.46
130	Grenada	32.75	58	6.41	102	5.20	79	0.20	1.23	0.16
131	Guadeloupe	*44.93*	39	63.59	27	*1.76*	113	1.42	36.13	0.04
132	Hungary	37.40	51	49.81	36	14.84	43	1.33	3.36	0.40
133	Korea (Rep.)	47.60	32	60.84	29	51.07	5	1.28	1.19	1.07
134	Lebanon	*19.49*	89	…	…	*8.58*	61	…	…	0.44
135	Libya	10.93	111	0.90	140	0.36	160	0.08	2.50	0.03
136	Malaysia	19.91	87	29.95	50	23.95	31	1.50	1.25	1.20
137	Mauritius	25.56	72	25.00	59	13.17	46	0.98	1.90	0.52
138	Mayotte	6.98	128	…	…	...	…	…	…	…
139	Mexico	13.72	102	21.68	61	3.62	91	1.58	5.98	0.26
140	Oman	8.97	122	12.37	82	4.57	82	1.38	2.70	0.51
141	Panama	14.83	96	20.70	63	*3.17*	95	1.40	6.53	0.21
142	Poland	29.51	62	26.02	57	9.84	56	0.88	2.64	0.33
143	Puerto Rico	33.64	57	30.65	48	15.18	42	0.91	2.02	0.45
144	Saudi Arabia	14.48	97	11.33	85	1.34	125	0.78	8.43	0.09
145	Seychelles	26.73	69	55.15	33	11.25	50	2.06	4.90	0.42
146	Slovak Republic	28.80	64	39.74	42	*12.03*	47	1.38	3.30	0.42
147	South Africa	11.25	105	21.00	62	7.01	67	1.87	3.00	0.62
148	St. Kitts and Nevis	*56.88*	20	…	…	*5.16*	80	…	…	0.09
149	St. Lucia	*31.35*	59	…	…	*1.95*	109	…	…	0.06
150	Trinidad & Tobago	23.99	76	17.34	72	9.23	58	0.72	1.88	0.38
151	Turkey	28.52	65	30.18	49	3.77	88	1.06	8.00	0.13
152	Uruguay	28.29	66	15.47	77	11.90	48	0.55	1.30	0.42
153	Venezuela	11.20	106	26.35	56	5.28	78	2.35	4.99	0.47
	Upper Middle Income	**22.76**		**29.09**		**9.95**		**1.28**	**2.92**	**0.44**

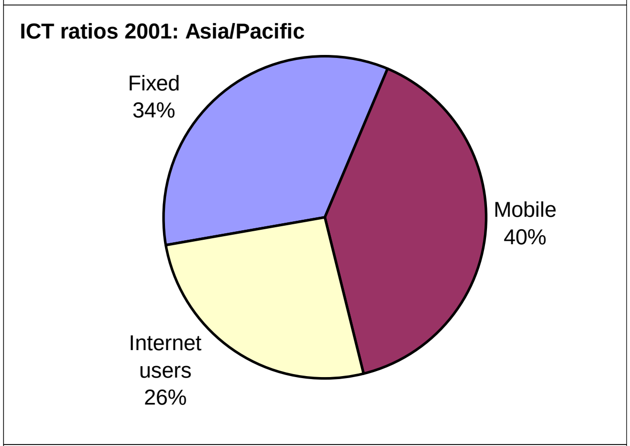
8. Network Penetration

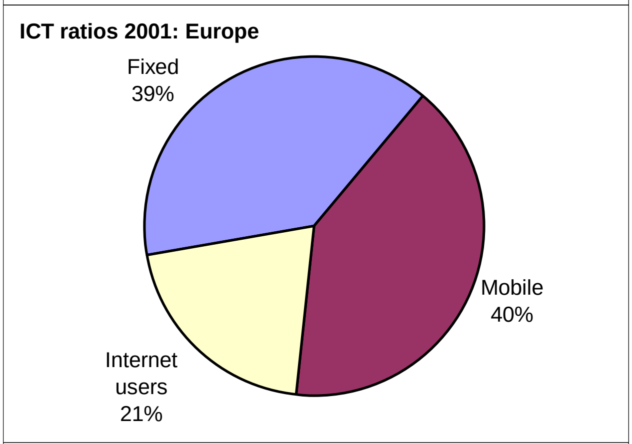
		Fixed lines		Mobile subscribers		Internet users		Ratios		
		per 100	rank	per 100	rank	per 100	rank	Mobile /Fixed	Mobile /Internet	Internet /Fixed
		2001		2001		2001		2001	2001	2001
154	Andorra	43.83	40	…	…	*8.97*	60	…	…	0.20
155	Aruba	35.03	56	50.00	35	22.64	35	1.43	2.21	0.65
156	Australia	52.02	26	57.75	32	37.23	15	1.11	1.55	0.72
157	Austria	46.81	36	80.66	8	31.94	23	1.72	2.53	0.68
158	Bahamas	40.03	46	19.66	67	5.49	77	0.49	3.58	0.14
159	Barbados	*46.29*	38	…	…	*3.74*	89	…	…	0.08
160	Belgium	49.30	27	74.72	15	27.99	28	1.52	2.67	0.57
161	Bermuda	*86.92*	2	20.64	64	*39.01*	14	0.24	0.53	0.45
162	Brunei Darussalam	*24.52*	74	…	…	10.45	53	…	…	0.43
163	Canada	65.51	11	32.00	46	43.53	10	0.49	0.74	0.66
164	Cyprus	*64.25*	12	46.43	37	*21.35*	37	0.72	2.17	0.33
165	Denmark	72.33	6	73.67	17	44.72	9	1.02	1.65	0.62
166	Faroe Islands	*55.45*	22	…	…	*6.73*	70	…	…	0.12
167	Finland	*54.76*	23	77.84	11	43.03	11	1.42	1.81	0.79
168	France	57.35	18	60.53	30	26.38	29	1.06	2.29	0.46
169	French Guiana	*26.24*	71	…	…	*1.15*	130	…	…	0.04
170	French Polynesia	22.19	82	28.27	53	6.75	69	1.27	4.19	0.30
171	Germany	*63.48*	13	68.29	24	*36.43*	16	1.08	1.87	0.57
172	Greece	*52.92*	25	75.14	14	13.21	45	1.42	5.69	0.25
173	Greenland	46.74	37	29.86	51	35.66	17	0.64	0.84	0.76
174	Guam	*47.80*	30	…	…	*3.04*	97	…	…	0.06
175	Guernsey	87.50	1	50.22	34	31.90	24	0.57	1.57	0.36
176	Hong Kong, China	*57.66*	17	85.46	3	*45.86*	7	1.48	1.86	0.80
177	Iceland	*66.39*	10	82.02	6	67.94	1	1.24	1.21	1.02
178	Ireland	48.45	28	72.94	18	23.31	32	1.51	3.13	0.48
179	Israel	*47.63*	31	80.82	7	*23.05*	33	1.70	3.51	0.48
180	Italy	47.06	35	83.94	4	33.18	21	1.78	2.53	0.71
181	Japan	*59.69*	15	58.76	31	*45.47*	8	0.98	1.29	0.76
182	Jersey	*84.79*	3	70.44	23	9.22	59	0.83	7.64	0.11
183	Kuwait	23.97	77	24.82	60	10.15	54	1.04	2.45	0.42
184	Luxembourg	*78.30*	4	96.73	1	*22.66*	34	1.24	4.27	0.29
185	Macao, China	39.39	49	43.41	40	22.54	36	1.10	1.93	0.57
186	Malta	*53.00*	24	35.40	44	*25.26*	30	0.67	1.40	0.48
187	Martinique	*43.00*	42	71.53	22	1.27	128	1.66	56.32	0.03
188	Neth. Antilles	37.23	52	…	…	0.93	139	…	…	0.02
189	Netherlands	*62.11*	14	73.91	16	*32.92*	22	1.19	2.25	0.53
190	New Caledonia	23.69	79	…	…	11.15	51	…	…	0.47
191	New Zealand	*47.14*	34	62.13	28	*28.07*	27	1.32	2.21	0.60
192	Northern Marianas	*39.59*	48	…	…	...	…	…	…	…
193	Norway	72.04	7	82.53	5	59.63	3	1.15	1.38	0.83
194	Portugal	*42.68*	43	77.43	12	*34.94*	18	1.81	2.22	0.82
195	Qatar	27.45	68	29.31	52	6.56	71	1.07	4.47	0.24
196	Réunion	*41.04*	44	…	…	*18.60*	40	…	…	0.45
197	Singapore	*47.14*	33	72.41	19	60.52	2	1.54	1.20	1.28
198	Slovenia	40.09	45	75.98	13	30.08	25	1.90	2.53	0.75
199	Spain	*43.11*	41	65.53	26	*18.27*	41	1.52	3.59	0.42
200	Sweden	73.91	5	79.03	9	51.63	4	1.07	1.53	0.70
201	Switzerland	*71.79*	8	72.38	20	*40.40*	12	1.01	1.79	0.56
202	Taiwan, China	*57.34*	19	96.55	2	34.90	19	1.68	2.77	0.61
203	United Arab Emirates	39.69	47	71.97	21	33.92	20	1.81	2.12	0.85
204	United Kingdom	*58.80*	16	78.28	10	*39.95*	13	1.33	1.96	0.68
205	United States	66.45	9	44.42	39	49.95	6	0.67	0.89	0.75
206	Virgin Islands (US)	*56.37*	21	…	…	*10.03*	55	…	…	0.18
	High Income	**59.72**		**62.07**		**40.39**		**1.04**	**1.54**	**0.68**
	WORLD	**17.08**		**15.61**		**8.28**		**0.91**	**1.89**	**0.48**
	Africa	**2.61**		**5.90**		**0.84**		**2.26**	**7.02**	**0.32**
	Americas	**35.21**		**20.80**		**21.68**		**0.59**	**0.96**	**0.62**
	Asia	**10.79**		**20.20**		**4.38**		**1.87**	**4.61**	**0.41**
	Europe	**40.62**		**48.30**		**18.45**		**1.19**	**2.62**	**0.45**
	Oceania	**40.02**		**22.80**		**27.72**		**0.57**	**0.82**	**0.69**

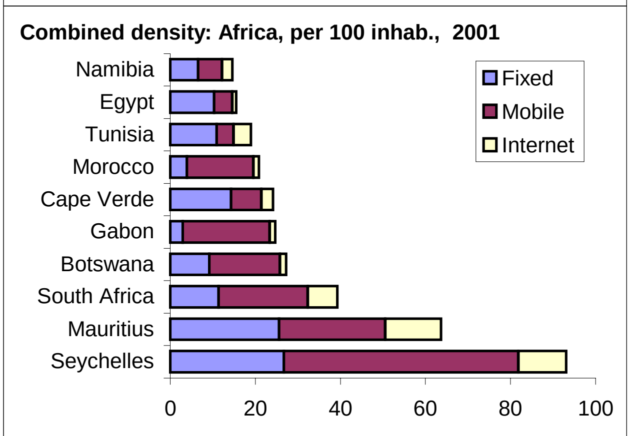
8. Network Penetration

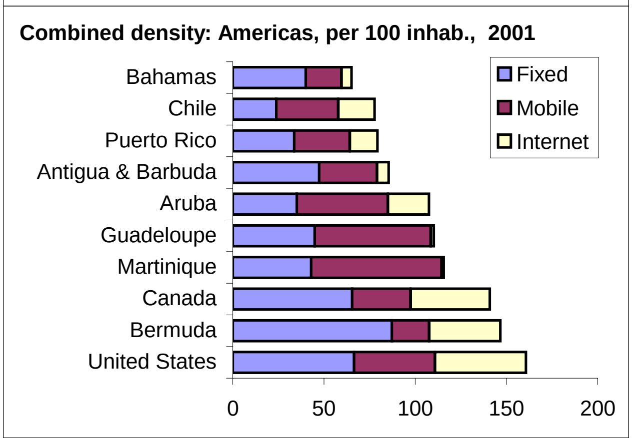


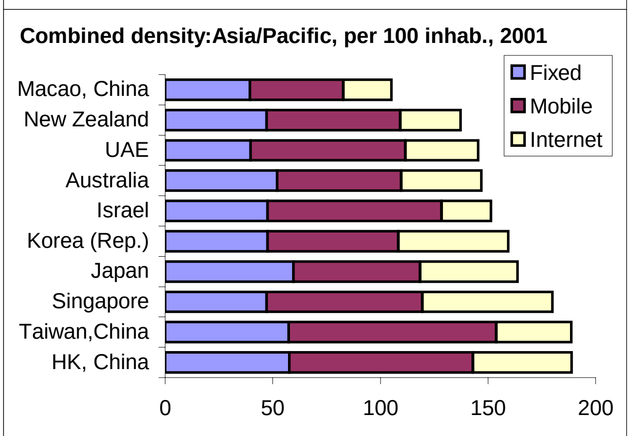


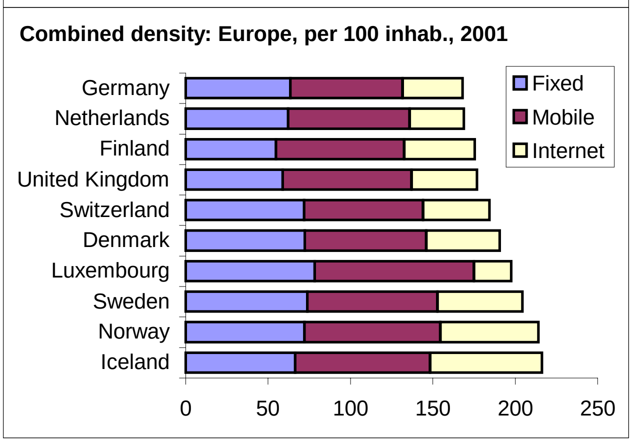






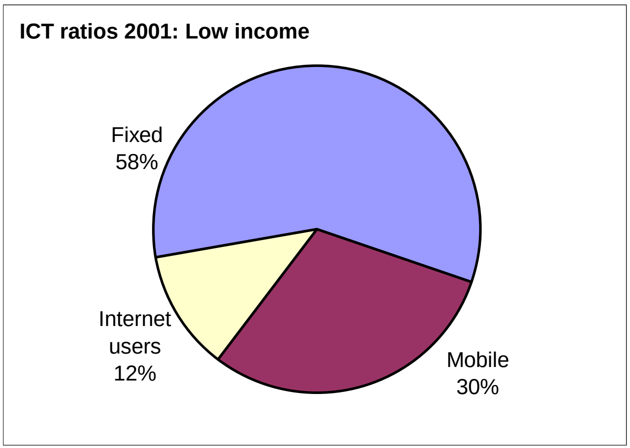


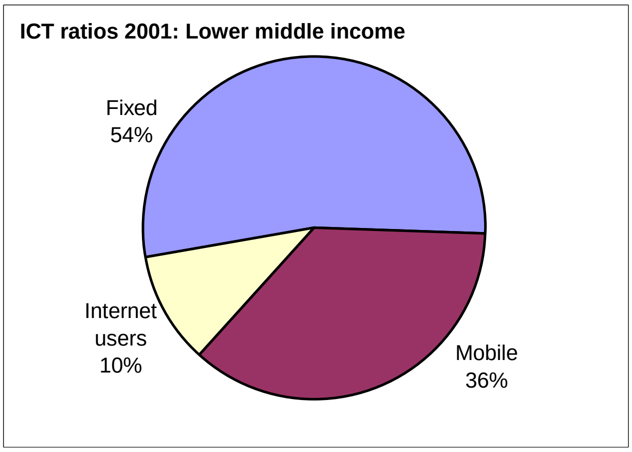


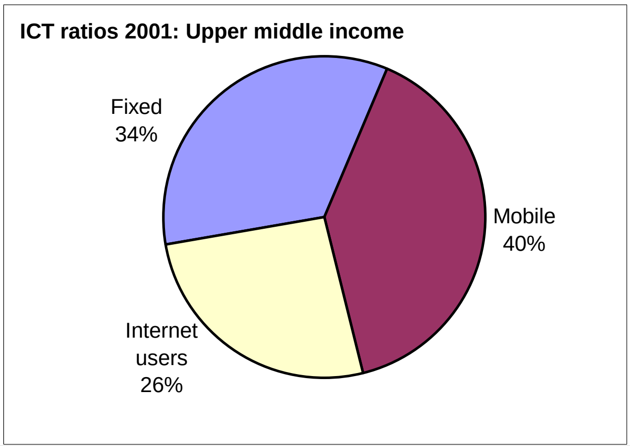


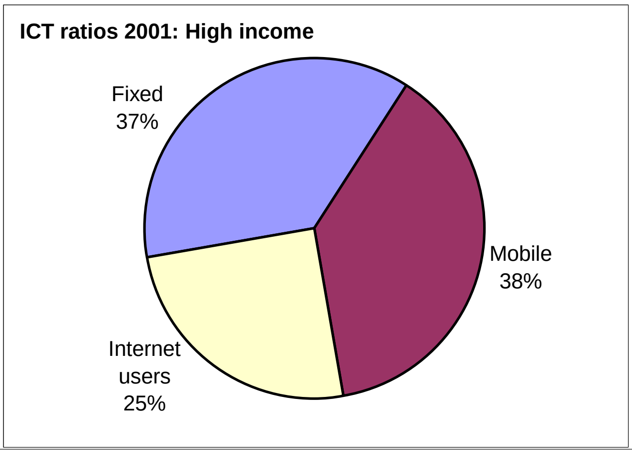
Note: Combined density values reflect the sum of mobile subscribers, fixed lines, and Internet users per 100 inhabitants.

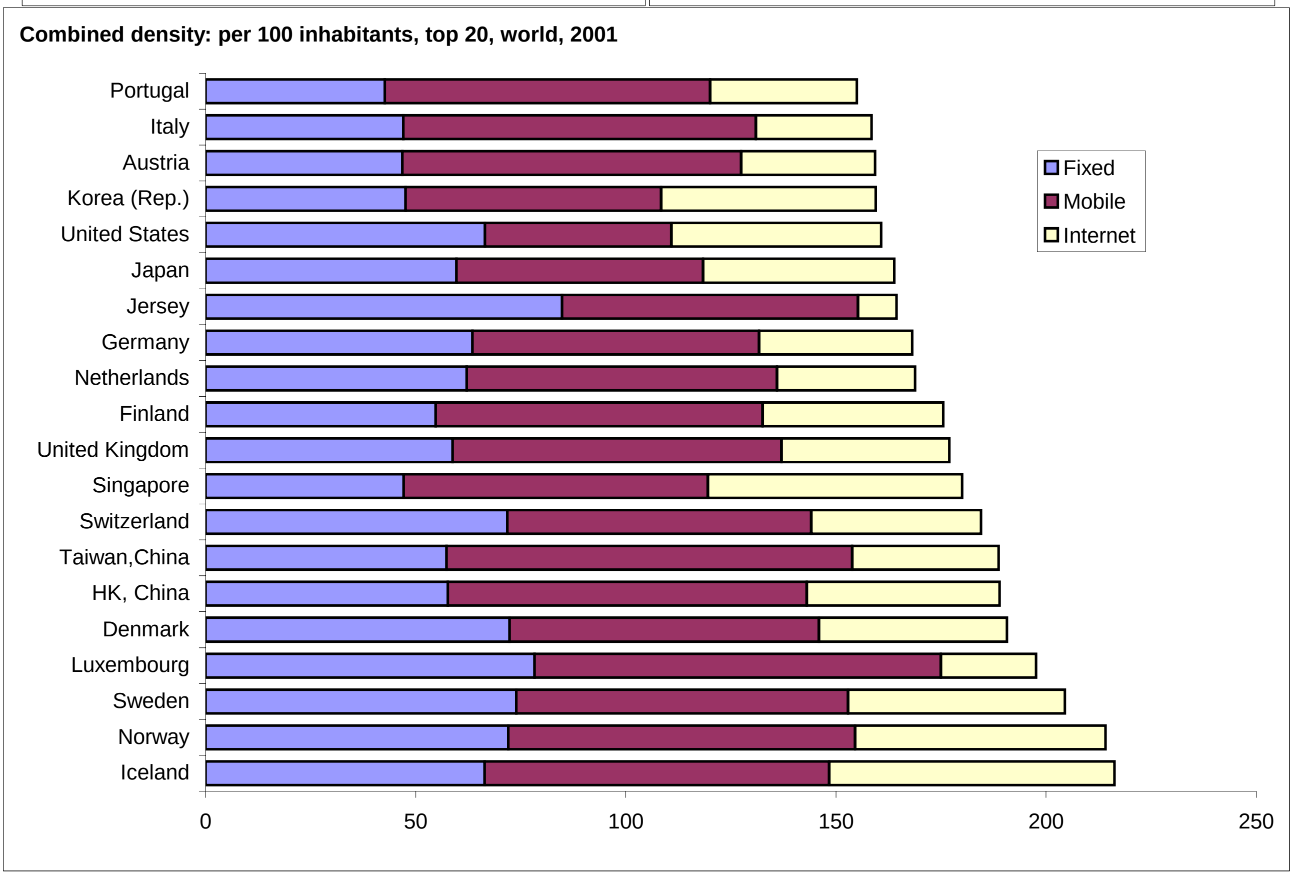
8. Network Penetration











Note: Combined density values reflect the sum of mobile subscribers, fixed lines, and Internet users per 100 inhabitants.

9. Intelligent Networks

		Broadband Subscribers					ISDN	
		Total (k)	of which (k)			per 100 inhabitants	Total (k)	per 100 inhabitants
			DSL	Cable	Other			
		2001	2001	2001	2001	2001	2001	2001
1	Afghanistan	-	-	-	-	-	-	-
2	Angola	-	-	-	-	-	-	-
3	Armenia	-	-	-	-	-	-	-
4	Azerbaijan	-	-	-	-	-	-	-
5	Bangladesh	-	-	-	-	-	-	-
6	Benin	-	-	-	-	-	-	-
7	Bhutan	-	-	-	-	-	-	-
8	Burkina Faso	-	-	-	-	-	-	-
9	Burundi	-	-	-	-	-	-	-
10	Cambodia	-	-	-	-	-	-	-
11	Cameroon	-	-	-	-	-	-	-
12	Central African Rep.	-	-	-	-	-	-	-
13	Chad	-	-	-	-	-	-	-
14	Comoros	-	-	-	-	-	-	-
15	Congo	-	-	-	-	-	-	-
16	Côte d'Ivoire	-	-	-	-	-	1.91	0.01
17	D.P.R. Korea	-	-	-	-	-	-	-
18	D.R. Congo	-	-	-	-	-	...	...
19	Eritrea	-	-	-	-	-	-	-
20	Ethiopia	-	-	-	-	-	-	-
21	Gambia	-	-	-	-	-	-	-
22	Georgia	-	-	-	-	-	...	...
23	Ghana	-	-	-	-	-	-	-
24	Guinea	-	-	-	-	-	-	-
25	Guinea-Bissau	-	-	-	-	-	-	-
26	Haiti	-	-	-	-	-	-	-
27	India	50.00	20.00	30.00	-	0.01	29.23	-
28	Indonesia	15.00	10.00	5.00	-	0.01	4.29	-
29	Kenya	-	-	-	-	-	-	-
30	Kyrgyzstan	-	-	-	-	-	...	...
31	Lao P.D.R.	-	-	-	-	-	-	-
32	Lesotho	-	-	-	-	-	-	-
33	Liberia	-	-	-	-	-	-	-
34	Madagascar	-	-	-	-	-	0.14	-
35	Malawi	-	-	-	-	-	-	-
36	Mali	-	-	-	-	-	-	-
37	Mauritania	-	-	-	-	-	-	-
38	Moldova	-	-	-	-	-	0.17	-
39	Mongolia	-	-	-	-	-	0.03	-
40	Mozambique	-	-	-	-	-	-	-
41	Myanmar	-	-	-	-	-	0.09	-
42	Nepal	-	-	-	-	-	-	-
43	Nicaragua	-	-	-	-	-	-	-
44	Niger	-	-	-	-	-	-	-
45	Nigeria	-	-	-	-	-	-	-
46	Pakistan	-	-	-	-	-	...	...
47	Rwanda	-	-	-	-	-	0.25	-
48	S. Tomé & Principe	-	-	-	-	-	0.06	0.04
49	Senegal	-	-	-	-	-	2.47	0.03
50	Sierra Leone	-	-	-	-	-	-	-
51	Solomon Islands	-	-	-	-	-	-	-
52	Somalia	-	-	-	-	-	-	-
53	Sudan	-	-	-	-	-	0.25	-
54	Tajikistan	-	-	-	-	-	-	-
55	Tanzania	-	-	-	-	-	-	-
56	Togo	-	-	-	-	-	0.11	-
57	Uganda	-	-	-	-	-	0.05	-
58	Ukraine	-	-	-	-	-	...	...
59	Uzbekistan	-	-	-	-	-	-	-
60	Viet Nam	-	-	-	-	-	-	-
61	Yemen	-	-	-	-	-	0.25	-
62	Zambia	-	-	-	-	-	-	-
63	Zimbabwe	-	-	-	-	-	0.24	-
	Low Income	**65.00**	**30.00**	**35.00**	**-**	**-**	**39.52**	**-**

9. Intelligent Networks

		Broadband Subscribers					ISDN	
		Total (k)	of which (k)			per 100		per 100
			DSL	Cable	Other	inhabitants	Total (k)	inhabitants
		2001	2001	2001	2001	2001	2001	2001
64	Albania	-	-	-	-	-	0.03	-
65	Algeria	-	-	-	-	-	-	-
66	Belarus	-	-	-	-	-	0.69	0.01
67	Belize	-	-	-	-	-	-	-
68	Bolivia	-	-	-	-	-	-	-
69	Bosnia	-	-	-	-	-	2.34	0.06
70	Bulgaria	-	-	-	-	-	5.40	0.07
71	Cape Verde	-	-	-	-	-	0.57	0.13
72	China	203.00	200.00	3.23	-	0.02	1 084.75	0.08
73	Colombia	-	-	-	-	-	88.73	0.21
74	Cuba	-	-	-	-	-	-	-
75	Djibouti	-	-	-	-	-	0.15	0.02
76	Dominican Rep.	-	-	-	-	-	0.30	-
77	Ecuador	-	-	-	-	-	0.12	-
78	Egypt	-	-	-	-	-	3.06	-
79	El Salvador	-	-	-	-	-	0.11	-
80	Equatorial Guinea	-	-	-	-	-	-	-
81	Fiji	-	-	-	-	-	-	-
82	Guatemala	-	-	-	-	-	1.20	0.01
83	Guyana	-	-	-	-	-	-	-
84	Honduras	-	-	-	-	-	-	-
85	Iran (I.R.)	-	-	-	-	-	-	-
86	Iraq	-	-	-	-	-	-	-
87	Jamaica	-	-	-	-	-	0.12	-
88	Jordan	-	-	-	-	-	1.81	0.03
89	Kazakhstan	-	-	-	-	-	-	-
90	Kiribati	-	-	-	-	-	-	-
91	Latvia	-	-	-	-	-	5.01	0.21
92	Lithuania	-	-	-	-	-	6.56	0.18
93	Maldives	-	-	-	-	-	-	-
94	Marshall Islands	-	-	-	-	-	-	-
95	Micronesia	-	-	-	-	-	-	-
96	Morocco	-	-	-	-	-	10.00	0.03
97	Namibia	-	-	-	-	-	2.23	0.12
98	Palestine	-	-	-	-	-	0.42	...
99	Papua New Guinea	-	-	-	-	-	-	-
100	Paraguay	-	-	-	-	-	0.01	-
101	Peru	-	-	-	-	-	22.50	0.09
102	Philippines	10.00	10.00	-	-	-	0.95	0.00
103	Romania	-	-	-	-	-	2.26	0.01
104	Russia	5.00	1.00	-	-	-	63.60	0.04
105	Samoa	-	-	-	-	-	0.00	-
106	Sri Lanka	-	-	-	-	-	1.10	0.01
107	St. Vincent	-	-	-	-	-	0.01	0.01
108	Suriname	-	-	-	-	-	0.04	0.01
109	Swaziland	-	-	-	-	-	0.02	-
110	Syria	-	-	-	-	-	0.25	-
111	TFYR Macedonia	-	-	-	-	-	4.09	0.20
112	Thailand	1.61	0.70	0.90	-	-	4.33	0.01
113	Tonga	-	-	-	-	-	-	-
114	Tunisia	-	-	-	-	-	0.64	0.01
115	Turkmenistan	-	-	-	-	-	0.02	-
116	Vanuatu	-	-	-	-	-	-	-
117	Yugoslavia	-	-	-	-	-	6.65	0.06
	Lower Middle Income	**219.61**	**211.70**	**4.13**	**-**	**0.00**	**1 320.06**	**0.04**

9. Intelligent Networks

		Broadband Subscribers					ISDN	
		Total (k)	of which (k)			per 100		per 100
			DSL	Cable	Other	inhabitants	Total (k)	inhabitants
		2001	2001	2001	2001	2001	2001	2001
118	Antigua & Barbuda	-	-	-	-	-	0.35	0.44
119	Argentina	83.00	39.00	44.00	-	0.22	…	…
120	Bahrain	-	-	-	-	-	1.53	0.22
121	Botswana	-	-	-	-	-	-	-
122	Brazil	303.00	243.00	60.00	-	0.18	-	-
123	Chile	59.98	-	-	-	0.39	…	…
124	Costa Rica	-	-	-	-	-	1.76	0.04
125	Croatia	-	-	-	-	-	0.59	0.01
126	Czech Republic	6.20	-	6.20	-	0.06	84.00	0.82
127	Dominica	-	-	-	-	-	-	-
128	Estonia	*10.01*	*10.01*	-	-	*0.70*	11.10	0.78
129	Gabon	-	-	-	-	-	-	-
130	Grenada	-	-	-	-	-	-	-
131	Guadeloupe	-	-	-	-	-	4.50	0.98
132	Hungary	20.00	6.20	13.80	-	0.20	103.66	1.04
133	Korea (Rep.)	7 805.52	4 452.59	2 723.33	629.61	16.35	134.76	0.28
134	Lebanon	-	-	-	-	-	-	-
135	Libya	-	-	-	-	-	-	-
136	Malaysia	4.00	4.00	-	-	0.02	34.51	0.15
137	Mauritius	-	-	-	-	-	1.41	0.12
138	Mayotte	-	-	-	-	-	0.26	0.18
139	Mexico	50.00	29.85	20.00	-	0.05	14.85	0.01
140	Oman	-	-	-	-	-	-	-
141	Panama	-	-	-	-	-	0.24	0.01
142	Poland	12.00	2.00	10.00	-	0.03	57.16	0.15
143	Puerto Rico	-	-	-	-	-	0.34	0.01
144	Saudi Arabia	-	-	-	-	-	-	-
145	Seychelles	-	-	-	-	-	0.17	0.21
146	Slovak Republic	-	-	-	-	-	11.91	0.22
147	South Africa	-	-	-	-	-	24.11	0.06
148	St. Kitts and Nevis	-	-	-	-	-	-	-
149	St. Lucia	-	-	-	-	-	…	…
150	Trinidad & Tobago	-	-	-	-	-	0.16	0.01
151	Turkey	4.00	4.00	-	-	0.01	8.69	0.01
152	Uruguay	-	-	-	-	-	1.91	0.06
153	Venezuela	31.98	17.00	-	-	0.13	-	-
	Upper Middle Income	**8 389.68**	**4 807.65**	**2 877.33**	**629.61**	**0.51**	**497.97**	**0.18**

9. Intelligent Networks

		Broadband Subscribers					ISDN	
		Total (k)	of which (k)			per 100 inhabitants	Total (k)	per 100 inhabitants
			DSL	Cable	Other			
		2001	2001	2001	2001	2001	2001	2001
154	Andorra	-	-	-	-	-	…	…
155	Aruba	-	-	-	-	-	0.49	0.46
156	Australia	122.80	26.60	92.50	-	0.64	…	…
157	Austria	241.70	100.60	141.10	-	2.97	339.90	4.18
158	Bahamas	-	-	-	-	-	-	-
159	Barbados	-	-	-	-	-	0.39	0.15
160	Belgium	459.00	230.00	-	...	4.46	437.20	4.25
161	Bermuda	-	-	-	-	-	1.16	1.80
162	Brunei Darussalam	-	-	-	-	-	…	…
163	Canada	2 836.05	1 086.05	1 750.00	-	9.45	113.28	0.37
164	Cyprus	-	-	-	-	-	14.08	2.08
165	Denmark	223.00	150.00	73.00	-	4.16	407.72	7.60
166	Faroe Islands	-	-	-	-	-	-	-
167	Finland	52.00	32.50	19.67	-	1.00	207.65	4.00
168	France	600.00	408.39	-	-	1.01	2 150.00	3.62
169	French Guiana	-	-	-	-	-	1.73	0.91
170	French Polynesia	-	-	-	-	-	1.11	0.47
171	Germany	2 100.00	2 070.00	30.00	-	2.55	9 120.00	11.07
172	Greece	*0.30*	*0.30*	-	-	*0.00*	100.92	0.95
173	Greenland	-	-	-	-	-	1.00	1.77
174	Guam	-	-	-	-	-	…	…
175	Guernsey	-	-	-	-	-	1.30	2.07
176	Hong Kong, China	623.00	...	160.00	...	9.22	13.51	0.20
177	Iceland	5.00	5.00	-	-	1.74	18.00	6.27
178	Ireland	*0.30*	*0.30*	-	-	*0.01*	43.37	1.13
179	Israel	40.00	40.00	-	-	0.62	56.80	0.87
180	Italy	390.00	390.00	-	-	0.67	2 207.95	3.81
181	Japan	3 835.00	2 378.80	1 456.00	-	3.01	10 330.00	8.11
182	Jersey	-	-	-	-	-	…	…
183	Kuwait	-	-	-	-	-	-	-
184	Luxembourg	1.22	1.22	-	-	0.27	41.09	9.19
185	Macao, China	-	-	-	-	-	0.24	0.05
186	Malta	-	-	-	-	-	0.86	0.22
187	Martinique	-	-	-	-	-	4.63	1.16
188	Neth. Antilles	-	-	-	-	-	-	-
189	Netherlands	466.20	138.00	328.20	-	2.90	1 100.00	6.83
190	New Caledonia	-	-	-	-	-	1.90	0.86
191	New Zealand	17.27	16.00	1.27	-	0.44	…	…
192	Northern Marianas	-	-	-	-	-	-	-
193	Norway	88.54	24.00	-	-	1.96	703.84	15.54
194	Portugal	96.32	2.47	93.84	-	0.94	251.36	2.44
195	Qatar	-	-	-	-	-	1.30	0.21
196	Réunion	-	-	-	-	-	8.19	1.12
197	Singapore	151.00	73.00	78.00	-	3.66	23.16	0.56
198	Slovenia	-	-	-	-	-	76.29	3.82
199	Spain	224.18	187.03	37.16	-	0.56	646.11	1.60
200	Sweden	356.50	241.00	115.50	-	4.00	270.40	3.03
201	Switzerland	107.30	40.00	67.30	-	1.49	726.34	10.06
202	Taiwan, China	1 130.00	915.00	210.00	-	5.04	37.48	0.17
203	United Arab Emirates	-	-	-	-	-	21.98	0.83
204	United Kingdom	479.20	170.00	309.20	-	0.80	855.00	1.42
205	United States	12 793.00	3 948.00	7 060.00	-	4.49	2 070.80	0.72
206	Virgin Islands (US)	-	-	-	-	-	-	-
	High Income	**27 438.88**	**12 674.25**	**12 022.73**	**-**	**1.28**	**32 408.51**	**2.74**
	WORLD	**36 113.17**	**17 723.60**	**14 939.18**	**629.61**	**0.61**	**34 266.06**	**0.80**
	Africa	**-**	**-**	**-**	**-**	**-**	**56.30**	**0.05**
	Americas	**14 272.28**	**4 928.05**	**7 757.64**	**-**	**0.35**	**2 329.69**	**0.22**
	Asia	**9 466.75**	**5 309.44**	**3 048.11**	**315.05**	**0.82**	**11 782.80**	**0.33**
	Europe	**12 250.41**	**7 446.96**	**4 052.01**	**314.55**	**0.65**	**20 094.27**	**2.77**
	Oceania	**123.73**	**39.15**	**81.42**	**-**	**0.07**	**3.01**	**0.12**

Note: Broadband (DSL, cable, other) data in italics are from the OECD, end of June, 2001.
All other broadband data is combined from the OECD and ITU. See http://www.oecd.org/pdf/M00020000/M00020255.pdf
ISDN data is from the ITU World Telecommunicaton Indicators Database

10. ITU Mobile/Internet Index

		Total		Infrastructure		Usage		Market	
		Score	*Rank*	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*
		2001	*2001*	*2001*	*2001*	*2001*	*2001*	*2001*	*2001*
1	Afghanistan	…	…	…	…	…	…	33.33	143
2	Angola	24.53	83	0.25	181	32.86	99	64.77	62
3	Armenia	16.96	142	2.39	129	29.07	121	34.00	142
4	Azerbaijan	20.47	116	3.09	118	38.21	46	37.50	129
5	Bangladesh	15.78	152	0.15	192	34.71	81	28.13	159
6	Benin	10.29	171	0.44	168	24.64	150	15.63	176
7	Bhutan	17.67	139	0.73	159	38.06	47	31.17	153
8	Burkina Faso	21.10	105	0.19	188	33.78	90	50.25	99
9	Burundi	…	…	0.11	195	…	…	79.55	40
10	Cambodia	19.22	129	0.26	179	26.35	139	50.00	100
11	Cameroon	17.45	141	0.50	164	18.51	168	50.28	98
12	Central African Rep.	22.67	97	0.11	194	25.39	145	65.06	60
13	Chad	14.51	159	0.08	198	26.33	140	31.57	151
14	Comoros	14.40	163	0.36	174	41.25	29	15.63	176
15	Congo	…	…	0.81	157	…	…	57.14	77
16	Côte d'Ivoire	20.89	111	1.04	153	21.52	158	59.95	70
17	D.P.R. Korea	…	…	…	…	…	…	12.50	182
18	D.R. Congo	22.25	102	0.04	201	…	…	66.67	56
19	Eritrea	24.38	85	0.23	184	49.57	7	47.47	109
20	Ethiopia	14.87	155	0.09	196	26.47	138	32.83	147
21	Gambia	18.22	132	1.17	149	45.53	14	25.00	167
22	Georgia	29.54	60	3.55	113	34.94	76	76.14	46
23	Ghana	28.48	64	0.40	170	30.31	114	82.83	33
24	Guinea	24.51	84	0.23	186	39.62	39	57.95	75
25	Guinea-Bissau	…	…	0.25	182	30.07	116	86.91	21
26	Haiti	…	…	0.44	167	…	…	88.89	16
27	India	30.75	54	0.72	160	45.30	15	76.26	45
28	Indonesia	29.93	58	12.39	70	39.38	40	55.56	82
29	Kenya	23.74	88	0.69	161	36.02	68	57.58	76
30	Kyrgyzstan	25.61	77	1.62	139	36.83	60	62.37	64
31	Lao P.D.R.	16.70	143	0.26	180	28.76	127	37.50	129
32	Lesotho	18.41	131	0.40	169	33.58	93	39.26	126
33	Liberia	…	…	0.05	200	…	…	12.50	182
34	Madagascar	30.47	57	0.24	183	28.48	130	92.93	9
35	Malawi	27.68	67	0.17	190	32.34	103	78.03	43
36	Mali	23.11	94	0.17	191	28.48	129	63.64	63
37	Mauritania	23.46	90	0.37	173	32.74	100	60.35	69
38	Moldova	19.79	125	3.08	119	27.55	135	45.45	113
39	Mongolia	23.86	87	2.04	133	30.41	113	60.95	68
40	Mozambique	20.12	120	0.23	185	26.49	137	53.54	88
41	Myanmar	10.45	170	0.11	193	24.92	149	16.67	175
42	Nepal	20.43	117	0.27	178	35.46	72	45.71	112
43	Nicaragua	20.36	118	1.13	150	23.70	154	55.45	84
44	Niger	18.12	136	0.05	199	28.61	128	43.75	119
45	Nigeria	26.74	70	0.28	177	24.30	152	82.10	36
46	Pakistan	27.19	68	0.50	165	33.28	96	74.49	49
47	Rwanda	16.61	145	0.20	187	37.92	51	28.13	159
48	S. Tomé & Principe	…	…	1.94	135	…	…	29.17	155
49	Senegal	20.62	114	1.31	146	40.39	33	39.50	125
50	Sierra Leone	17.66	140	0.17	189	20.29	163	50.00	100
51	Solomon Islands	14.98	154	1.18	148	28.97	122	28.57	156
52	Somalia	22.96	96	0.09	197	25.00	147	66.67	56
53	Sudan	25.26	80	0.31	175	34.87	78	65.55	59
54	Tajikistan	14.45	161	0.62	162	19.07	167	37.50	129
55	Tanzania	19.81	124	0.39	171	22.10	156	56.36	80
56	Togo	22.51	99	0.93	155	38.94	43	49.24	106
57	Uganda	26.42	73	0.30	176	30.95	108	74.14	50
58	Ukraine	19.41	127	4.42	107	35.45	73	33.33	143
59	Uzbekistan	15.00	153	1.09	152	20.33	162	37.50	129
60	Viet Nam	16.68	144	1.04	154	31.32	106	33.33	143
61	Yemen	18.14	135	0.47	166	38.27	45	33.33	143
62	Zambia	21.55	103	0.38	172	33.95	86	51.52	95
63	Zimbabwe	19.88	122	0.86	156	33.34	95	44.44	115
	Low Income	**20.86**		**0.94**		**31.55**		**50.06**	

10. ITU Mobile/Internet Index

		Total		Infrastructure		Usage		Market	
		Score	*Rank*	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*
		2001	*2001*	*2001*	*2001*	*2001*	*2001*	*2001*	*2001*
64	Albania	23.15	93	2.07	132	28.78	126	59.66	71
65	Algeria	16.45	147	1.09	151	35.51	71	28.13	159
66	Belarus	19.36	128	4.96	102	33.16	97	34.38	140
67	Belize	19.81	123	6.89	95	17.98	170	47.50	108
68	Bolivia	20.23	119	2.44	127	17.57	172	58.45	74
69	Bosnia	20.93	109	2.65	125	34.75	80	43.69	120
70	Bulgaria	25.71	76	9.35	84	36.65	63	47.47	109
71	Cape Verde	26.47	72	3.50	114	37.71	54	61.18	65
72	China	31.95	47	14.95	63	36.79	61	61.11	66
73	Colombia	30.57	56	4.80	103	30.61	112	82.07	37
74	Cuba	13.37	165	1.20	147	10.08	183	41.00	123
75	Djibouti	11.65	168	0.55	163	26.06	141	19.44	173
76	Dominican Rep.	33.81	41	4.06	109	35.20	75	91.92	10
77	Ecuador	14.56	158	3.00	120	7.28	184	44.95	114
78	Egypt	21.02	107	2.26	130	37.66	56	41.92	122
79	El Salvador	30.97	51	3.60	112	30.14	115	86.55	22
80	Equatorial Guinea	…	…	0.76	158	…	…	32.78	148
81	Fiji	12.53	167	4.46	105	25.58	144	15.63	176
82	Guatemala	24.77	81	2.77	122	14.51	177	79.05	41
83	Guyana	25.38	79	4.46	106	38.04	48	54.55	86
84	Honduras	18.15	134	1.36	145	29.82	119	40.06	124
85	Iran (I.R.)	13.19	166	3.72	111	17.56	173	27.78	164
86	Iraq	…	…	…	…	…	…	12.50	182
87	Jamaica	26.42	74	8.10	89	20.52	161	68.95	54
88	Jordan	29.30	61	11.59	76	40.55	31	53.45	90
89	Kazakhstan	26.60	71	2.40	128	31.05	107	70.56	53
90	Kiribati	16.22	149	1.90	136	32.51	101	28.57	156
91	Latvia	31.11	50	14.83	64	39.23	41	55.56	82
92	Lithuania	32.33	46	21.35	45	27.61	134	59.00	73
93	Maldives	17.72	138	3.20	116	32.99	98	31.50	152
94	Marshall Islands	16.07	150	2.72	124	30.71	110	28.13	159
95	Micronesia	16.32	148	2.75	123	34.78	79	25.00	167
96	Morocco	23.26	91	2.81	121	33.80	88	53.64	87
97	Namibia	19.47	126	2.58	126	19.18	166	53.54	88
98	Palestine	…	…	…	…	…	…	…	…
99	Papua New Guinea	14.71	157	1.75	138	17.98	169	37.37	136
100	Paraguay	18.00	137	3.88	110	13.76	179	50.51	97
101	Peru	34.30	39	17.70	54	11.00	182	90.77	13
102	Philippines	40.49	33	14.08	66	33.80	89	100.00	1
103	Romania	37.11	37	31.82	35	40.81	30	44.00	117
104	Russia	30.85	52	16.40	58	46.74	11	43.89	118
105	Samoa	14.74	156	1.43	143	23.98	153	32.14	150
106	Sri Lanka	29.19	62	1.48	142	37.70	55	76.09	47
107	St. Vincent	22.31	101	6.76	96	36.85	59	38.89	127
108	Suriname	22.33	100	5.64	99	25.25	146	52.78	91
109	Swaziland	14.46	160	1.58	140	29.66	120	25.00	167
110	Syria	11.28	169	1.88	137	19.50	164	21.88	171
111	TFYR Macedonia	20.65	113	6.12	98	37.87	52	32.50	149
112	Thailand	27.94	66	15.21	62	36.90	58	44.44	115
113	Tonga	16.59	146	2.11	131	12.14	181	50.00	100
114	Tunisia	18.18	133	3.31	115	29.98	118	36.11	137
115	Turkmenistan	…	…	1.38	144	…	…	37.50	129
116	Vanuatu	14.41	162	1.52	141	26.02	142	28.57	156
117	Yugoslavia	26.98	69	7.37	94	28.19	131	65.00	61
	Lower Middle Income	**22.47**		**5.78**		**28.65**		**48.06**	

10. ITU Mobile/Internet Index

		Total		Infrastructure		Usage		Market	
		Score	Rank	Score	Rank	Score	Rank	Score	Rank
		2001	2001	2001	2001	2001	2001	2001	2001
118	Antigua & Barbuda	30.59	55	17.50	56	49.86	6	37.50	129
119	Argentina	32.85	45	7.52	93	20.85	159	95.50	6
120	Bahrain	29.91	59	16.08	60	37.93	50	49.55	105
121	Botswana	24.56	82	4.76	104	36.17	67	52.56	93
122	Brazil	33.11	43	17.70	55	21.89	157	75.14	48
123	Chile	34.24	40	12.28	71	16.69	174	95.71	5
124	Costa Rica	22.58	98	8.70	86	34.03	85	38.89	127
125	Croatia	41.36	32	38.55	29	36.45	64	51.91	94
126	Czech Republic	50.95	24	39.63	26	40.15	36	84.41	30
127	Dominica	20.93	110	7.61	92	32.38	102	36.11	137
128	Estonia	45.39	29	32.72	33	34.89	77	81.23	39
129	Gabon	20.49	115	3.18	117	24.46	151	51.14	96
130	Grenada	20.69	112	8.36	88	37.93	49	28.13	159
131	Guadeloupe	…	…	19.73	47	…	…	…	…
132	Hungary	38.97	34	25.70	41	38.46	44	66.00	58
133	Korea (Rep.)	63.42	7	65.12	3	33.77	91	89.68	14
134	Lebanon	25.43	78	21.95	44	36.40	65	21.43	172
135	Libya	…	…	2.00	134	…	…	15.63	176
136	Malaysia	38.92	35	23.54	42	35.36	74	73.23	51
137	Mauritius	28.23	65	10.43	81	35.82	69	56.25	81
138	Mayotte	…	…	…	…	…	…	…	…
139	Mexico	31.11	49	5.37	100	28.11	132	85.61	27
140	Oman	13.60	164	4.39	108	29.99	117	15.63	176
141	Panama	21.09	106	6.47	97	14.88	176	56.55	78
142	Poland	42.81	31	30.00	39	42.33	24	68.91	55
143	Puerto Rico	…	…	13.53	68	12.44	180	…	…
144	Saudi Arabia	19.93	121	5.09	101	33.42	94	36.11	137
145	Seychelles	33.11	42	16.14	59	39.04	42	61.11	66
146	Slovak Republic	31.83	48	14.18	65	42.57	23	56.41	79
147	South Africa	30.84	53	11.95	74	40.42	32	59.04	72
148	St. Kitts and Nevis	…	…	15.22	61	45.26	16	…	…
149	St. Lucia	…	…	8.48	87	…	…	27.78	164
150	Trinidad & Tobago	23.47	89	7.98	91	27.92	133	50.00	100
151	Turkey	29.11	63	19.66	48	42.75	22	34.34	141
152	Uruguay	21.01	108	9.62	83	17.59	171	47.22	111
153	Venezuela	33.05	44	10.74	80	16.65	175	94.09	8
	Upper Middle Income	**31.12**		**16.05**		**32.40**		**56.02**	

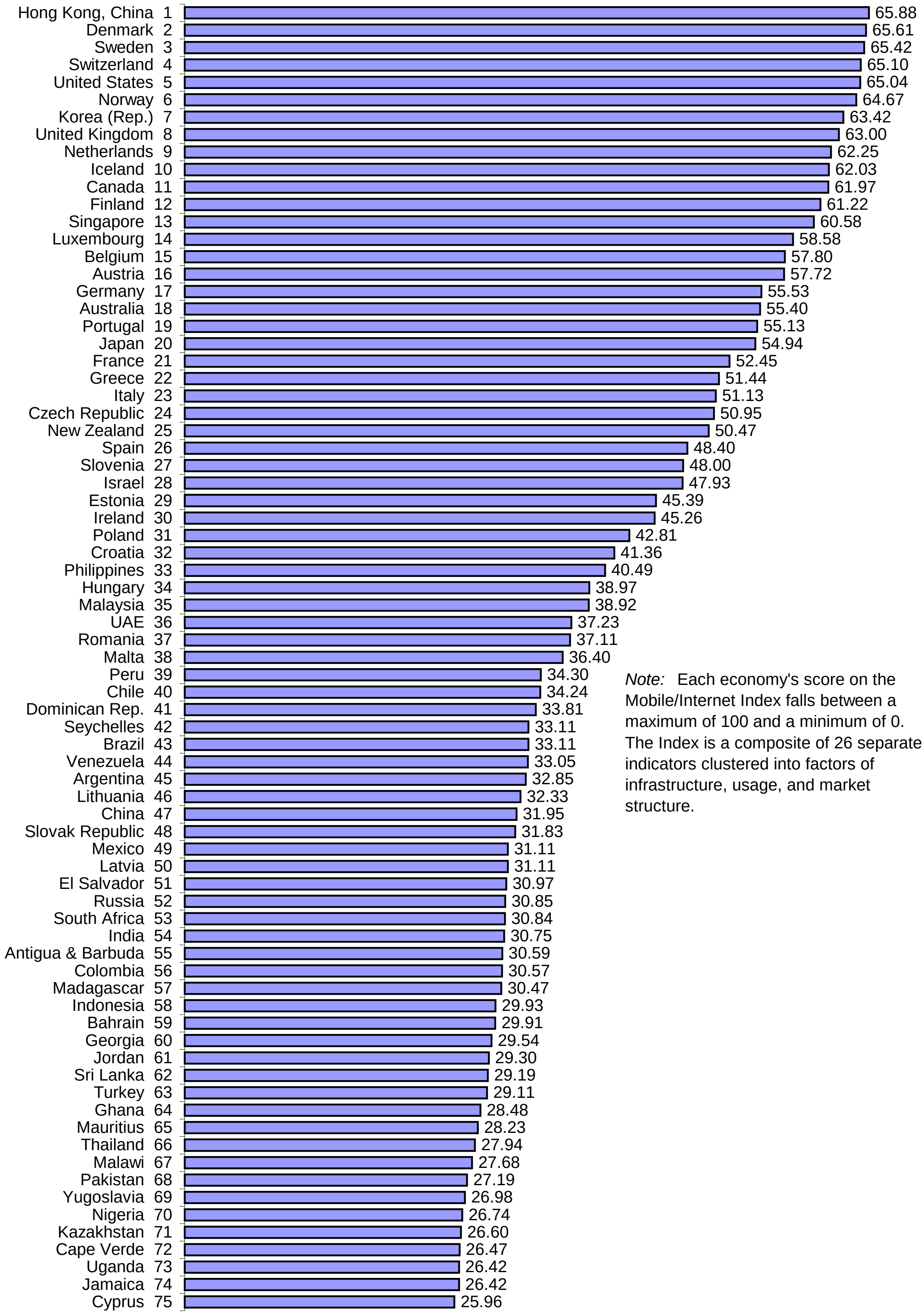
10. ITU Mobile/Internet Index

		Total		Infrastructure		Usage		Market	
		Score	*Rank*	*Score*	*Rank*	*Score*	*Rank*	*Score*	*Rank*
		2001	*2001*	*2001*	*2001*	*2001*	*2001*	*2001*	*2001*
154	Andorra	23.17	92	17.44	57	42.18	25	15.63	176
155	Aruba	…	…	17.97	53	28.81	125	…	…
156	Australia	55.40	18	48.54	19	39.91	38	84.64	29
157	Austria	57.72	16	50.54	17	44.65	17	85.14	28
158	Bahamas	16.01	151	9.67	82	14.30	178	30.40	154
159	Barbados	23.10	95	11.73	75	25.82	143	43.13	121
160	Belgium	57.80	15	54.61	11	34.70	82	87.27	20
161	Bermuda	…	…	39.59	27	59.43	1	…	…
162	Brunei Darussalam	18.83	130	11.18	79	34.19	84	18.75	174
163	Canada	61.97	11	52.57	15	48.26	10	94.50	7
164	Cyprus	25.96	75	22.56	43	33.74	92	25.00	167
165	Denmark	65.61	2	65.37	2	43.60	19	88.09	17
166	Faroe Islands	…	…	31.45	36	19.44	165	…	…
167	Finland	61.22	12	53.76	12	45.88	13	91.50	11
168	France	52.45	21	46.68	22	33.83	87	82.64	35
169	French Guiana	…	…	13.72	67	…	…	…	…
170	French Polynesia	…	…	9.31	85	28.83	124	…	…
171	Germany	55.53	17	50.76	16	37.85	53	82.73	34
172	Greece	51.44	22	38.27	31	43.42	20	85.77	25
173	Greenland	…	…	19.06	49	27.15	136	…	…
174	Guam	…	…	12.42	69	20.73	160	…	…
175	Guernsey	…	…	34.58	32	31.99	104	…	…
176	Hong Kong, China	65.88	1	58.42	8	50.58	4	96.10	3
177	Iceland	62.03	10	56.26	9	51.97	3	83.64	31
178	Ireland	45.26	30	30.94	38	35.53	70	83.64	31
179	Israel	47.93	28	48.32	21	46.10	12	49.00	107
180	Italy	51.13	23	43.47	25	31.56	105	86.05	24
181	Japan	54.94	20	58.42	7	24.93	148	78.00	44
182	Jersey	…	…	30.96	37	…	…	…	…
183	Kuwait	24.31	86	11.50	77	36.76	62	37.50	129
184	Luxembourg	58.58	14	49.95	18	55.37	2	79.04	42
185	Macao, China	…	…	18.07	51	36.18	66	…	…
186	Malta	36.40	38	32.06	34	28.87	123	52.64	92
187	Martinique	…	…	18.27	50	…	…	…	…
188	Neth. Antilles	…	…	8.07	90	…	…	…	…
189	Netherlands	62.25	9	62.94	5	41.28	28	81.82	38
190	New Caledonia	…	…	11.20	78	22.87	155	…	…
191	New Zealand	50.47	25	44.64	24	40.36	34	72.22	52
192	Northern Marianas	…	…	12.10	73	…	…	…	…
193	Norway	64.67	6	64.41	4	41.87	26	88.00	18
194	Portugal	55.13	19	45.72	23	41.30	27	87.78	19
195	Qatar	21.35	104	12.27	72	34.36	83	26.50	166
196	Réunion	…	…	20.30	46	…	…	…	…
197	Singapore	60.58	13	53.65	13	43.71	18	91.31	12
198	Slovenia	48.00	27	48.51	20	39.96	37	55.00	85
199	Spain	48.40	26	38.53	30	30.90	109	85.64	26
200	Sweden	65.42	3	67.62	1	40.26	35	86.18	23
201	Switzerland	65.10	4	60.28	6	50.16	5	89.68	14
202	Taiwan, China	…	…	39.14	28	30.69	111	…	…
203	United Arab Emirates	37.23	36	28.04	40	42.81	21	50.00	100
204	United Kingdom	63.00	8	53.62	14	48.76	9	96.00	4
205	United States	65.04	5	55.59	10	48.97	8	100.00	1
206	Virgin Islands (US)	…	…	18.01	52	36.96	57	…	…
	High Income	**49.43**		**36.10**		**37.70**		**71.41**	
	WORLD	**29.14**		**14.09**		**32.48**		**54.70**	
	Africa	**20.56**		**1.94**		**31.89**		**50.17**	
	Americas	**25.20**		**11.03**		**27.06**		**62.02**	
	Asia	**27.17**		**13.10**		**33.92**		**48.59**	
	Europe	**41.92**		**32.23**		**37.68**		**66.02**	
	Oceania	**20.04**		**10.54**		**27.53**		**39.17**	

Notes: Rankings are based on a scale of 1 being the highest and 206 being the lowest. In the case of missing data, there will be fewer than 206 economies ranked.

10. ITU Mobile/Internet Index

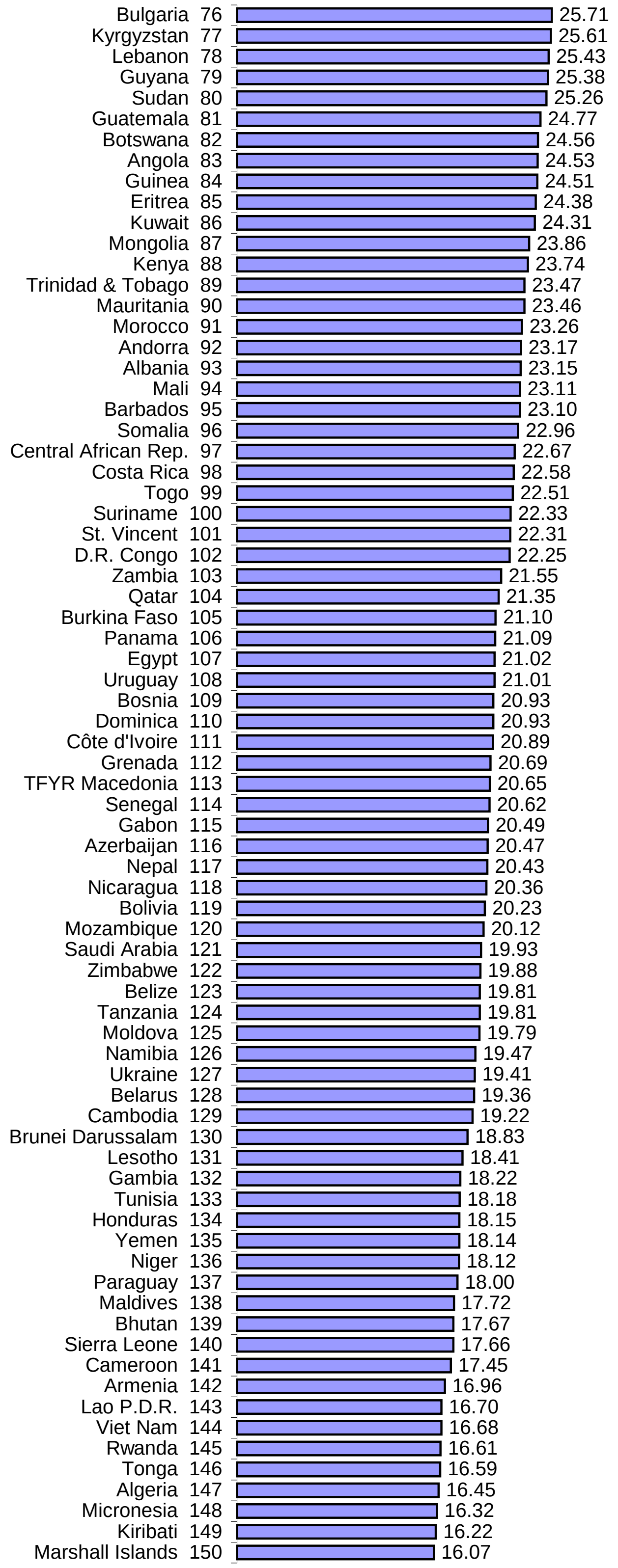
ITU Mobile/Internet Index, economies 1-75, 2001



Note: Each economy's score on the Mobile/Internet Index falls between a maximum of 100 and a minimum of 0. The Index is a composite of 26 separate indicators clustered into factors of infrastructure, usage, and market structure.

10. ITU Mobile/Internet Index

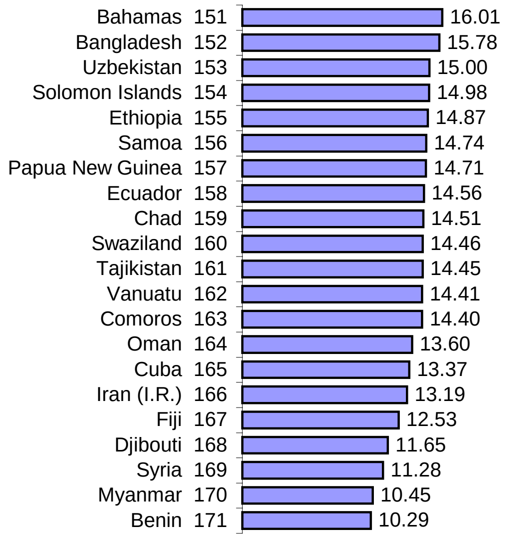
ITU Mobile/Internet Index, economies 76-150, 2001



Note: Each economy's score on the Mobile/Internet Index falls between a maximum of 100 and a minimum of 0. The Index is a composite of 26 separate indicators clustered into factors of infrastructure, usage, and market structure.

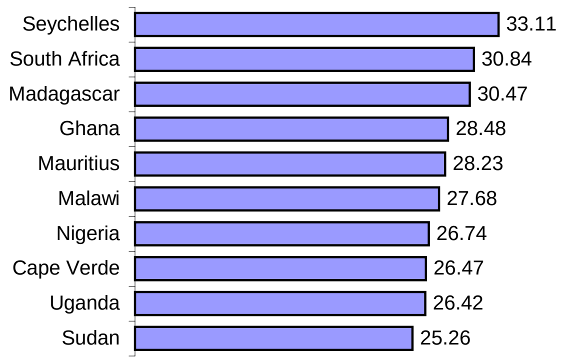
10. ITU Mobile/Internet Index

ITU Mobile/Internet Index, economies 151-171, 2001

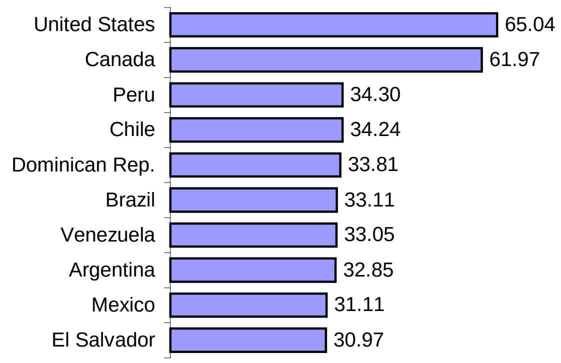


Note: Each economy's score on the Mobile/Internet Index falls between a maximum of 100 and a minimum of 0. The Index is a composite of 26 separate indicators clustered into factors of infrastructure, usage, and market structure.

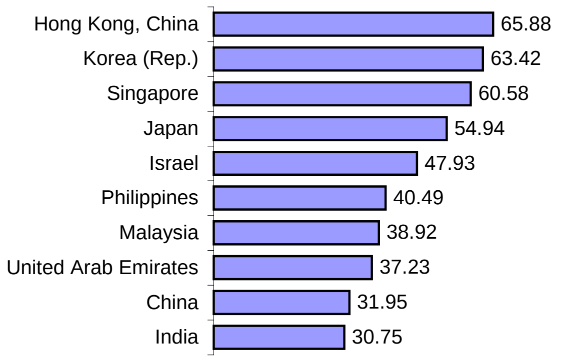
Mobile/Internet Index, top 10: Africa



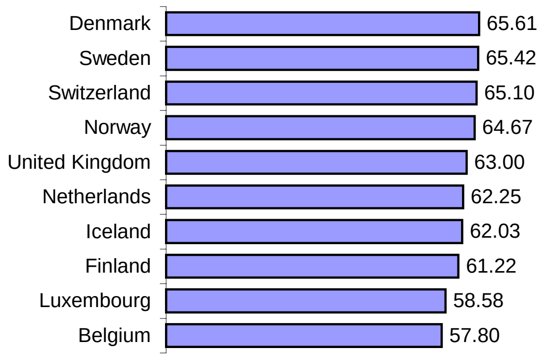
Mobile/Internet Index, top 10: Americas



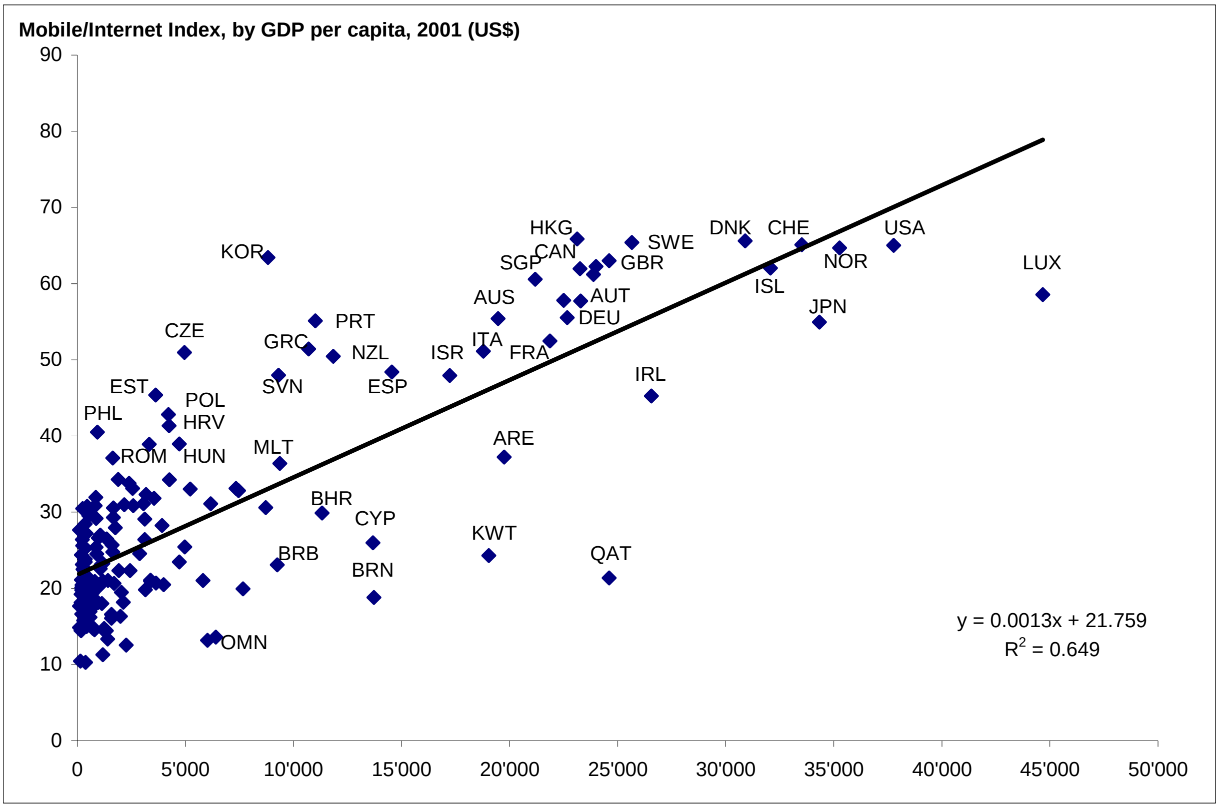
Mobile/Internet Index, top 10: Asia/Pacific

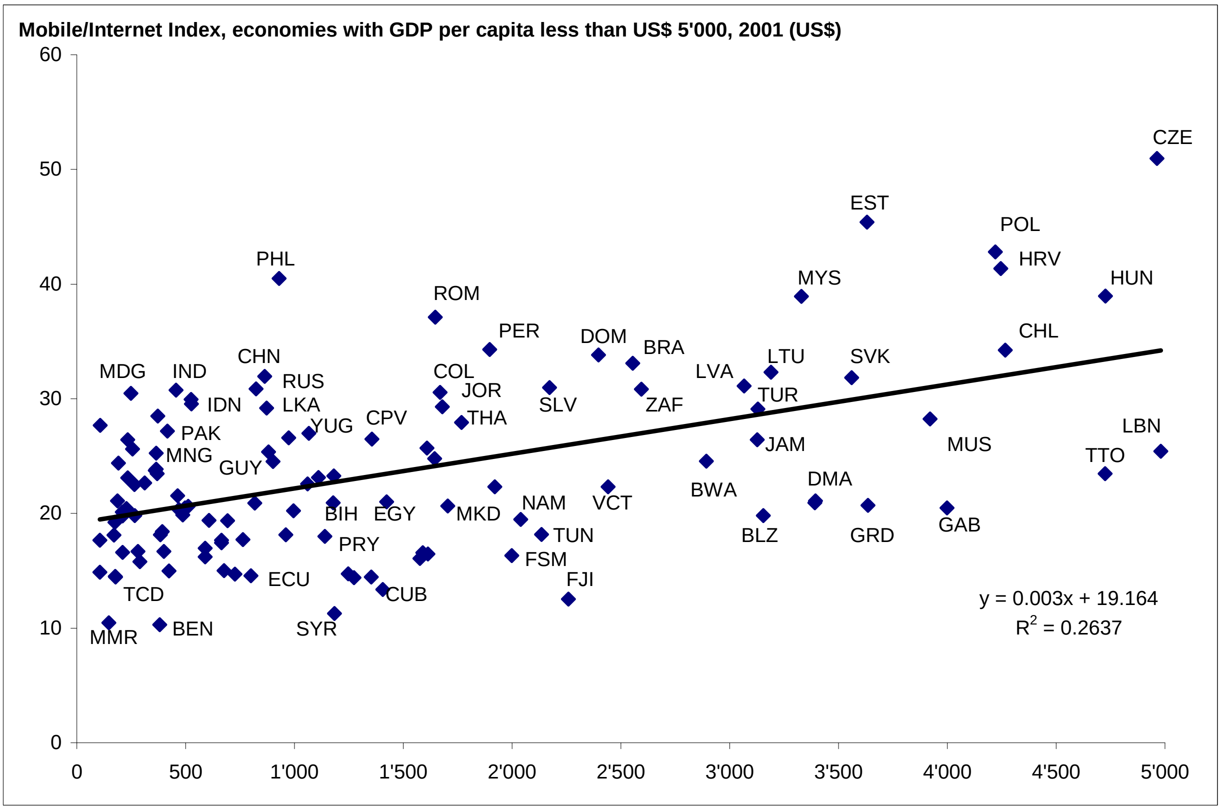


Mobile/Internet Index, top 10: Europe



10. ITU Mobile/Internet Index





Note: Economies on the trend lines are performing as would be predicted according to their GDP per capita. Economies above the lines are outperforming their peers, while those below it are underperforming. For abbreviations, see "List of Economies."

11. Internet Tariffs

		Dial-Up Internet tariffs (US$), 2001 — 30 hours of use per month						
		PSTN monthly subscription	***Peak***			***Off-Peak***		
			PSTN usage	*ISP charge*	*Total*	*PSTN usage*	*ISP charge*	*Total*
1	Afghanistan	...	...	...	...	...	...	...
2	Angola	1.1	9.6	20.0	30.66 *	9.6	20.0	30.66 *
3	Armenia	1.7	66.7	42.0	110.39 *	46.7	42.0	90.38 *
4	Azerbaijan	0.6	172.3	-	172.98	129.2	-	129.83
5	Bangladesh	2.9	19.6	34.5	56.96	19.6	17.3	39.70
6	Benin	3.5	55.6	128.9	188.03	55.6	128.9	188.03
7	Bhutan	2.6	13.4	40.1	55.96	13.4	40.1	55.96
8	Burkina Faso	7.6	50.6	28.8	86.91	50.6	28.8	86.91
9	Burundi	0.6	10.8	...	...	10.8	...	...
10	Cambodia	7.9	17.8	103.8	129.56	17.8	103.8	129.56
11	Cameroon	2.5	33.7	77.2	113.42	33.7	77.2	113.42
12	Central African Rep.	5.5	84.3	165.7	255.55	84.3	165.7	255.55
13	Chad	...	...	...	...	...	...	...
14	Comoros	8.4	84.3	93.6	186.34	84.3	93.6	186.34
15	Congo	...	...	...	...	...	...	...
16	Côte d'Ivoire	5.4	30.3	183.3	218.99	15.2	183.3	203.83
17	D.P.R. Korea	...	...	...	...	...	...	...
18	D.R. Congo	...	...	95.0	...	...	95.0	...
19	Eritrea	2.3	12.6	22.5	37.47	12.6	22.5	37.47
20	Ethiopia	1.0	14.6	94.0	109.57	14.6	94.0	109.57
21	Gambia	2.3	161.8	18.0	182.17	161.8	18.0	182.17
22	Georgia	1.0	-	27.0	27.98	-	20.3	21.31
23	Ghana	0.5	22.5	36.0	59.02 *	22.5	36.0	59.02 *
24	Guinea	2.7	51.6	58.5	112.76	51.6	58.5	112.76
25	Guinea-Bissau	...	...	...	...	...	...	...
26	Haiti	...	...	...	...	...	...	...
27	India	5.6	10.7	10.0	26.26	10.7	10.0	26.26
28	Indonesia	2.7	12.2	12.5	27.37	12.2	12.5	27.37
29	Kenya	3.3	27.6	78.7	109.58	27.6	65.6	96.46
30	Kyrgyzstan	0.6	-	28.4	28.96	-	10.4	10.96
31	Lao P.D.R.	1.3	10.3	50.4	61.94	10.3	50.4	61.94
32	Lesotho	4.3	10.4	12.2	26.95 *	10.4	12.2	26.95 *
33	Liberia	...	...	...	...	...	...	...
34	Madagascar	5.9	53.2	66.5	125.60	26.6	66.5	99.00
35	Malawi	1.7	15.1	...	...	15.1	...	...
36	Mali	2.7	43.0	70.2	115.90	43.0	70.2	115.90
37	Mauritania	6.3	45.8	29.3	81.40	45.8	29.3	81.40
38	Moldova	0.5	10.1	33.3	43.93	10.1	33.3	43.93
39	Mongolia	0.7	10.0	51.5	62.23	10.0	51.5	62.23
40	Mozambique	...	...	...	...	...	...	...
41	Myanmar	...	...	...	...	...	...	...
42	Nepal	2.1	8.4	15.8	26.30 *	4.2	15.8	22.08 *
43	Nicaragua	5.9	48.7	30.0	84.65 *	32.6	30.0	68.56 *
44	Niger	4.0	63.2	126.4	193.56	31.6	63.2	98.76
45	Nigeria	0.5	34.2	44.2	78.96	34.2	44.2	78.96
46	Pakistan	4.6	11.9	22.8	39.41	11.9	12.6	29.18
47	Rwanda	1.3	21.6	38.5	61.33 *	21.6	38.5	61.33 *
48	S. Tomé & Principe	...	...	...	...	...	...	...
49	Senegal	3.4	63.2	14.0	80.64 *	31.6	14.0	49.04 *
50	Sierra Leone	...	...	...	...	...	...	...
51	Solomon Islands	7.5	54.2	82.5	144.28	54.2	82.5	144.28
52	Somalia	...	...	...	...	...	...	...
53	Sudan	1.9	14.0	4.8	20.74	14.0	2.5	18.40
54	Tajikistan	...	...	...	...	...	...	...
55	Tanzania	3.8	47.2	69.0	120.06 *	47.2	69.0	120.06 *
56	Togo	2.4	59.7	8.0	70.07 *	44.7	8.0	55.15 *
57	Uganda	6.1	82.1	30.0	118.17	49.3	30.0	85.34
58	Ukraine	0.8	2.2	18.0	20.96	2.2	7.2	10.16
59	Uzbekistan	1.5	5.7	177.5	184.69	5.7	76.7	83.89
60	Viet Nam	1.9	15.2	28.6	45.76	15.2	19.7	36.86
61	Yemen	0.6	11.1	44.5	56.28	5.6	44.5	50.71
62	Zambia	1.6	36.6	19.0	57.25	18.3	19.0	38.93
63	Zimbabwe	3.6	27.0	49.2	79.83	20.3	45.5	69.39
Low Income		**3.0**	**36.1**	**52.8**	**92.08**	**30.6**	**47.5**	**80.98**

* Unlimited Internet access.

** Data from OECD.

11. Internet Tariffs

	Dial-Up Internet tariffs (US$), 2001 — 30 hours of use per month						
	PSTN monthly subscription	Peak			Off-Peak		
		PSTN usage	ISP charge	Total	PSTN usage	ISP charge	Total
64 Albania	0.4	12.1	19.0	31.48	12.1	19.0	31.48
65 Algeria	2.7	10.4	26.6	39.60	10.4	26.6	39.60
66 Belarus	0.3	3.0	30.0	33.38	3.0	15.4	18.74
67 Belize	...	...	...	...	...	...	...
68 Bolivia	...	...	...	...	...	...	...
69 Bosnia	1.5	14.2	19.3	35.00	7.5	19.3	28.35
70 Bulgaria	1.9	1.1	7.8	10.77	1.1	7.8	10.77
71 Cape Verde	2.0	7.2	21.7	30.96	4.1	21.7	27.81
72 China	3.0	8.7	6.5	18.24	8.7	6.5	18.24
73 Colombia	4.2	15.1	-	19.26	15.1	-	19.26
74 Cuba	...	...	...	...	...	...	...
75 Djibouti	19.7	118.2	168.8	306.62	118.2	168.8	306.62
76 Dominican Rep.	32.9	-	18.0	50.85 *	-	18.0	50.85 *
77 Ecuador	...	...	...	...	...	...	...
78 Egypt	1.1	8.6	8.6	18.37	8.6	8.6	18.37
79 El Salvador	7.1	37.0	31.0	75.08	37.0	26.0	70.08
80 Equatorial Guinea	...	...	...	...	...	...	...
81 Fiji	1.5	33.8	72.3	107.57	33.8	72.3	107.57
82 Guatemala	...	...	...	...	...	...	...
83 Guyana	1.4	2.0	3.0	6.36	1.0	3.0	5.37
84 Honduras	2.0	36.4	15.0	53.41	36.4	15.0	53.41
85 Iran (I.R.)	...	...	...	...	...	...	...
86 Iraq	...	...	...	...	...	...	...
87 Jamaica	...	...	49.3	...	...	49.3	...
88 Jordan	4.7	25.4	23.9	54.01	25.4	23.9	54.01
89 Kazakhstan	2.6	1.3	1.1	4.92	1.3	1.1	4.92
90 Kiribati	4.7	62.8	154.7	222.09	62.8	154.7	222.09
91 Latvia	4.9	68.9	40.3	114.10	49.2	28.5	82.62
92 Lithuania	4.3	40.5	63.0	107.75	22.5	45.0	71.75
93 Maldives	2.5	38.2	280.4	321.16	38.2	127.4	168.22
94 Marshall Islands	9.0	-	150.0	159.00	-	150.0	159.00
95 Micronesia	8.0	-	45.0	53.00	-	45.0	53.00
96 Morocco	6.1	45.2	26.3	77.61	45.2	26.3	77.61
97 Namibia	...	...	...	...	...	...	...
98 Palestine	6.0	30.1	21.5	57.56	16.9	21.5	44.38
99 Papua New Guinea	1.1	215.8	46.8	263.67	151.1	33.8	185.97
100 Paraguay	...	...	...	...	...	...	...
101 Peru	...	...	...	...	...	...	...
102 Philippines	13.8	-	23.9	37.69	-	23.9	37.69
103 Romania	5.7	66.9	15.0	87.60	22.1	15.0	42.82
104 Russia	1.8	8.5	14.8	25.11	8.5	14.8	25.11
105 Samoa	3.0	21.9	16.8	41.70	21.9	16.8	41.70
106 Sri Lanka	2.6	25.7	6.5	34.80	2.9	6.5	11.97
107 St. Vincent	6.3	56.7	29.6	92.59	37.8	29.6	73.70
108 Suriname	...	...	...	...	...	...	...
109 Swaziland	1.5	28.5	11.5	41.57	14.3	11.5	27.31
110 Syria	...	...	...	...	...	...	...
111 TFYR Macedonia	3.0	4.6	12.1	19.73 *	2.3	12.1	17.45 *
112 Thailand	2.5	44.9	11.2	58.59	44.9	9.0	56.35
113 Tonga	5.0	34.1	173.6	212.73	34.1	173.6	212.73
114 Tunisia	1.9	13.1	33.6	48.66	13.1	24.8	39.91
115 Turkmenistan	...	...	...	...	...	...	...
116 Vanuatu	7.3	88.2	32.7	128.07	44.0	32.7	83.88
117 Yugoslavia	0.9	8.0	...	...	8.0	...	...
Lower Middle Income	**4.9**	**31.7**	**44.4**	**81.60**	**24.7**	**38.6**	**68.44**

* Unlimited Internet access.

** Data from OECD.

11. Internet Tariffs

	Dial-Up Internet tariffs (US$), 2001 30 hours of use per month						
	PSTN monthly subscription	Peak			Off-Peak		
		PSTN usage	ISP charge	Total	PSTN usage	ISP charge	Total
118 Antigua & Barbuda	11.1	33.3	29.6	74.07	15.6	29.6	56.30
119 Argentina	13.2	54.0	77.9	145.12	28.1	77.9	119.26
120 Bahrain	3.1	33.2	41.1	77.26	31.6	41.1	75.68
121 Botswana	3.0	12.9	14.7	30.65 *	8.2	14.7	25.95 *
122 Brazil	...	...	...	...	...	...	...
123 Chile	...	...	...	...	...	...	...
124 Costa Rica	3.6	12.7	16.0	32.22 *	5.7	16.0	25.31 *
125 Croatia	7.2	50.0	29.1	86.35	25.0	20.4	52.66
126 Czech Republic	4.5	41.8	-	46.24 **	11.6	-	16.06 **
127 Dominica	7.4	62.2	25.0	94.63	62.2	25.0	94.63
128 Estonia	4.4	48.8	...	... *	33.9	...	... *
129 Gabon	13.7	75.8	35.1	124.65 *	75.8	35.1	124.65 *
130 Grenada	14.1	-	29.6	43.70	-	29.6	43.70
131 Guadeloupe	...	...	...	...	...	...	...
132 Hungary	9.8	36.3	15.6	61.79 **	13.6	12.7	36.13 **
133 Korea (Rep.)	2.3	-	11.2	13.52 **	-	7.8	10.15 **
134 Lebanon	13.3	43.8	60.0	117.05	21.9	60.0	95.16
135 Libya	3.3	12.0	108.0	123.34	12.0	108.0	123.34
136 Malaysia	5.3	14.2	5.3	24.74	14.2	5.3	24.74
137 Mauritius	2.3	22.9	22.9	48.00	22.9	22.9	48.00
138 Mayotte	...	...	...	...	...	...	...
139 Mexico	20.1	-	10.7	30.78 **	-	10.7	30.78 **
140 Oman	7.9	47.4	19.5	74.74	47.4	19.5	74.74
141 Panama	...	...	...	...	...	...	...
142 Poland	10.7	18.4	-	29.11 **	18.4	-	29.11 **
143 Puerto Rico	19.5	78.0	...	...	78.0	...	...
144 Saudi Arabia	8.0	8.0	43.2	59.20	8.0	43.2	59.20
145 Seychelles	8.8	84.1	30.6	123.47	84.1	30.6	123.47
146 Slovak Republic	3.4	64.7	8.5	76.61 *	32.3	8.5	44.29 *
147 South Africa	9.0	54.5	8.5	72.00 *	19.9	8.5	37.42 *
148 St. Kitts and Nevis	3.0	13.3	29.6	45.93	13.3	29.6	45.93
149 St. Lucia	...	...	29.6	...	...	29.6	...
150 Trinidad & Tobago	4.6	21.9	34.8	61.27	21.9	34.8	61.27
151 Turkey	3.7	7.4	1.4	12.52 **	4.1	1.4	9.17 **
152 Uruguay	...	...	...	...	...	...	...
153 Venezuela	...	...	...	...	...	...	...
Upper Middle Income	**7.9**	**34.0**	**27.3**	**66.50**	**25.3**	**26.8**	**57.20**

* Unlimited Internet access.

** Data from OECD.

11. Internet Tariffs

		Dial-Up Internet tariffs (US$), 2001 30 hours of use per month						
		PSTN monthly subscription	Peak			Off-Peak		
			PSTN usage	ISP charge	Total	PSTN usage	ISP charge	Total
154	Andorra	3.6	52.6	33.1	89.30	52.6	33.1	89.30
155	Aruba	8.4	53.6	19.6	81.56 *	53.6	19.6	81.56 *
156	Australia	7.6	3.0	13.1	23.71 **	2.6	13.1	23.32 **
157	Austria	15.3	33.5	-	48.79 **	17.2	-	32.50 **
158	Bahamas	...	...	57.5	...	...	57.5	...
159	Barbados	...	...	...	...	...	...	...
160	Belgium	14.2	66.6	-	80.85 **	27.5	-	41.72 **
161	Bermuda	...	...	...	...	...	...	...
162	Brunei Darussalam	-	-	17.4	17.44	-	17.4	17.44
163	Canada	12.9	-	12.0	24.87 **	-	12.0	24.87 **
164	Cyprus	...	...	...	...	...	...	...
165	Denmark	13.3	-	21.0	34.36 **	-	21.0	34.36 **
166	Faroe Islands	...	...	...	...	...	...	...
167	Finland	10.9	18.6	-	29.50 **	10.6	-	21.53 **
168	France	11.0	-	19.8	30.79 **	-	19.8	30.79 **
169	French Guiana	...	...	...	...	...	...	...
170	French Polynesia	18.3	174.3	28.0	220.64 *	174.3	28.0	220.64 *
171	Germany	11.1	-	13.0	24.13 **	-	13.0	24.13 **
172	Greece	8.5	10.8	15.2	34.49 **	5.4	15.2	29.09 **
173	Greenland	...	...	...	...	...	...	...
174	Guam	14.0	-	136.5	150.50	-	136.5	150.50
175	Guernsey	...	...	...	...	...	...	...
176	Hongkong, China	11.6	-	17.7	29.27 *	-	17.7	29.27 *
177	Iceland	10.0	26.8	9.8	46.67 **	14.0	9.8	33.79 **
178	Ireland	15.9	27.7	13.5	56.99 **	16.4	-	32.31 **
179	Israel	9.2	11.0	19.9	40.07	11.0	11.0	31.25
180	Italy	10.8	29.4	-	40.12 **	17.6	-	28.38 **
181	Japan	14.1	27.7	16.5	58.36 **	27.7	16.5	58.36 **
182	Jersey	...	...	...	...	...	...	...
183	Kuwait	8.1	-	31.6	39.68	-	31.6	39.68
184	Luxembourg	12.0	45.0	4.2	61.24 **	24.5	4.2	40.69 **
185	Macao, China	8.3	-	18.9	27.27	-	18.9	27.27
186	Malta	...	...	...	...	...	...	...
187	Martinique	...	...	...	...	...	...	...
188	Neth. Antilles	...	...	...	...	...	...	...
189	Netherlands	14.4	36.2	-	50.65 **	16.4	-	30.81 **
190	New Caledonia	11.4	190.2	106.4	308.05	95.1	106.4	212.95
191	New Zealand	15.5	-	10.6	26.11 **	-	10.6	26.11 **
192	Northern Marianas	...	...	...	...	...	...	...
193	Norway	16.5	20.6	10.8	47.92 **	20.6	10.8	47.92 **
194	Portugal	12.2	28.8	-	41.00 **	13.0	-	25.16 **
195	Qatar	9.1	-	48.4	57.50	-	48.4	57.50
196	Réunion	9.9	56.2	20.8	86.97	56.2	20.8	86.97
197	Singapore	4.8	14.7	-	19.49	7.3	-	12.17
198	Slovenia	4.6	27.9	29.2	61.63	18.6	29.2	52.34
199	Spain	10.0	32.1	-	42.17 **	-	16.8	26.85 **
200	Sweden	12.2	41.5	2.3	56.05 **	21.3	2.3	35.87 **
201	Switzerland	14.4	48.0	-	62.46 **	30.9	-	45.31 **
202	Taiwan, China	1.4	32.5	3.2	37.11	19.1	3.2	23.73
203	United Arab Emirates	4.1	-	20.2	24.25	-	13.3	17.38
204	United Kingdom	13.8	-	21.4	35.24 **	-	14.3	28.09 **
205	United States	13.1	3.5	5.4	22.05 **	3.5	5.4	22.05 **
206	Virgin Islands (US)	...	...	...	...	...	...	...
High Income		**10.7**	**28.5**	**19.9**	**58.19**	**19.4**	**19.4**	**48.56**
WORLD		**6.3**	**38.1**	**40.9**	**76.18**	**29.8**	**37.2**	**65.25**
Africa		**4.2**	**42.2**	**52.8**	**99.84**	**36.8**	**50.7**	**91.90**
Americas		**10.0**	**27.8**	**26.3**	**57.69**	**23.3**	**26.1**	**52.61**
Asia		**4.7**	**19.8**	**36.0**	**60.42**	**16.0**	**27.6**	**48.19**
Europe		**7.8**	**27.0**	**14.1**	**49.10**	**15.2**	**12.2**	**35.18**
Oceania		**8.1**	**62.7**	**76.4**	**147.22**	**48.1**	**75.4**	**131.70**

Note: For data comparability and coverage, see the technical notes.

Source: ITU.

* Unlimited Internet access.

** Data from OECD.

12. Comparative Mobile and Internet Tariffs

		Internet access		Mobile phone	
		30 hours/ month US$ 2001	*as % of GDP per capita 2001*	*90 minutes/ month US$ 2001*	*as % of GDP per capita 2001*
1	Afghanistan	…	…	…	…
2	Angola	30.66	0.41	37.05	0.49
3	Armenia	100.38	2.04	35.18	0.72
4	Azerbaijan	151.40	3.65	20.80	0.50
5	Bangladesh	48.33	2.00	18.65	0.77
6	Benin	188.03	5.93	44.38	1.40
7	Bhutan	55.96	1.01	…	…
8	Burkina Faso	86.91	5.59	30.56	1.97
9	Burundi	…	…	87.41	11.00
10	Cambodia	129.56	8.90	41.74	2.87
11	Cameroon	113.42	2.05	75.04	1.36
12	Central African Rep.	255.55	9.84	17.54	0.68
13	Chad	…	…	…	…
14	Comoros	186.34	…	…	…
15	Congo	…	…	…	…
16	Côte d'Ivoire	211.41	3.10	65.26	0.96
17	D.P.R. Korea	…	…	…	…
18	D.R. Congo	…	…	…	…
19	Eritrea	37.47	2.35	…	…
20	Ethiopia	109.57	12.40	13.97	1.58
21	Gambia	182.17	…	14.86	…
22	Georgia	24.65	0.56	20.00	0.46
23	Ghana	59.02	1.90	37.00	1.19
24	Guinea	112.76	…	22.87	…
25	Guinea-Bissau	…	…	…	…
26	Haiti	…	…	…	…
27	India	26.26	0.69	12.54	0.33
28	Indonesia	27.37	0.63	12.94	0.30
29	Kenya	103.02	3.43	27.57	0.92
30	Kyrgyzstan	19.96	0.94	…	…
31	Lao P.D.R.	61.94	2.65	17.31	0.74
32	Lesotho	26.95	0.82	34.93	1.07
33	Liberia	…	…	…	…
34	Madagascar	112.30	5.43	30.59	1.48
35	Malawi	…	…	12.93	1.44
36	Mali	115.90	5.96	46.35	2.38
37	Mauritania	81.40	2.65	…	…
38	Moldova	43.93	2.50	84.83	4.83
39	Mongolia	62.23	2.05	30.00	0.99
40	Mozambique	…	…	28.61	1.64
41	Myanmar	…	…	1.40	0.11
42	Nepal	24.19	1.28	24.47	1.29
43	Nicaragua	76.61	1.96	67.70	1.73
44	Niger	146.16	10.24	14.85	1.04
45	Nigeria	78.96	…	…	…
46	Pakistan	34.29	0.99	19.36	0.56
47	Rwanda	61.33	3.51	…	…
48	S. Tomé & Principe	…	…	…	…
49	Senegal	64.84	1.52	26.18	0.61
50	Sierra Leone	…	…	…	-
51	Solomon Islands	144.28	4.09	44.98	1.27
52	Somalia	…	…	…	…
53	Sudan	19.57	0.64	15.87	0.52
54	Tajikistan	…	…	67.49	4.54
55	Tanzania	120.06	5.40	54.08	2.43
56	Togo	62.61	2.83	28.69	1.30
57	Uganda	101.76	5.22	32.11	1.65
58	Ukraine	15.56	0.31	58.69	1.16
59	Uzbekistan	134.29	2.38	37.00	0.66
60	Viet Nam	41.31	1.24	23.24	0.70
61	Yemen	53.49	1.67	14.53	0.45
62	Zambia	48.09	1.25	29.90	0.78
63	Zimbabwe	74.61	1.84	22.42	0.55
	Low Income	**86.53**	**3.16**	**33.42**	**1.44**

12. Comparative Mobile and Internet Tariffs

		Internet access		Mobile phone	
		30 hours/ month US$ 2001	as % of GDP per capita 2001	90 minutes/ month US$ 2001	as % of GDP per capita 2001
64	Albania	31.48	0.34	60.96	0.66
65	Algeria	39.60	0.29	21.16	0.16
66	Belarus	26.06	0.45	40.11	0.70
67	Belize	…	…	55.75	0.21
68	Bolivia	…	…	35.70	0.43
69	Bosnia	31.67	0.32	27.69	0.28
70	Bulgaria	10.77	0.08	…	…
71	Cape Verde	29.38	0.26	51.52	0.46
72	China	18.24	0.25	6.04	0.08
73	Colombia	19.26	0.14	26.69	0.19
74	Cuba	…	…	76.00	0.65
75	Djibouti	306.62	…	34.60	…
76	Dominican Rep.	50.85	0.25	25.27	0.13
77	Ecuador	…	…	87.00	1.31
78	Egypt	18.37	0.15	42.07	0.35
79	El Salvador	72.58	0.40	27.71	0.15
80	Equatorial Guinea	…	…	…	…
81	Fiji	107.57	0.57	49.75	0.26
82	Guatemala	…	…	38.57	0.28
83	Guyana	5.87	0.08	54.25	0.74
84	Honduras	53.41	0.67	38.74	0.48
85	Iran (I.R.)	…	…	16.57	0.03
86	Iraq	…	…	…	…
87	Jamaica	…	…	25.85	0.10
88	Jordan	54.01	0.39	25.63	0.18
89	Kazakhstan	4.92	0.06	…	…
90	Kiribati	222.09	4.52	57.42	1.17
91	Latvia	98.36	0.38	19.84	0.08
92	Lithuania	89.75	0.34	58.00	0.22
93	Maldives	244.69	3.85	44.60	0.70
94	Marshall Islands	159.00	1.21	50.00	0.38
95	Micronesia	53.00	0.32	…	…
96	Morocco	77.61	0.79	28.69	0.29
97	Namibia	…	…	35.42	0.21
98	Palestine	50.97	…	…	…
99	Papua New Guinea	224.82	3.71	114.21	1.89
100	Paraguay	…	…	57.52	0.61
101	Peru	…	…	62.28	0.39
102	Philippines	…	…	29.87	0.39
103	Romania	65.21	0.48	20.92	0.15
104	Russia	25.11	0.37	1.22	0.02
105	Samoa	41.70	0.40	…	…
106	Sri Lanka	23.39	0.32	4.92	0.07
107	St. Vincent	83.15	0.41	51.89	0.26
108	Suriname	…	…	30.35	0.19
109	Swaziland	34.44	0.31	37.68	0.33
110	Syria	…	…	20.54	0.21
111	TFYR Macedonia	18.59	0.13	42.71	0.30
112	Thailand	57.47	0.39	19.20	0.13
113	Tonga	212.73	1.61	…	…
114	Tunisia	44.28	0.25	35.71	0.20
115	Turkmenistan	…	…	…	…
116	Vanuatu	105.97	1.00	65.30	0.62
117	Yugoslavia	…	…	5.24	0.06
	Lower Middle Income	**76.03**	**0.73**	**39.14**	**0.38**

12. Comparative Mobile and Internet Tariffs

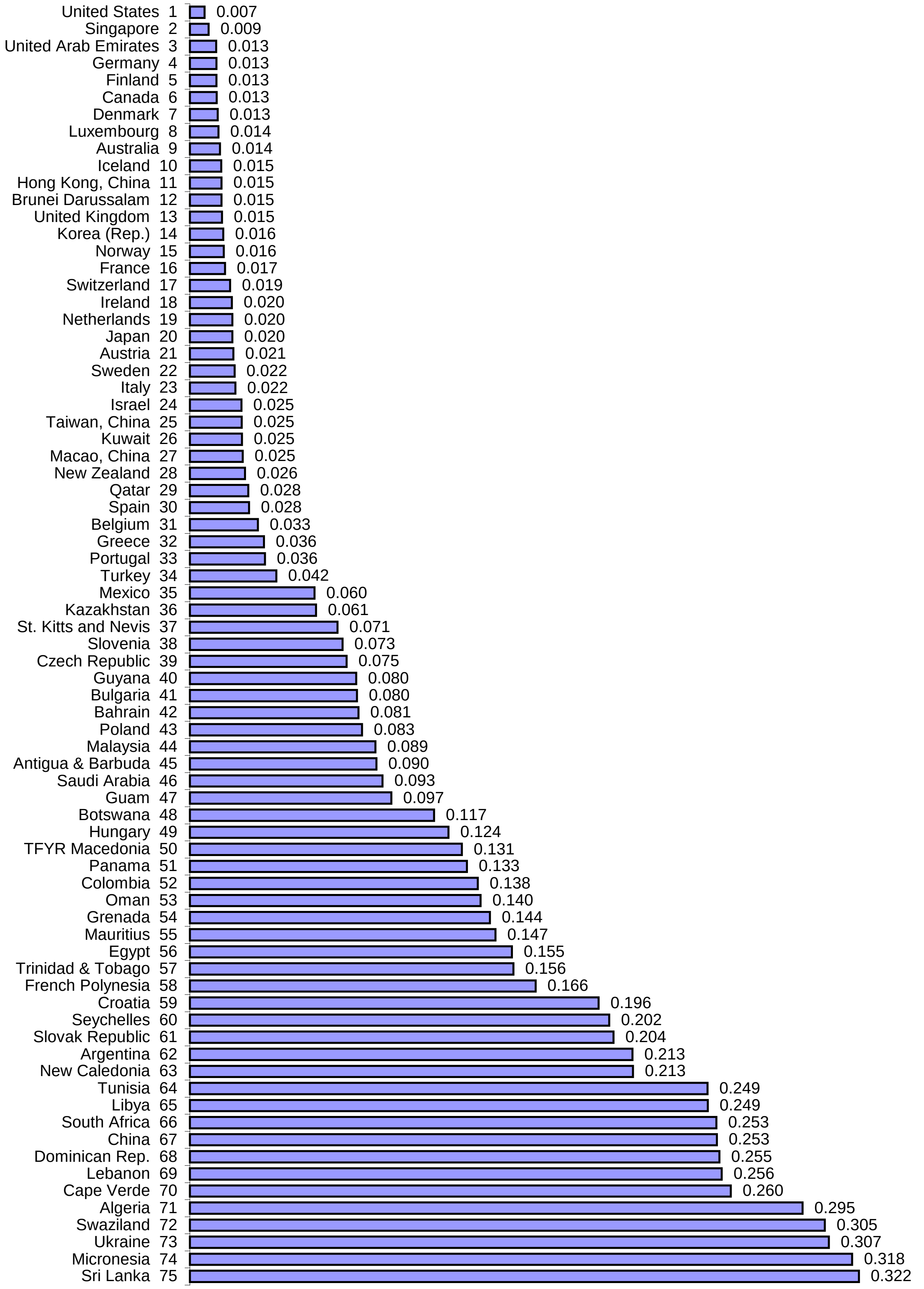
		Internet access		Mobile phone	
		30 hours/ month US$ 2001	as % of GDP per capita 2001	90 minutes/ month US$ 2001	as % of GDP per capita 2001
118	Antigua & Barbuda	65.19	0.09	…	…
119	Argentina	132.19	0.21	67.90	0.11
120	Bahrain	76.47	0.08	36.97	0.04
121	Botswana	28.30	0.12	38.96	0.16
122	Brazil	…	…	18.31	0.09
123	Chile	…	…	50.12	0.14
124	Costa Rica	28.77	0.33	23.04	0.26
125	Croatia	69.50	0.20	34.32	0.10
126	Czech Republic	31.15	0.08	30.52	0.07
127	Dominica	94.63	0.33	…	…
128	Estonia	…	…	16.09	0.05
129	Gabon	124.65	0.37	48.68	0.15
130	Grenada	43.70	0.14	35.19	0.12
131	Guadeloupe	…	…	73.74	…
132	Hungary	48.96	0.12	46.70	0.12
133	Korea (Rep.)	11.83	0.02	24.65	0.03
134	Lebanon	106.10	0.26	21.08	0.05
135	Libya	123.34	0.25	…	…
136	Malaysia	24.74	0.09	26.45	0.10
137	Mauritius	48.00	0.15	9.33	0.03
138	Mayotte	…	…	…	…
139	Mexico	30.78	0.06	49.82	0.10
140	Oman	74.74	0.14	69.74	0.13
141	Panama	37.69	0.13	56.00	0.20
142	Poland	29.11	0.08	32.12	0.09
143	Puerto Rico	…	…	66.55	0.09
144	Saudi Arabia	59.20	0.09	44.80	0.07
145	Seychelles	123.47	0.20	32.31	0.05
146	Slovak Republic	60.45	0.20	24.25	0.08
147	South Africa	54.71	0.25	45.97	0.21
148	St. Kitts and Nevis	45.93	0.07	…	…
149	St. Lucia	…	…	…	…
150	Trinidad & Tobago	61.27	0.16	43.02	0.11
151	Turkey	10.85	0.04	21.27	0.08
152	Uruguay	…	…	35.35	0.07
153	Venezuela	…	…	40.72	0.09
	Upper Middle Income	**60.95**	**0.16**	**38.80**	**0.10**

12. Comparative Mobile and Internet Tariffs

		Internet access		Mobile phone	
		30 hours/ month US$ 2001	as % of GDP per capita 2001	90 minutes/ month US$ 2001	as % of GDP per capita 2001
154	Andorra	89.30	...	26.19	...
155	Aruba	81.56	...	...	...
156	Australia	23.52	0.01	75.47	0.05
157	Austria	40.64	0.02	35.57	0.02
158	Bahamas	...	...	85.50	...
159	Barbados	...	...	22.65	0.03
160	Belgium	61.29	0.03	44.35	0.02
161	Bermuda	...	...	47.50	0.02
162	Brunei Darussalam	17.44	0.02	16.28	0.01
163	Canada	24.87	0.01	31.88	0.02
164	Cyprus	...	...	23.87	0.02
165	Denmark	34.36	0.01	28.09	0.01
166	Faroe Islands	...	...	...	...
167	Finland	25.51	0.01	21.65	0.01
168	France	30.79	0.02	86.06	0.05
169	French Guiana	...	...	...	...
170	French Polynesia	220.64	0.17	36.75	0.03
171	Germany	24.13	0.01	42.79	0.02
172	Greece	31.79	0.04	46.39	0.05
173	Greenland	...	...	23.95	...
174	Guam	150.50	0.10	...	...
175	Guernsey	...	...	36.21	0.01
176	Hong Kong, China	29.27	0.02	22.85	0.01
177	Iceland	40.23	0.02	24.17	0.01
178	Ireland	44.65	0.02	84.05	0.04
179	Israel	35.66	0.02	18.01	0.01
180	Italy	34.25	0.02	76.92	0.05
181	Japan	58.36	0.02	61.24	0.02
182	Jersey	...	...	28.79	...
183	Kuwait	39.68	0.03	25.06	0.02
184	Luxembourg	50.96	0.01	21.61	0.01
185	Macao, China	27.27	0.03	29.14	0.03
186	Malta	...	...	44.77	0.06
187	Martinique	...	...	...	...
188	Neth. Antilles	...	...	...	...
189	Netherlands	40.73	0.02	37.80	0.02
190	New Caledonia	260.50	0.21	70.97	0.06
191	New Zealand	26.11	0.03	80.45	0.08
192	Northern Marianas	...	...	...	...
193	Norway	47.92	0.02	28.14	0.01
194	Portugal	33.08	0.04	36.06	0.04
195	Qatar	57.50	0.03	24.86	0.01
196	Réunion	86.97	...	68.07	...
197	Singapore	15.83	0.01	33.72	0.02
198	Slovenia	56.98	0.07	42.67	0.05
199	Spain	34.51	0.03	83.12	0.07
200	Sweden	45.96	0.02	53.44	0.02
201	Switzerland	53.88	0.02	47.93	0.02
202	Taiwan, China	30.42	0.02	36.32	0.03
203	United Arab Emirates	20.82	0.01	15.53	0.01
204	United Kingdom	31.67	0.02	38.64	0.02
205	United States	22.05	0.01	38.95	0.01
206	Virgin Islands (US)	...	...	...	...
	High Income	**53.37**	**0.03**	**42.32**	**0.03**
	WORLD	**70.71**	**1.18**	**38.38**	**0.54**
	Africa	**95.87**	**2.50**	**35.42**	**1.14**
	Americas	**54.23**	**0.30**	**46.89**	**0.30**
	Asia	**54.73**	**1.02**	**26.77**	**0.46**
	Europe	**42.14**	**0.19**	**39.27**	**0.24**
	Oceania	**139.46**	**1.28**	**64.53**	**0.58**

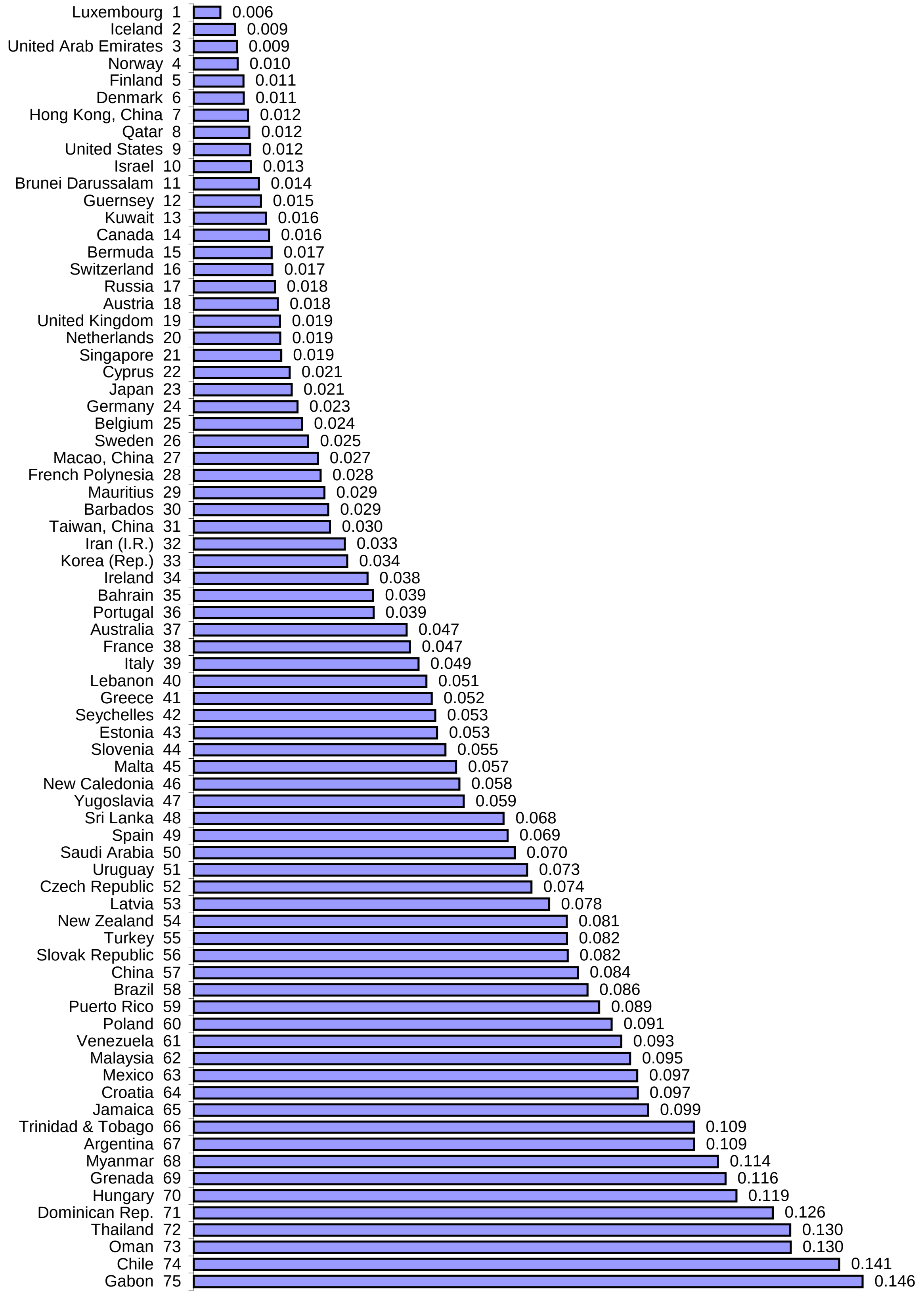
12. Comparative Mobile and Internet Tariffs

Internet use, 30 hours/month, as a percentage of GDP per capita, top 75 economies, 2001



12. Comparative Mobile and Internet Tariffs

Mobile cellular use, 90 minutes/month, as a percentage of GDP per capita, top 75 economies, 2001



13. High-Speed Mobile Networks

		High-speed mobile networks		
		In operation		*Licensed*
		2.5 G	*3G*	*3G*
		2001	*2001*	*2001*
1	Afghanistan	-	-	-
2	Angola	-	-	-
3	Armenia	-	-	-
4	Azerbaijan	-	-	-
5	Bangladesh	-	-	-
6	Benin	-	-	-
7	Bhutan	-	-	-
8	Burkina Faso	-	-	-
9	Burundi	-	-	-
10	Cambodia	-	-	-
11	Cameroon	-	-	-
12	Central African Rep.	-	-	-
13	Chad	-	-	-
14	Comoros	-	-	-
15	Congo	-	-	-
16	Côte d'Ivoire	-	-	-
17	D.P.R. Korea	-	-	-
18	D.R. Congo	-	-	-
19	Eritrea	-	-	-
20	Ethiopia	-	-	-
21	Gambia	-	-	-
22	Georgia	-	-	-
23	Ghana	-	-	-
24	Guinea	-	-	-
25	Guinea-Bissau	-	-	-
26	Haiti	-	-	-
27	India	-	-	-
28	Indonesia	Yes	-	-
29	Kenya	-	-	-
30	Kyrgyzstan	-	-	-
31	Lao P.D.R.	-	-	-
32	Lesotho	-	-	-
33	Liberia	-	-	-
34	Madagascar	-	-	-
35	Malawi	-	-	-
36	Mali	-	-	-
37	Mauritania	-	-	-
38	Moldova	-	-	-
39	Mongolia	-	-	-
40	Mozambique	-	-	-
41	Myanmar	-	-	-
42	Nepal	-	-	-
43	Nicaragua	-	-	-
44	Niger	-	-	-
45	Nigeria	-	-	-
46	Pakistan	-	-	-
47	Rwanda	-	-	-
48	S. Tomé & Principe	-	-	-
49	Senegal	-	-	-
50	Sierra Leone	-	-	-
51	Solomon Islands	-	-	-
52	Somalia	-	-	-
53	Sudan	-	-	-
54	Tajikistan	-	-	-
55	Tanzania	-	-	-
56	Togo	-	-	-
57	Uganda	-	-	-
58	Ukraine	-	-	-
59	Uzbekistan	-	-	-
60	Viet Nam	-	-	-
61	Yemen	-	-	-
62	Zambia	-	-	-
63	Zimbabwe	-	-	-
	Low Income (# of economies)	**1**	**0**	**0**

13. High-Speed Mobile Networks

		High-speed mobile networks		
		In operation		Licensed
		2.5 G	3G	3G
		2001	2001	2001
64	Albania	-	-	-
65	Algeria	-	-	-
66	Belarus	-	-	-
67	Belize	-	-	-
68	Bolivia	-	-	-
69	Bosnia	-	-	-
70	Bulgaria	-	-	-
71	Cape Verde	-	-	-
72	China	Yes	-	-
73	Colombia	-	-	-
74	Cuba	-	-	-
75	Djibouti	-	-	-
76	Dominican Rep.	-	-	-
77	Ecuador	-	-	-
78	Egypt	-	-	-
79	El Salvador	-	-	-
80	Equatorial Guinea	-	-	-
81	Fiji	-	-	-
82	Guatemala	-	-	-
83	Guyana	-	-	-
84	Honduras	-	-	-
85	Iran (I.R.)	-	-	-
86	Iraq	-	-	-
87	Jamaica	-	-	-
88	Jordan	Testing	-	-
89	Kazakhstan	-	-	-
90	Kiribati	-	-	-
91	Latvia	-	-	-
92	Lithuania	Yes	-	-
93	Maldives	-	-	-
94	Marshall Islands	-	-	-
95	Micronesia	-	-	-
96	Morocco	-	-	-
97	Namibia	-	-	-
98	Palestine	-	-	-
99	Papua New Guinea	-	-	-
100	Paraguay	-	-	-
101	Peru	Yes	-	-
102	Philippines	Yes	-	-
103	Romania	Yes	Yes*	Yes*
104	Russia	Yes	-	-
105	Samoa	-	-	-
106	Sri Lanka	-	-	-
107	St. Vincent	-	-	-
108	Suriname	-	-	-
109	Swaziland	-	-	-
110	Syria	-	-	-
111	TFYR Macedonia	-	-	-
112	Thailand	Yes	-	-
113	Tonga	-	-	-
114	Tunisia	-	-	-
115	Turkmenistan	-	-	-
116	Vanuatu	-	-	-
117	Yugoslavia	-	-	-
	Lower Middle Income (# of economies)	**7.5**	**1**	**1**

13. High-Speed Mobile Networks

		High-speed mobile networks		
		In operation		Licensed
		2.5 G	3G	3G
		2001	2001	2001
118	Antigua & Barbuda	-	-	-
119	Argentina	-	-	-
120	Bahrain	-	-	-
121	Botswana	-	-	-
122	Brazil	-	Yes*	Yes*
123	Chile	-	-	-
124	Costa Rica	-	-	-
125	Croatia	Yes	-	-
126	Czech Republic	Yes	-	Yes
127	Dominica	-	-	-
128	Estonia	Yes	-	-
129	Gabon	-	-	-
130	Grenada	-	-	-
131	Guadeloupe	-	-	-
132	Hungary	Yes	-	-
133	Korea (Rep.)	Yes	Yes	Yes
134	Lebanon	Yes	-	-
135	Libya	-	-	-
136	Malaysia	Yes	-	-
137	Mauritius	-	-	-
138	Mayotte	-	-	-
139	Mexico	-	-	-
140	Oman	-	-	-
141	Panama	-	-	-
142	Poland	Yes	-	Yes
143	Puerto Rico	-	-	-
144	Saudi Arabia	-	-	-
145	Seychelles	-	-	-
146	Slovak Republic	-	-	-
147	South Africa	Testing	-	-
148	St. Kitts and Nevis	-	-	-
149	St. Lucia	-	-	-
150	Trinidad & Tobago	-	-	-
151	Turkey	Yes	-	-
152	Uruguay	-	-	-
153	Venezuela	-	-	Yes*
	Upper Middle Income (# of economies)	**9.5**	**2**	**5**

13. High-Speed Mobile Networks

		High-speed mobile networks		
		In operation		Licensed
		2.5 G	3G	3G
		2001	2001	2001
154	Andorra	-	-	-
155	Aruba	-	-	-
156	Australia	Yes	-	Yes
157	Austria	Yes	-	Yes
158	Bahamas	-	-	-
159	Barbados	-	-	-
160	Belgium	Yes	-	Yes
161	Bermuda	-	-	-
162	Brunei Darussalam	-	-	-
163	Canada	Yes	-	Yes
164	Cyprus	-	-	-
165	Denmark	Yes	-	Yes
166	Faroe Islands	-	-	-
167	Finland	Yes	-	Yes
168	France	Yes	-	Yes
169	French Guiana	-	-	-
170	French Polynesia	-	-	-
171	Germany	Yes	-	Yes
172	Greece	Yes	-	Yes
173	Greenland	-	-	-
174	Guam	-	-	-
175	Guernsey	-	-	-
176	Hong Kong, China	Yes	-	Yes
177	Iceland	Yes	-	-
178	Ireland	Testing	-	-
179	Israel	Yes	-	Yes
180	Italy	Yes	-	Yes
181	Japan	Yes	Yes	Yes
182	Jersey	-	-	-
183	Kuwait	-	-	-
184	Luxembourg	Yes	-	-
185	Macao, China	-	-	-
186	Malta	Yes	-	-
187	Martinique	-	-	-
188	Neth. Antilles	-	-	-
189	Netherlands	Yes	-	Yes
190	New Caledonia	-	-	-
191	New Zealand	Yes	-	Yes
192	Northern Marianas	-	-	-
193	Norway	Yes	-	Yes
194	Portugal	Yes	-	Yes
195	Qatar	-	-	-
196	Réunion	-	-	-
197	Singapore	Yes	-	Yes
198	Slovenia	Yes	-	Yes
199	Spain	Yes	-	Yes
200	Sweden	Yes	-	Yes
201	Switzerland	Yes	-	Yes
202	Taiwan, China	Yes	-	-
203	United Arab Emirates	Testing	-	-
204	United Kingdom	Yes	-	Yes
205	United States		Yes*	Yes*
206	Virgin Islands (US)	-	-	-
	High Income (# of economies)	**29**	**2**	**24**
	WORLD	**47**	**5**	**30**
	Africa	**1**	**-**	**-**
	Americas	**3**	**2**	**6**
	Asia	**13**	**2**	**5**
	Europe	**29**	**1**	**19**
	Oceania	**2**	**-**	**2**

Note: Economies testing 2.5G networks count as .5 in totals.

TECHNICAL NOTES

General methodology
The compound annual growth rate (CAGR) is computed by the formula:

$$[(P_v / P_0)^{(1/n)}]-1$$

where P_v = Present value
P_0 = Beginning value
n = Number of periods

The result is multiplied by 100 to obtain a percentage.

United States dollar figures are reached by applying the average annual exchange rate (from the International Monetary Fund, IMF) to the figure reported in national currency. For countries where the IMF rate is unavailable or where the exchange rate typically applied to foreign exchange transactions differs markedly from the official IMF rate, a World Bank conversion rate is used. For the few countries where neither the IMF nor World Bank rates are available, a United Nations end-of-period rate was used.

Group figures are either *totals* or weighted *averages* depending on the indicator. For example, for fixed telephone lines, the total number of *fixed telephone lines* for each grouping is shown, while for *fixed lines per 100 inhabitants,* the weighted average is shown. Group figures are shown in bold in the tables. In cases of significant missing data, group totals are not shown. Group growth rates generally refer only to countries for which data is available for both years.

1. Basic indicators
The data for *Population* are mid-year estimates from the United Nations (UN). National statistics have been used for some countries. Population *Density* is based on land area data from the UN; the land area does not include any overseas dependencies but does include inland waters. The data for *Gross Domestic Product* (GDP) are generally from the IMF, the Organisation for Economic Co-operation and Development (OECD) or the World Bank. They are current price data in national currency converted to United States dollars by the method identified above. Readers are advised to consult the publications of the international organisations listed in *Sources* for precise definitions of the demographic and macro-economic data. *Total telephone subscribers* refer to the sum of main telephone lines and cellular mobile subscribers. *Total telephone subscribers per 100 inhabitants* is calculated by dividing the total number of telephone subscribers by the population and multiplying by 100.

2. Information technology
Internet hosts refer to the number of computers in the economy that are directly linked to the worldwide Internet network. Note that Internet host computers are identified by a two digit country code (e.g. .ch, fr) or a three digit generic top-level domain (e.g. .com, .org), generally reflecting the nature of the organisation using the Internet. The number of hosts are assigned to countries based on the country code although this does not necessarily indicate that the host is actually physically in the country. In addition, all other hosts for which there is no country code identification are assigned to the United States. Therefore the number of Internet hosts shown for each country can only be considered an approximation. Data on Internet host computers come from the Internet Software Consortium (http://www.isc.org) and RIPE (http://www.ripe.net). *Users* is based on reported estimates, derivations based on reported Internet Access Provider subscriber counts, or calculated by multiplying the number of hosts by an estimated multiplier. *Estimated PCs* shows the number of Personal Computers (PCs), both in absolute numbers and in terms of PC ownership per 100 inhabitants. These numbers are derived from the annual questionnaire and supplemented by other sources.

3. Internet users
This table shows the number of *Internet users* and *Internet users per 100 inhabitants* annually from 1995 to 2001 with corresponding annual growth rates. *Internet users per 100 inhabitants* is calculated by dividing the number of main lines by the population and multiplying by 100.

4. Internet user charts
The Internet user charts break down Internet use by income and region for 1995 and 2001. They also list the top ten economies in terms of highest Internet user growth from 1999-2001. The third set of charts shows Internet growth by region from 1995-2001. The last two graphs show the top 10 economies by total Internet users and also by penetration per 100 inhabitants. Charts on Internet user growth rates exclude countries with 10'000 or fewer subscribers as of 31 December 2001.

5. Secure servers and Internet service providers
Secure servers and *ISP* data are from Netcraft. The SSL data represents the number of servers offering encryption with a key length greater than 40 bits. Netcraft classifies systems limited to a 40-bit key as "weak" since messages encoded in this way can be broken relatively quickly given specialist knowledge and tools.

6. Fixed lines

This table shows the number of *fixed lines* (main telephone lines) and *fixed lines per 100 inhabitants* for the years indicated and corresponding annual growth rates. *Fixed lines* refer to telephone lines connecting a customer's equipment (e.g., telephone set, facsimile machine) to the Public Switched Telephone Network (PSTN) and which have a dedicated port on a telephone exchange. Note that for most countries, fixed lines also include public payphones. *Fixed lines per 100 inhabitants* is calculated by dividing the number of main lines by the population and multiplying by 100.

7. Mobile subscribers

Mobile subscribers refer to users of portable telephones subscribing to an automatic public mobile telephone service using cellular technology that provides access to the PSTN. *Per 100 inhabitants* is obtained by dividing the number of mobile subscribers by the population and multiplying by 100. Mobile subscriber numbers include only cellular phones, not other types of mobile communication.

8. Network penetration

Network penetration looks at the density of *main lines*, *mobile subscribers* and *Internet users* per 100 inhabitants. Rankings show the relative position of each economy in terms of its respective density on a scale of 1 to 206, with 1 being the highest density and 206 being the lowest.

The first four ICT ratio charts show ratios, by region, of fixed lines, mobile subscribers, and Internet users. The percentages are not penetration rates but rather the relative percentage of ICTs out of the three groups. The second group of charts shows the top 10 economies by region in terms of combined fixed lines, mobile subscribers, and Internet users. The third group of charts shows ICT ratios by income group. The fourth group of charts aggregates all three densities to reflect the total number of mobile subscribers, Internet users and fixed lines per 100 inhabitants in the top 20 economies.

9. Intelligent networks

Broadband data is from the OECD and other sources. OECD statistics are given in italic and represent selected economies and with data current through the end of June 2001. Non-OECD data are government figures or estimates. This selection of economies does not include some economies which have broadband connections but for which the data was unavailable. The next ITU Telecommunication Indicators questionnaire will address broadband and the figures in the following years will certainly be more robust than this first year of reporting.

ISDN subscribers refers to the number of subscribers to the Integrated Services Digital Network. It includes both basic rate and primary rate interface subscribers.

10. Mobile/Internet Index

The Mobile/Internet Index measures how developed each economy is in terms of information and communication technologies (ICTs) while also capturing how poised it is to take advantage of future ICT advancements. The index has 26 variables sorted into three clusters: infrastructure, usage, and market structure. The infrastructure component receives 50 per cent of the weight with 25 per cent on usage and 25 per cent on market structure. These three parts combine to give a score between 0 and 100 with 100 being the highest possible score. Economies are then ranked from 1 to 206 with 1 being the highest economy and 206 being the lowest. Each economy is also ranked for each of the three clusters using the same 1 to 206 scale. For more information on the index, see the methodology section in the Annex starting on page A-71.

The first index chart shows the top 75 economies in the index by score. The second chart shows the economies from 76-150. The third chart concludes with the economies ranked from 151 to 194. The next four charts show the top ten scores by region.

The final two charts show the relationship of GDP per capita to the index score. Economies are identified by their 3-digit abbreviations as given in the list of economies starting on page A-2. The first chart plots all economies while the second chart focuses only on those with a per capita GDP of less than US$ 5'000 per year.

11. Internet Tariffs

The table shows the costs associated with 30 hours of dial-up Internet use per month. *PSTN monthly subscription* refers to monthly subscription payable by subscribers for access to the public switched telephone network. *PSTN usage charge* refers to the amount payable to the telephone company for local telephone charges while logged on. *ISP charge* refers to the Internet monthly subscription levied by an Internet service provider plus extra charges once any free hours have been used up. *Total Internet charge* refers to the sum of PSTN monthly subscription, PSTN usage charge and ISP charges. Some restrictions applicable to telephone tariffs apply to Internet tariffs. Taxes involved in these three charges are included to improve comparability.

12. Comparative mobile and Internet tariffs

This table uses the *Internet tariff basket* from Table 11 to express the cost of 30 hours of dial-up use relative to monthly GDP per capita for the economy.

The *mobile phone basket* is computed using the monthly subscription rate and 90 minutes of service. The basket assumes the 90 minutes of calls are comprised of 30 three-minute calls during peak hours.

13. High-speed mobile

Operational data for 2.5G and 3G networks reflect the situation on 31 December 2001 in the respective economies. 3G operational data includes CDMA2000 1x networks and assumes frequencies have been licensed if the network is in operation. The licensing portion of the table does not include economies with CDMA networks that have not upgraded to CDMA2000 1x, even though the spectrum may well be available for use under existing CDMA licences. Economies in the testing phase of CDMA2000 1x networks are counted only as having licensed the spectrum, not as having deployed services commercially.

METHODOLOGY: ITU MOBILE/INTERNET INDEX

The ITU Mobile/Internet Index has been specially prepared for this report. It measures the relative level of mobile and Internet development in an economy and also helps predict how well that economy might take advantage of information and communication technologies (ICT) in the future.

While there is a myriad of factors that determine access to ICTs, three main factors stand out: infrastructure, usage and market structure. These three clusters of variables together determine how economies stand to benefit from ICTs.

The infrastructure factor, broken down in Table 1, measures the development of the key physical elements of the mobile and Internet network. First the infrastructure factor takes into account current data on fixed lines, mobile subscribers, estimated Internet users, and PCs as a representation of the users and devices on a network. Next, the infrastructure factor measures the state of Internet development by using data on international bandwidth, broadband subscribers and availability of leased lines. The infrastructure factor also includes data on the level of development of the mobile network by looking at 2.5G deployment, 3G licensing, and 3G deployment. The 3G licensing and deployment variables include CDMA2000 1x networks but at half the score of a W-CDMA network or license due to their lower speeds. For example, in 2001, Brazil had a commercially deployed CDMA2000 1x network, so it received 0.5 out of 1 for the 3G licence, and 0.5 out of 1 for the 3G deployment variable.

Table 1: Infrastructure

Physical network infrastructure	*Only included if six of the ten variables are present.*
Fixed	Fixed lines per 100 inhabitants
Mobile	Mobile cellular subscribers per 100 inhabitants
Users	Estimated Internet users per 100 inhabitants
PCs	Personal computers per 100 inhabitants
Bandwidth	International Internet bandwidth (Mbit/s) (Telegeography/ITU)
Broadband	Broadband subscribers per 100 inhabitants (OECD/ITU)
Leased lines	Number of leased lines in the country in Dec of the year (Netcraft)
2.5G deployment	Does the economy have a 2.5G mobile network in operation?
3G licence	Has the economy licensed 3G?
3G deployment	Does the economy have a 3G mobile network in operation?

Note: All data sourced from ITU unless otherwise stated.

The network usage factor, shown in Table 2, attempts to gauge how users are taking advantage of the existing network by looking at six indicators of usage and cost. First, the network factor looks at how many roaming agreements an economy has. This is done by looking at the mobile operator with the highest number of agreements and using it as a representative for the economy. ISP data serves as a proxy for Internet usage while secure socket layer (SSL) data shows how the domestic Internet is being used for secure transactions, (i.e. e-commerce). The network usage factor also examines local prices for mobile calls and Internet access by compiling a "basket" of minutes. The mobile tariff basket is compiled with the monthly subscription fee plus the cost of 30 three-minute calls (90 minutes in total). Finally, the revenue variable gives information about quality and services that isn't available with prices and minutes alone. Economies with higher revenue per capita in US$, may do so in part because the service quality is high and reliable, there are more services bundled and sold by the provider, or the service is used more intensively. This revenue variable allows seeing usage mediated by quality and other service diversity.

Table 2: Network usage

Network usage	*Only included if four of the six variables are present*
Roaming	Roaming agreements (based on main operator)
ISPs	Number of ISPs in the country (Source: Netcraft)
Secure socket layers	Number of servers using SSL encryption > 40 bits (Source: Netcraft)
Mobile cost basket	Subscription + 30 three-minute, local, peak calls a month
Internet cost basket	30 hours of monthly residential Internet access (PSTN and ISP charges)
Revenue	Telecom revenue as a percentage of GDP

Note: All data sourced from ITU unless otherwise stated.

The market structure variable, shown in Table 3, attempts to capture the overall ICT market structure for the economy. The variable is broken into ten indicators, each connected to a slightly different market or piece of information.

The first variable shows if the incumbent telephone operator is public or private. This privatization variable is the bellwether of the group because it usually sets the trend for the other communication markets. The second, closely related, variable is the number of years the incumbent operator has been private. By including the years since privatization we assume that economies with a history of a private market perform somewhat differently than newly privatized markets. This learning curve may have a significant beneficial effect in the initial stages of privatisation, but the increase in benefit tapers off over time. Thus, the maximum number value for privatization is set at 20 years before 2001, which corresponds to the year 1981. Economies such as the Philippines and the United States, that have had privatized markets for the longest time, are given the maximum score.

Another important set of variables deals with the relationship between the regulator and the incumbent operator, based on the premise that separate regulators are generally better able to implement policies and regulate operators in a neutral manner. The first variable looks at whether or not the regulator is a separate entity. The second variable measures the number of years the regulator has been autonomous, assuming the regulator becomes more effective over time as it distances itself from the company or companies it is regulating. It is assumed that the marginal benefit for additional years of separate regulation is negligible beyond 11 years before the year of reckoning (1990 in this study). As a result, any economy that has had a separate regulator for more than 11 years receives the maximum score.

The remaining indicators each describe different, but important segments of the ICT market. Each one of these market structures is included because only when combined do they reflect the overall market structure for ICTs. The six market structures included are local telephone service, domestic long distance calls, international calls, mobile services, leased lines, and Internet service providers. If an economy is too small to have a domestic long distance market, this variable is dropped.

Table 3: Market conditions

Market conditions	*Only included if five of the ten variables are present*
Private	Is the incumbent public (0) or privatized (1)?
Years private	For how many years has the incumbent been private?
Separate regulator	Is there a separate regulator? Yes =1, No = 0.
Years separate	For how many years has the regulator been separate?
Local calls - market	What is the market structure for local services?
Long distance - market	What is the market structure for long distance?
Int'l calls - market	What is the market structure for international calls?
Mobile - market	What is the market structure for cellular?
Leased lines - market	What is the market structure for leased lines?
ISP - market	What is the market structure for Internet service providers?

Note: All data sourced from ITU unless otherwise stated.
Market structures: Fully competitive = 4, partially competitive = 3, duopoly = 2, monopoly = 1.

Building the Index

Each major factor (infrastructure, usage, and market structure) is a composite variable of either six or ten actual indicators. These "subvariables" need to be arranged in a manner that allows them to be pulled together and measured as a whole. All variables are standardized (converted to a scale between 0 and 1) to be able to combine them later.

The variables comprising the three main groups are converted to a percentage of the maximum observed value. For example, Luxembourg had 96.73 mobile subscribers for every 100 inhabitants in 2001, the highest in the world. Luxembourg receives a value of 1 and all other economies are given as a percentage out of 96.73. Hong Kong, China had 84.35 subscribers per 100 inhabitants and receives a value of 0.87 or (84.35/96.72), and so on (see Table 4).

Table 4: Normalizing variables

Country	Mobile users/100	Score/max	Mobile ratio
Luxembourg	96.73	96.92/96.72 = 1.00	1.00
Hong Kong, China	84.35	84.35/96.72 = 0.87	0.87

This process is repeated for all variables in the group. Using this method, each indicator has a maximum value of 1 and can be averaged with the other indicators to come up with a factor score for infrastructure, usage or market structure. Sometimes an economy may be missing coverage in certain variables within the group. In these cases, the missing indicators are dropped completely from the analysis and the remaining indicators are averaged. The entire group is eliminated if a significant number of variables are missing. As an example, if an economy is missing three of the ten indicators composing the infrastructure factor, the remaining seven variables are averaged to come up with the factor score. This gives each indicator an effective weight of 1/7th. An economy with complete data for all ten indicators would, by contrast, receive the average of all ten variables with an effective weighting of 1/10th for each indicator. The individual variable weights are given Table 5 for each of the groups.

Table 5: Averaging to create the three factors

Infrastructure	
# of variables	**Weight**
10 of 10	1/10
9 of 10	1/9
8 of 10	1/8
7 of 10	1/7
6 of 10	1/6
Less than 6	Dropped

Usage	
# of variables	**Weight**
6 of 6	1/6
5 of 6	1/5
4 of 6	1/4
Less than 4	Dropped

Market Structure	
# of variables	**Weight**
10 of 10	1/10
9 of 10	1/9
8 of 10	1/8
7 of 10	1/7
6 of 10	1/6
5 of 10	1/5

Next, the three newly formed composite variables are each weighted, with 50 per cent of the weight going to the infrastructure component, 25 per cent to usage and the remaining 25 per cent going to the market structure component. These factors are essentially arbitrary and can be varied if research suggests that one factor should be relatively more or less important. Similarly, weights can also be assigned to individual indicators if required.

Any economy missing any of the three factors is dropped from the analysis. There are a total of 171 economies that have all three composite factors in the analysis. There were 20 economies missing either the usage or market structure variable and five economies missing both the usage and market structure components.

Estimating data: Filling in data gaps

There are some missing values in the data set but it is still possible to deduce certain figures based on earlier years. This type of estimation is not ideal but nevertheless valuable if it can capture the trend or most recent information for an economy, allowing for it to be included in the analysis. The reasoning behind this decision is that an imputed value, based on historical values, is more reliable than an imputed value deduced from other indicators.

The first estimation technique focuses on filling in gaps for missing data between years. If a year is missing the analysis initially looks for a trend derived from the previous concurrent three years of data. This is computed using a simple linear trend line. When the previous concurrent three years are not available, the second choice is the value for the previous year. If there is no data for the previous year, the analysis includes the maximum value over the time period.

The justification for using the maximum value is that most telecommunication values increase over time because telecommunication tends to build on existing infrastructure.

DATA SOURCES

The data for the ITU Mobile/Internet Index comes from public and private sources. Unless otherwise noted, all data is from the ITU *World Telecommunication Indicators Database*. The following is a list of outside sources used to compile this report.

Telecommunications
The telecommunication data are obtained via an annual questionnaire. Depending on the economy, the questionnaire is sent to the government ministry responsible for telecommunications, to the telecommunication regulator or to the telecommunication operator. Data is cross-checked and supplemented from reports issued by these organisations as well as regional telecommunication agencies. In a few cases, data are obtained from ITU research. In some instances, estimates, generally based on extrapolation or interpolation techniques, are made by ITU. For more information on the data sources see: ITU *World Telecommunication Indicators Database*, available at: http://www.itu.int/ITU-D/ict/publications/world/world.html.

Secure socket layers (SSL) and Internet service providers (ISP)
SSL and ISP data are from Netcraft. See http://www.netcraft.com.

Broadband subscribers
Data for broadband subscribers are taken from the OECD, as well as from original sources where available. The number of broadband subscribers will be included in the next edition of the *World Telecommunication Indicators Database*. For OECD data, see: http://www.sourceoecd.org/content/html/index.htm and http://www.oecd.org/pdf/M00020000/M00020255.pdf.

International Bandwidth
International bandwidth figures are from Telegeography and the ITU.
See http://www.telegeography.com and http://www.itu.int/ITU-D/ict/publications/world/world.html.

Demographic and economic
In addition to national sources, demographic and economic statistics were obtained from the following:

International Monetary Fund. Various years. *International Financial Statistics.* Washington, D.C.
United Nations. Various years. *Monthly Bulletin of Statistics*, New York.
World Bank. Various years, *World Development Indicators*, Washington, D.C.