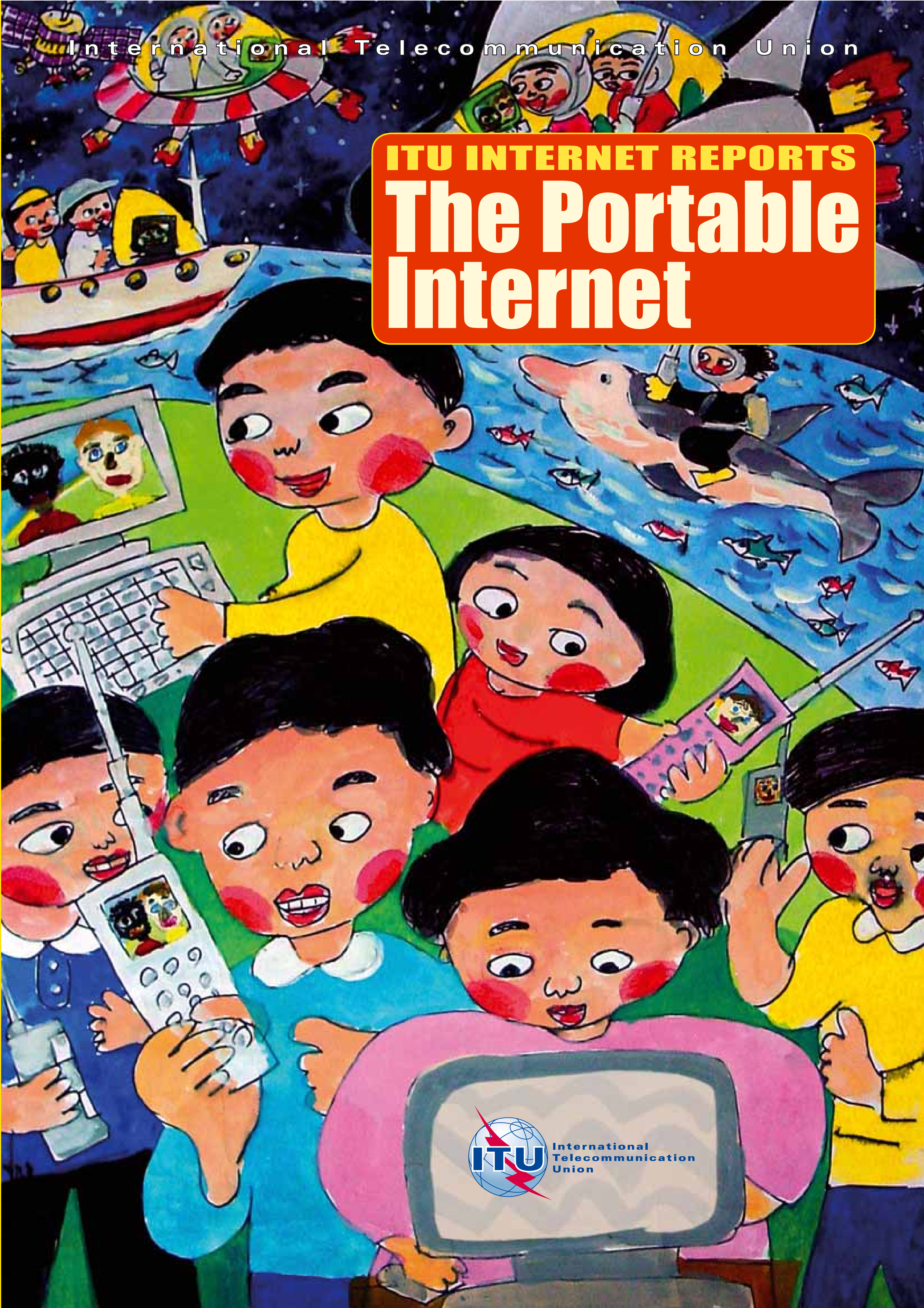
International Telecommunication Union

ITU INTERNET REPORTS
The Portable Internet



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International Telecommunication Union

ITU Internet Reports

The Portable Internet

September 2004

International Telecommunication Union

International Telecommunication Union (ITU), Geneva

ISBN 92-61-10741-9

FOREWORD

"The Portable Internet" is the sixth in the series of "ITU Internet Reports", originally launched in 1997. It has been prepared to coincide with ITU TELECOM Asia 2004, Exhibition and Forum, to be held in Busan (Republic of Korea) from 7 to 11 September 2004. This new report examines the emergence of high-speed wireless Internet access together with the proliferation of portable devices. In so doing, it explores the market potential and future impact of the new set of technologies underlying the "portable Internet".

Chapter one, the ***Introduction***, defines the portable Internet for the purposes of the report, focusing in particular on its disruptive nature relative to existing business models, and examines the stakes for the industry. Chapter two, ***Technologies for the portable Internet***, provides a technical overview of high-speed cellular mobile and other wireless networks underlying the portable Internet. Chapter three, ***Market trends***, looks at growth patterns, market opportunities, pricing strategies and corporate strategies. Chapter four, ***Policy and regulatory aspects,*** discusses the challenges faced by regulators and policy-makers in an increasingly mobile environment. Chapter five, ***The portable Internet as a tool for bridging the digital divide***, considers the impact of the portable Internet in underserved areas and looks at the role played by national policy, community initiatives, education and affordability in extending its reach. Chapter six, ***The future of portable Internet technologies,*** explores cutting-edge developments and future market applications. Chapter seven, ***The information society and the human factor***, looks at the impact of portable Internet technologies on society and socialization.

ITU, the United Nations specialized agency for telecommunications, is committed to playing a positive role in the development of the information society and to extending the benefits of advances in new information and communication technologies (ICT), such as the portable Internet, to all the world's inhabitants. This is in line with the Decision of the highest policy-making body of ITU (Resolution 101 of the Plenipotentiary Conference (Minneapolis, 1998, updated Marrakesh 2002)), which calls upon ITU to "fully embrace the opportunities for telecommunication development that arise from the growth of IP-based services", and subsequent ongoing calls from ITU Member States to continue to actively pursue this objective. The ITU Internet Reports hopefully make a significant contribution to that commitment.

ACKNOWLEDGEMENTS

The text of this report was prepared by a team from ITU's Strategy and Policy Unit (SPU) led by Lara Srivastava, comprising Avita Dodoo, Joanna Goodrick, Tim Kelly, Eric Lie and Taylor Reynolds together with Maria Cristina Bueti, Nicolas Derobert, Ayanna Samuels and Christine Sund.

The statistical tables were drawn from the ITU World Telecommunication Indicators Database and compiled by Taylor Reynolds and Maria Cristina Bueti. The report was edited by Lara Srivastava. Special thanks go to Jean Jacques Mendez for the cover design, Simon de Nicola and Maynard Adea for assistance with the overall formatting.

Some of the research for this report was carried out under the "New Initiatives Programme", launched in 1999 (http://www.itu.int/ni). Under this programme, relevant workshops have been held on "Radio Spectrum Management for a Converging World" from 16-18 February 2004 in Geneva (http://www.itu.int/spectrum), and on "Shaping the Future Mobile Information Society" on 4-5 March 2004 in Seoul, Republic of Korea (http://www.itu.int/futuremobile).

The report has benefited from the input and comments of many people to whom we owe our thanks. Among others, we would like to thank ITU's Robert Shaw, Tatiana Kurakova, as well as Robert Burke of MIT Media Lab Europe. Thanks also go to all those who gave their generous permission to use material reproduced in the report. We would like to thank the Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT), Japan, and the Ministry of Information and Communication (MIC) of the Republic of Korea, whose generous support has allowed us to expand our case study and research programme. We would also like to express our gratitude to respondents from public telecommunication operators, Internet service providers, regulatory bodies and national administrations who helped by providing specific information and data related to the development of portable Internet technologies in their regions.

Much of the data contained in this report is taken from the ITU World Telecommunication Indicators Database, managed by the Market, Economics and Finance Unit (formerly the Telecommunication Data and Statistics Unit) of the ITU Telecommunication Development Bureau (BDT). 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. For more information on ITU Internet Reports, including a summary of this edition, visit http://www.itu.int/portableinternet.

The cover design is adapted from one of the winning exhibits from the Asia region in the World Summit on the Information Society (WSIS) poster competition of December 2003, on the occasion of the first phase of the Summit. Thanks go to the artist, Rune Kondo, 12 years, from Japan, and to the UN Cyberschoolbus project. The drawing was selected because it shows the Internet being used in a variety of different locations; on land, at sea, in the air and even in space.

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Data Notes

A number of economic and regional groupings are used in the report. Economic groupings are based on gross national income (GNI) per capita classifications used by The World Bank. Economies are classified according to their 2002 GNI per capita in the following groups:

Gross National Income (GNI) per capita of:

- Low Income US$ 735 or less
- Lower middle US$ 736–2'935
- Upper middle US$ 2'936–9'075
- High US$ 9'075 or more

See the *Statistical Annex* for the income classification of specific economies.

The classification *developed* and *developing* is also used in the report. *Developed* economies are classified as: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and the United States. *Advanced* economies include *Developed* plus Hong Kong, China; Republic of Korea; Singapore and Taiwan, China as well as Cyprus and Israel. All other economies are considered *developing* for the purposes of this report. The classification *least developed countries* (LDCs) is also employed. The LDCs are Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Cape Verde, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Maldives, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Samoa, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, Sudan, Togo, Tuvalu, Uganda, United Republic of Tanzania, Vanuatu, Yemen, and Zambia. *Emerging* is also sometimes used in the report. These are countries that are neither developed nor LDCs. The grouping *Organization for Economic Cooperation and Development* (OECD) is also used. Members include all the developed countries plus Czech Republic, Hungary, Republic of Korea, Mexico, Poland, Slovak Republic and Turkey. A number of regional groupings are used in the report. The main regional groupings are *Africa, Asia, Americas, Europe* and *Oceania.* Note that *Pacific* is also used in the report to refer to the Oceania region. See *List of economies* in the *Statistical Annex* for the primary regional classification of specific economies. The following subregional groupings are also used in the report:

- *Arab region*— Arabic-speaking economies;
- *Asia-Pacific* — refers to all economies in Asia east of, and including Iran, as well as Pacific Ocean economies;
- *Central and Eastern Europe* — Albania, Bosnia, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Romania, Serbia and Montenegro, Slovak Republic, Slovenia and The Former Yugoslav Republic of Macedonia;
- *Commonwealth of Independent States* — 12 republics emerging from the former Soviet Union excluding the Baltic nations;
- *Latin America and the Caribbean* — Central (including Mexico) and South America and the Caribbean;
- *North America* — Generally, Canada and the United States although in some charts, Mexico is also included (if so, this is noted);
- *Southern Europe* – Cyprus, Malta and Turkey;
- *Western Europe* — refers to the member states of the European Union, Iceland, Norway and Switzerland.

Data notes

- Billion is one thousand million.
- Dollars are current United States dollars (US$) unless otherwise noted. National currency values have been converted using average annual exchange rates. Growth rates are based on current prices unless otherwise noted.
- Thousands are separated by an apostrophe (1'000).
- Totals may not always add up due to rounding.

Additional definitions are provided in the technical notes of the World Telecommunication Indicators. Note that data in some charts and tables referring to the same item may not be consistent and may also differ from the tables shown in the Statistical Annex. This can happen because of revisions to data that occurred after sections of the report were written as well as different estimation techniques and/or exchange rates. These variations tend to be insignificant in their impact on the analysis and conclusions drawn in the report. Finally it should be noted that the data generally refer to fiscal years as reported by countries.

GLOSSARY

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*. A cooperation between regional standards bodies to ensure global interworking for 3G systems.

Access charge: Amount paid per minute, charged by network operators for the use of their network by other network operators.

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. Corresponds to ITU Recommendation (standard) ITU-T G.992.1

Air time: The minutes of calls a subscriber makes from a mobile phone. Also referred to as *talk time*.

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.

ARPU: *Average Revenue Per User*. Usually expressed per month but also per year.

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 necessarly periodic.

B2B: *Business to Business*. Term used to identify a business-to-business transaction.

B2C: *Business to Consumer*. Term used to identify a business-to-consumer transaction.

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 enables the transmission of signals over short distances between mobile phones, computers and other devices. It is typically used to replace cable.

Bluetooth TM: Short-range radio link standard. Uses unlicensed spectrum @ 2.45 GHz to provide 1 Mbit/s.

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 wireless LAN (WLAN) services.

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

Byte:
(1) A set of bits that represent a single character. A byte is composed of 8 bits.
(2) A bit string that is operated upon as a unit and the size of which is independent of redundancy or framing techniques.

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

CAGR: *Compound annual growth rate*. See the Technical Notes.

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 under the IMT-2000 banner, first developed in Korea. Includes CDMA2000 1x, 1xEV-DO (Evolution, Data Optimized) and 1xEV-DV (Evolution, Data and Voice).

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).

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 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).

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.

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. 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.

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

DSL: *Digital subscriber line*. DSL is a technology for bringing high-bandwidth information to homes and small businesses over ordinary copper telephone lines. See also *xDSL* , which refers to different variations of DSL, such as ADSL, HDSL, and RADSL

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.

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 lines, and e-mail addresses.

Ethernet: A protocol for interconnecting computers and peripheral devices at high speed. Recently Gigabit Ethernet has become available which enables speeds up to 1 Gbit/s. Ethernet can run on several types of wiring including: twisted pair, coaxial, and even fibre optic cable.

Exchange: See Switch.

Extranet: An extranet is an intranet that is partially accessible to authorized outsiders, through the use of passwords.

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).

Firewall: Software or hardware that controls access in and out of a network. Firewalls can be dedicated computers that act as the intermediary between a business network and the Internet, or can be software tools that help individual computers control which programs are allowed access to the Internet.

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.

FWA: *Fixed wireless access*. Technologies that provide Internet access between stationary points.

Gateway: Any mechanism for providing access to another network.

Gbit/s: *Gigabit per second.* See also bit/s.

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

GNI: *Gross national income*. The market value of all final goods and services produced in a nation's economy, including goods and services produced abroad. GNI in constant prices, differs from GNP in that it also includes a terms of trade adjustment; and gross capital formation which includes a third category of capital formation: net acquisition of valuables.

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 under development.

GSM: *Global System for Mobile communications*. European-developed digital mobile cellular standard. 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.

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.

Hotspot: An access point to a wireless local area network (WLAN). Hotspots are areas where wireless data can be sent and received, and Internet access is provided to wireless devices. For example, a laptop computer can be used to access the Internet in a hotspot provided in an airport or hotel.

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.

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*. A Hypertext document format used on the World Wide Web. Mark-up languages for translating Web content onto mobile phones include cHTML, WML and xHTML.

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.

IMT-2000: *International Mobile Telecommunications-2000.* 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.

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 (referred to as an "interconnection charge", "access charge" or "network usage charge").

Internet: Interconnected global networks that use the Internet protocol (see *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.

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

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. See also *VoIP* and *Voice over broadband.*

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, and other ISPs, access to the Internet. ISPs may also 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/.

Local Area Network (LAN): 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).

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. See *GPS*.

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.

Mbit/s: *Megabit per second*. See also bit/s.

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

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

Multimedia Message Service (MMS): 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.

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.

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*.

PDA: *Personal digital assistant*. A generic term for handheld devices that combine computing and possibly communication functions.

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).

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.

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.

RFID: *Radio frequency identification*. A system of radio tagging that provides identification data for goods in order to make them traceable. Typically used by manufacturers to make goods such as clothing items traceable without having to read bar code data for individual items.

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

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.

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.

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

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.

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).

TD-SCDMA: *Time division – Synchronous Code Division Multiple Access.* A third-generation digital cellular standard technology developed by the China Academy of Telecommunications Technology. The standard combines time division multiple access (TDMA) with an adaptive, synchronous-mode code division multiple access (CDMA) component. Networks are not yet commercially deployed.

Teledensity: Number of main telephone lines per 100 inhabitants within a geographical area. *Effective teledensity* reports fixed-line teledensity or mobile density—whichever is higher—in a particular geographical region. See *Penetration* and *Total teledensity*.

Total teledensity: Sum of the number of fixed lines and mobile phone subscribers per 100 inhabitants. (See Technical Notes). See *Penetration.*

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

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/.

Uniform Resource Locator (URL): 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.

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.

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.

USO: *Universal service obligations*.
Requirements that governments place on operators to offer service in all areas, regardless of economic feasibility.

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

VPN: *Virtual private network*. A method of encrypting a connection over the Internet. VPNs are used extensively in business to allow employees to access private networks at the office from remote locations. VPNs are especially useful for sending sensitive data.

WAN: *Wide area network*. WAN refers to a network that connects computers over long distances.

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 organisations URL.

Wi-Fi: *Wireless fidelity*. A mark of interoperability among devices adhering to the 802.11b specification for Wireless LANs from the Institute of Electrical and Electronics Engineers (IEEE). However, the term Wi-Fi is sometimes mistakenly used as a generic term for wireless LAN.

Wi-Fi5: *Wireless fidelity 5*. A mark of interoperability among devices adhering to the 802.11a standard at 5 MHz.

WiMAX: Fixed wireless standard IEEE 802.16 that allows for long-range wireless communication at 70 Mbit/s over 50 kilometres. It can be used as a backbone Internet connection to rural areas.

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* or *Radio 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.

WLL: *Wireless local loop*. Typically a phone network that relies on wireless technologies to provide the last kilometre connection between the telecommunication central office and the end-user.

World Wide Web (WWW):
(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.

WSIS: *The United Nations World Summit on the Information Society*. The first phase of WSIS took place in Geneva (hosted by the Government of Switzerland) from 10 to 12 December 2003. The second phase will take place in Tunis (hosted by the Government of Tunisia), from 16 to 18 November 2005. For more information see: http://www.itu.int/wsis.

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).

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.

ACCC	Australian Competition and Consumer Commission
AM	Amplitude modulation
BCI	Brain computer interfaces
CB	Citizen band (radio)
CCTV	Closed caption television
CLI	Caller line identification
COFDM	Coded orthogonal frequency division multiplexing
DDDS	Dynamic delegation discovery system
DFS	Dynamic frequency selection
DMB	Digital media broadcasting
DVD-RW	Re-writable DVD
DVR	Digital video recorder
ETC	Ethiopia Telecommunications Corporation
ETSI	European Telecommunications Standards Institute
EU	European Union
EV-DO	Evolution data only
EV-DV	Evolution data and voice
FCC	Federal Communications Commission
FM	Frequency modulation
FSO	Free space optics
GHz	Gigahertz
HAPS	High-altitude platform station
HDTV	High definition television
HSDPA	High speed downlink packet access
IANA	Internet Assigned Numbers Authority
IC	Integrated circuit
ICANN	Internet Corporation for Assigned Names and Numbers
ICAO	International Civil Aviation Organization
ICT	Information and communication technologies
ID	Identification
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IR	Infrared
ISDN-BRI	Integrated service digital network – basic rate interface
ISO	International Organization for Standardization
IT	Information technology
ITU-D	ITU Development Sector

ITU-R	ITU Radiocommunication Sector
ITU-T	ITU Standardization Sector
IXP	Internet exchange point
LAPS	Low-altitude platform station
LDC	Least developed countries
LEO	Low earth orbit
LMDS	Local multipoint distribution systems
OECD	Organisation for Economic Co-operation and Development
OFDM	Orthogonal frequency division multiplexing
MMDS	Multi-channel multipoint distribution systems
MPHPT	Ministry of Public Management, Home Affairs, Posts and Telecommunications (Japan)
MVNO	Mobile virtual network operator
P2P	Peer-to-peer
PC	Personal computer
PDC	Personal digital cellular
PIN	Personal identification number
PPTP	Point-to-point tunneling protocol
PTS	Swedish National Post and Telecom Agency
QoS	Quality of service
RADIUS	Remote authentication dial-in user service
RIR	Regional Internet Registries
RSN	Robust secure network
SAR	Specific absorption rate
SPU	ITU Strategy and Policy Unit
TLD	Top level domain
TPC	Transit power control
TRAI	Telecommunication Regulatory Agency of India
UN	United Nations
URI	Uniform resource identifier
USB	Universal serial bus
UWB	Ultra-wide band
VCD	Video compact disc
VCR	Video cassette recorder
VSAT	Very small aperture terminal
WAS	Wireless access system
WBA	Wireless broadband access
WEP	Wired equivalence privacy
WHO	World Health Organization
WPA	Wi-Fi protected access
WRC	World Radiocommunication Conference

1 CHAPTER ONE: INTRODUCTION

1.1 The portable Internet: A disruptive technology?

One thing that just about every commercial firm fears is that another company may enter its market, using a new technology or technique to provide a superior product or service at a lower price. Telecommunications have traditionally been characterized by long network planning cycles and high fixed investment costs. This makes the industry particularly vulnerable to disruptive or "subversive" technologies.[1] Unlike the slow process of improving on a particular product or service through incremental change, disruptive technologies undermine the fundamental economics of product development and threaten to tear up the page and start again. The "portable Internet", the subject of this book, offers just such a possibility.

The term "portable Internet" is used here to describe a platform for high-speed data access using Internet Protocol (IP), which covers:

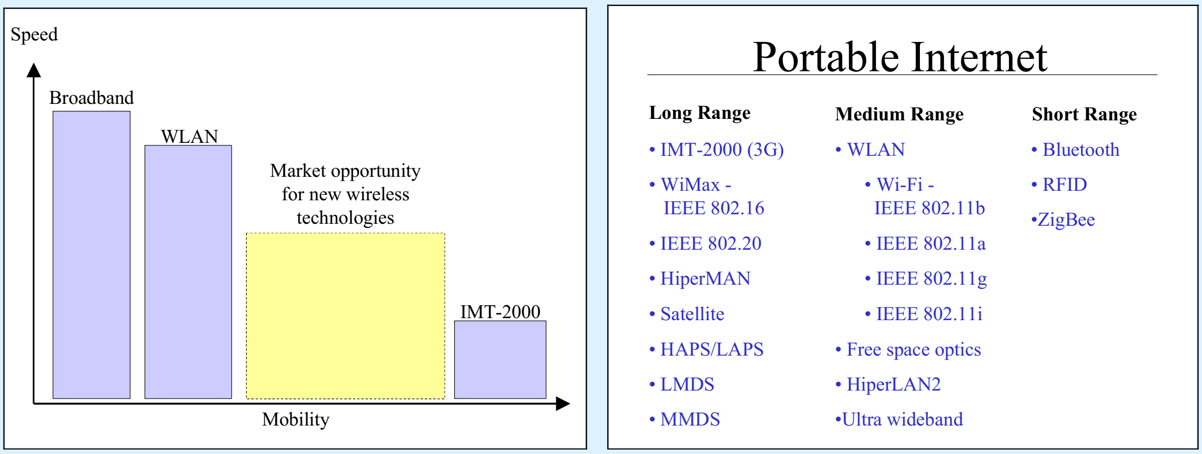
- Advanced wireless technologies like Wi-Fi, WiMAX[2], IMT-2000 (3G mobile) and systems beyond IMT-2000 under development (e.g. 4G[3]), Ultra wide band (UWB) and radio frequency identification (RFID) tags (see Box1.1). These may operate at long, medium and short-ranges;
- New techniques that make more efficient use of the available spectrum, include spread spectrum, smart antennae, agile radios and mesh networks.

Box 1.1: What is the portable Internet?
The portable Internet as it is defined here

Users accessing the Internet often face a trade-off between higher connection speeds and mobility (see left chart). Fixed-line technologies generally offer higher speeds while IMT-2000 mobile phone networks offer greater mobility. Wireless Local Area Network (WLAN) technologies fall in between, offering users limited mobility with only a small decrease in overall speeds. However, there is a wide gap between the amount of mobility offered by 3G and that of WLAN and many see this as the prime market segment for new portable Internet technologies, especially in developing countries.

The portable Internet, as defined here, comprises a wide range of technologies, each filling the need for a specific type of user access. These technologies can be categorized according to the geographical reach of their radio signals (see right chart). Short-range technologies, such as Bluetooth and ZigBee, allow low-power connectivity within a range of 30 metres. Medium-range technologies can communicate at least 150 metres from a hotspot (e.g. Wi-Fi, or IEEE 802.11b) and up to several kilometres, depending on environmental and regulatory factors. Finally, long-range technologies such as WiMAX (IEEE 802.16) and IMT-2000 (3G) have ranges that extend up to 50 kilometres from a base station, and can extend to near-nationwide coverage when offered as a networked service. Also in this category fit solutions based on high- or low-altitude platform stations (HAPS/LAPS) that can serve a whole town, and satellite that can serve a whole region.

Figure 1.1: The portable Internet



Note: For abbreviations and acronyms, see Glossary.
Source: ITU

In short, what is happening is a revolution in wireless technologies that has already transformed voice telecommunication services (mobile voice users are more numerous now than fixed-line voice users) and will transform the data industry over the coming decade. A wireless IP platform can be used to carry high-speed services, such as video entertainment and data transfer, but it can also be used to carry low-speed services, such as voice or e-mail, as well as medium-speed services, such as web-browsing. Thus it is potentially substitutable over a wide-range of existing networks and services, and impacts on a large number of current business models.

The history of telecommunications is replete with examples of a market based on slow and incremental change in one technology being undermined by a disruptive technology coming from elsewhere (see Table 1.1). The electronic telegraph was challenged in the late 1800s by the development of voice telephony systems. Although the telegraph survived the initial onslaught, and continued to operate in many countries until well into the late twentieth Century, the real market growth had decisively shifted elsewhere. A century later, networks based on IP (such as the Internet) began to compete with the public switched telephone network (PSTN) both for voice and data traffic, with voice over IP providing a low-cost alternative to PSTN voice, and e-mail providing a virtually no-cost alternative to fax.

Although each example of a disruptive technology is different, they tend to share certain characteristics:

- **Tangible advantage**. In order to displace an existing technology, a new technology must typically be able to demonstrate a distinct improvement in either price or performance, and preferably both.
- **Left field.** The new technology often comes from a different set of companies from those that have an installed base, or a vested interest in the existing technology. Overconfidence in the durability of the old technology may well have led to over-investment,
- **High resistance**. As well as profit margins, the new technology may threaten jobs, careers and livelihoods. Thus there is often stern resistance to the adoption of the new technology and widespread ridicule of its shortcomings.
- **Steady progress**. Although the new technology may not initially measure up to the older technology in terms of reliability, convenience or quality, the gap is quickly closed as the new technology benefits from an inflow of research spending.
- **Policy challenge.** Typically, the prevailing policy and regulatory environment will have been developed around the existing technology. The new technology may well exploit loopholes in existing regulations, or may quickly make them redundant.
- **Long, slow decline**. It is unusual for a new technology to be completely supplanted by an upstart. Rather, it is more often the case that the old and the new technology continue to co-exist for many years. The older technology may even continue to grow, but not at as fast a rate as the new one.

Portable Internet technologies share many of these characteristics. But which markets will portable Internet technologies complement and which will they substitute? Two possible market areas are fixed-line broadband and existing cellular mobile. These are explored in chapter three. But because the portable Internet also promises such high bandwidth, at a relatively low cost, other industries may also come in the firing line, including fixed-line Internet access (including broadband), television and radio, gaming and gambling, and video on demand.

Although the examples offered in Table 1.1 are drawn from the ICT sector, a closer analogy to the potential impact of the portable Internet may be drawn from the consumer electronics sector, more specifically that of the personal stereo, or "Walkman".[4] Following its introduction by Sony in 1979, the Walkman had a dramatic effect on the music market both for "fixed" stereo hi-fis (incorporating record players, cassette players and radios) and "mobile" transistor radios. Although it did not replace stereo hi-fis, it pushed the medium of choice decisively away from vinyl records to pre-recorded cassettes; at least until the arrival of the compact disc in 1986. It is foreseeable that the impact of the "portable" Internet in the coming decade will be comparable to the impact of the "portable" stereo in the 1980s.

Table 1.1: Past and future shocks
Examples of disruptive technologies affecting the telecommunication sector

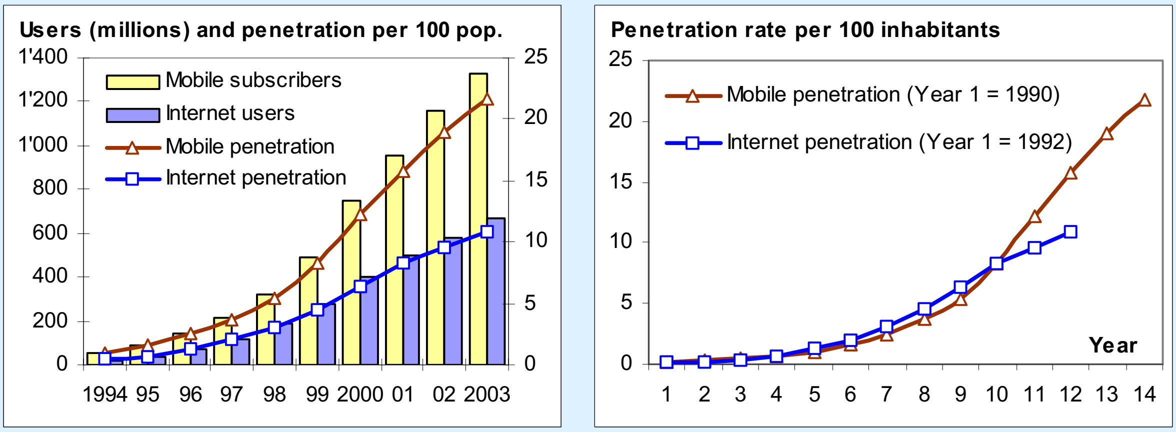
Existing technology/technique	Incoming technology/technique	Characteristics and consequences of the shift
Telegraph networks	Early voice telephony	In the late nineteenth Century, the arrival of voice telephony began to substitute for telegraphic communications as the primary way for conveying information quickly from point-to-point. Although the price savings were modest, the gain in functionality (ease of use, interactivity etc) was great. In addition to reducing the traffic on existing telegraph networks, the advent of telephony left a whole army of telegraph operators unemployed.
Facsimile networks	E-mail	In the 1980s, based on new standards for "G3" fax machines, fax became a huge and profitable business both for terminal manufacturers and operators. Fax itself had undercut the lucrative market in express mail and courier services. The growth of fax was initially slowed and later reversed by computer communications, especially IP-based e-mail. Fax modems in PCs also stole some of the market for dedicated fax terminals.
Circuit-switched voice telephony Conventional traffic routing	Packet-switched voice telephony (voice over IP) Least-cost traffic routing (e.g. call-back, resale etc)	As the volume of voice traffic, especially international traffic, grew, public telecommunication operators enjoyed a period of high profitability in the mid-1990s on the back of international switched telephone networks. However, the arrival of the Internet, with its distance- and duration-independent tariff structure, and its ability to carry voice traffic indistinguishably from data traffic, forced a rapid reduction in prices, and profitability. Incumbent operators with multi-million dollar central office exchanges faced themselves competing with start-ups with IP routers purchased for a few thousand dollars.
Leased lines Integrated services digital networks (ISDN)	Broadband	In the 1980s and 1990s, public telecommunication operators built a lucrative business from offering ISDN and from selling private leased lines to corporate users. The arrival of low-cost residential broadband, based around digital subscriber line (DSL) and cable modem technologies, has forced down the price of rival business-oriented service offerings, and threatens to displace them entirely.
Low-speed cellular mobile networks? Dial-up Internet access in rural areas?	Portable Internet technologies?	A series of advanced wireless technologies and techniques now provides service providers and users with a much wider choice to replace low-speed cellular networks. Although much investment has already gone into 3G cellular; so-called "4G cellular", as well as non cellular technologies such as Wi-Fi and WiMAX now offer a possible alternative. Furthermore, they offer a feasible substitute for dial-up Internet in rural areas and developing countries where broadband may not be economically viable.

Note: These examples relate to different historical periods.
Source: ITU

1.2 The stakes

The "footprint" that this new set of "portable Internet" technologies will address is wide. As of the start of 2004, there were 1.32 billion cellular mobile users and 665 million Internet users worldwide. During the 1990s, both industries grew at similar rates (albeit two years apart).[5] In the first part of the new decade, they have diverged (Figure 1.2), as Internet has slowed down while mobile has surged ahead. In particular, between 2000 and 2003, around twice as many new mobile cellular have been added worldwide as new Internet users. Perhaps the key to getting Internet growth back on track is to make high-speed Internet access available to more of those mobile users, especially the 200 million or so users who now own a mobile phone but not a fixed-line telephone. Portable Internet technologies, such as IMT-2000 and WiMax, will offer just such a possibility.

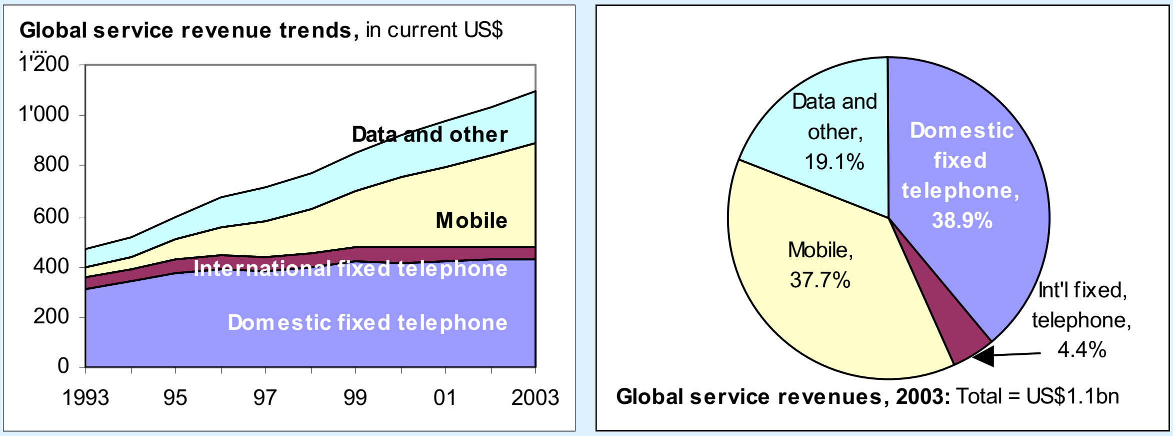
Figure 1.2: The stakes in play: The mobile and Internet sectors worldwide
Mobile and Internet users, worldwide, 1994-2003, and staggered penetration rates since 1990/92



Source: *ITU World Telecommunication Indicators Database*

With a substantial potential subscriber base, the financial stakes in play are impressive. Over the last decade, the telecommunication services sector has more than doubled in size, crossing the USD1 trillion mark during 2002 (see Figure 1.3). But growth in the fixed-line telephone business has been stagnant since the mid-1990s and even declining since 2001, especially for international telephone traffic, which has been the segment of the market most affected by rising competition and least-cost routing of calls over IP-based networks. Virtually all of the global growth in the telecommunication services sector over the last decade has come from the mobile sector and from "other", non-voice services, principally Internet and broadband. Taken together, the value of mobile and "other" non-voice services is now greater than that of the traditional fixed-line telephone services, which have been the mainstay of public telecommunication operators since the late nineteenth century. Furthermore, during 2004, it is likely that global revenues from mobile networks will exceed those from global fixed-line networks for the first time.[6]

Figure 1.3: The money in play: Telecommunication service revenues worldwide
Revenues from public switched telephone, cellular mobile and other telecommunication networks worldwide, 1993-2003 and 2003, in current USD billions

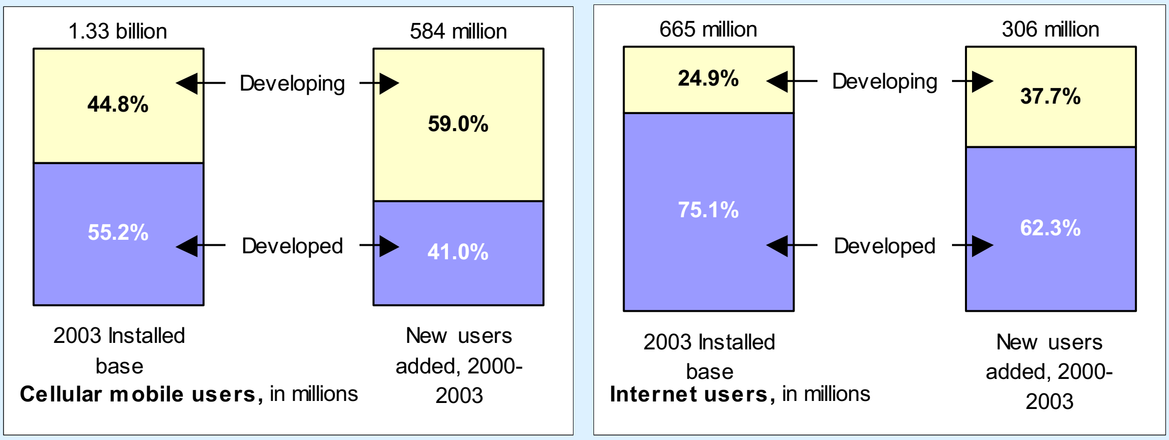


Note: "Domestic fixed telephone" = revenue from national usage of public switched telephone networks (PSTNs), principally for voice traffic, fax and dial-up Internet.
International fixed telephone" = revenue from international usage of PSTNs, principally for voice traffic and fax.
"Mobile" = revenue from cellular mobile telephone networks, both domestic and international, including voice and short message service (SMS).
"Data and other" includes a variety of non-voice telecommunication services, including broadband (DSL, cable modem), Internet services provision (usage charges, excluding dial-up), leased lines, telex, etc.

Source: ITU World Telecommunication Indicators Database and ITU estimates

A third feature of the stakes in play is that, although the developed world still accounts for the largest segment of the global telecommunication sector by value and by number of subscribers, it is the developing world where much of the new growth is occurring, and where most of the potential for future growth resides (see Figure 1.4). For cellular mobile, developed economies account for 55 per cent of the global installed base of users (compared with a 19 per cent share of the global population), However, in the period between 2000 and 2003, it was the developing world that accounted for almost 60 per cent of the new growth in the market (new mobile users added). Similarly, although developed economies account for just over three-quarters of Internet users worldwide, they account for a much smaller share (62 per cent) of the new Internet users added worldwide since 2000.

Figure 1.4: The market in play: Telecommunication market size and growth
Number of users, 2003, and users added 2000-2003, in mobile and Internet markets in developed and developing economies, worldwide



Note: For definitions of "developed" and "developing" economies, see the Data Notes
Source: ITU World Telecommunication Indicators Database and ITU estimates

What these three sets of charts indicate is that the market that the future portable Internet will address is very large, very valuable and (insofar as it targets new users rather than replacements) is predominantly to be found in the developing world. But what exactly is the portable Internet?

1.3 Mobile, portable: what's the difference?

In 2002, ITU's fourth edition in the Internet Reports series addressed the topic "Internet for a Mobile Generation". In this new sixth edition, we revisit the concept of accessing the Internet from non-fixed devices. But what is the difference in the concept of "mobile Internet" and "portable Internet"? The difference is really one of degree, rather than definition, and may be summarized as follows:

- **Mobility**: The concept of "mobile Internet" refers chiefly to access to the Internet from low-speed cellular mobile networks, whereas the term "portable Internet" refers to access from a wider range of wireless services, including Wireless LAN and WiMAX.
- **Speed**: Speeds of Internet access from cellular mobile devices are generally restricted to below 19.2 kbit/s for second generation (2G) mobile technologies (like GSM or Japan's Personal Digital Cellular); below 115 kbit/s for 2.5G technologies (like GPRS or CDMA) and below 384 kbit/s for 3G technologies (like CDMA2000 and W-CDMA). The term "portable Internet" incorporates all these technologies but also the much faster speeds available on Wi-Fi, WiMAX and other advanced wireless technologies.
- **Storage**: The price/performance ratio of computer memory has tended, in recent years, to double every two years or so, following a similar logic to Moore's Law for the number of transistors that can be fitted onto an integrated circuit.[7] Thus multi-gigabyte hard drives are now commonplace in

laptop computers as well as entertainment devices such as hard-drive music players (e.g. Apple's iPod) and 3G mobile phones. Applied to the portable Internet, this implies that whole libraries of songs, books, journals, films, and so on, can be carried around in a portable device with updates being downloaded via the Internet.

- **Everything over IP (Internet Protocol)**: Moving from 2G and 2.5G to IMT-2000 or 3G mobile technologies (and from CDMA2000 1x to CDMA2000 1x EV-DO and EV-DV) enables both data and voice to be carried over an IP platform. Equally, advanced wireless technologies that are optimised for data, like Wi-Fi and WiMAX, can also carry voice over IP traffic.[8]

Why is all this significant? Although one can access the Internet from today's mobile devices, it can in many cases be costly to do so, and frustrating because of the slow download times. This is particularly the case in Europe. There are significant constraints on performance (such as the 168 character limit on short message service or SMS on GSM networks) and on memory storage. Furthermore, because pricing for today's mobile devices is typically by the minute or the message, there are strong disincentives that deter users from casual browsing or "frivolous" use, which are essential for users to become familiar and comfortable with new technologies. The early history of the World Wide Web teaches us that widespread take-off only really happened after 1997, when AOL, the largest ISP at the time, announced it was shifting from a business model based on per-minute metering to one based on flat-rate usage. It is likely that take-up of "portable Internet" technologies will also be constrained until flat-rate pricing becomes more widely available (see Chapter three).

But the dilemma that the mobile industry faces in the shift towards portable Internet technologies is that the once higher capacity networks (running IP) are available, it will be hard to sustain the business models, based on per-minute and per-message billing, that currently prevail in the industry. The mobile industry now generates revenue of over USD 400 billion per year, more than 90 per cent of which comes from voice (Figure 1.4). This is a similar situation to the fixed-line voice industry in the mid-1990s before the development of high-capacity IP networks between major cities and before the advent of broadband in the local loop. On the fixed-line network, the shift of voice onto IP has dramatically reduced the prices that could be levied for minutes of voice traffic, especially on international routes. The signs are that the same shift of voice onto IP is about to happen also on mobile networks.

The resulting dilemma for the cellular mobile operators is this:

- Should they keep their networks on a per-minute billing platform, incompatible with WLAN and WiMAX, but risk missing out on the development of markets based on portable Internet technologies?
- Or, as they can now offer higher-speed services over IMT-2000 (3G) networks, should they offer devices that will interwork with portable Internet technologies, and move towards flat-rate billing, but risk seeing their high-value minutes of voice traffic migrate onto a VoIP platform?

For many years up to the mid-1990s, the traditional fixed-line telephone industry tried to ignore the Internet, but they found that more and more of their voice traffic was migrating onto the Internet. When public telecommunication operators (PTO) finally did embrace the Internet, they found a ready market for dial-up Internet and later DSL (digital subscriber line) broadband services.

In the fixed-line industry, the transition to an IP platform that began in the mid-1990s is now well under way[9]. Still, it will probably take at least a further decade to complete. The effects of the transition on voice profits were one reason for the slump that the industry went through in the early part of the new century. Public telecommunication operators (PTOs) had delayed embracing the revenue potential of the Internet for too long, and were reaping too many of the risks.

In the mobile industry, the transition to an IP platform is only just beginning, but is likely to take place much more quickly, with even more drastic effects on the economic prospects of that industry. Will mobile operators behave like the fixed-line PTOs a decade earlier? Or will they embrace the portable Internet, both its risks and rewards?

1.4 Structure of the report

This report puts together a powerful argument for why portable Internet technologies are likely to be the "next big thing" in both developing and developed economies alike, and why both fixed-line PTOs and mobile operators cannot afford to ignore it. In Chapter two, ***Technologies for the portable Internet***, we look at the technology underlying the portable Internet, while Chapter three, ***Market trends***, considers the market opportunity. Chapter four, ***Policy and regulatory aspects***, examines the challenges faced by policy-makers and regulators, while Chapter five, ***The portable Internet as a tool for bridging the digital divide***, focuses on its potential for use in developing countries. Chapter six, ***The future of portable Internet technologies***, looks ahead to future market applications and, finally, Chapter seven, ***The information society and the human factor***, looks at its impact on society and socialization.

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1 For a discussion of other disruptive technologies forecast to threaten the current ICT sector, see Joab Jackson "Disruptive technologies", at http://www.washingtontechnology.com/news/17_20/cover-stories/19859-1.html or the special report in InfoWorld at http://archive.infoworld.com/features/fedt.html

2 The term "Wireless Networks" is used here to describe a series of different technical standards, many of which are being standardized under the aegis of the Institute of Electrical and Electronic Engineers (IEEE). The best known of these standards is the so-called "Wi-Fi" (wireless fidelity) standard (IEEE 802.11a and b) which offers connectivity at 11 or 22 Mbit/s over a range of up to 150 metres, using license-exempt spectrum in the 2.4 GHz band (see http://www.oreillynet.com/pub/a/wireless/2001/03/02/802.11b_facts.html). But coming up quickly are other radio-based standards, including WiMAX (IEEE 802.16), which offers high-speed connectivity over a range of up to 50 kilometres, operating in bands that stretch from 10-66 GHz and from 2-11GHz (802.16a) without a requirement for line of sight (see http://www.intel.com/ebusiness/pdf/wireless/intel/80216_WiMAX.pdf). WiMAX actually stands for Wireless Interoperability for Microwave Access, a standards Forum that currently has around 80 members.

3 Although the term 4G has been widely used to describe the next generation of advanced wireless services, no clear definition has yet emerged. In this report, it is being used as a subset of future portable Internet technologies.

4 For a brief history of the Walkman, see http://pocketcalculatorshow.com/walkman/history.html

5 During the 1990s, as we noted in the fourth edition of the *ITU Internet Reports: Internet for a Mobile Generation* (2001), the rate of growth, and the penetration of mobile and Internet services were almost identical, but with a two year lag (see Figure 1.2, right chart). This two year lag might be ascribed to the fact that the second generation digital mobile phones (e.g. GSM) were launched in 1991 while the first Internet browsers (e.g. Mosaic) were introduced two years later in 2003. This two year-lagged relationship seems to have broken down since the turn of the century, with Internet growing much more slowly than would have been the case if it had continued to emulate the mobile sector's growth.

6 Interestingly, ITU predicted that the worldwide cross-over in mobile versus fixed-line revenue would take place in 2004 in its 1999 *World Telecommunication Development Report*, p 94.

7 For a description of Moore's Law, see http://www.intel.com/research/silicon/mooreslaw.htm, though the term is also loosely applied to technological change in a range of computing functions, such as processor power, random access memory, transmission speed etc.

8 For a successful implementation of voice over Wireless LAN, see the case study of "Bhutan: Wireless IP-based rural access pilot project", available on the ITU website at http://www.itu.int/osg/spu/ni/futuremobile/technology/bhutancase.pdf

9 For instance, BT, the incumbent fixed-line operator in the United Kingdom, announced in June 2004 that they would complete the transition to an all-IP network by 2009 (see http://www.btplc.com/News/Pressreleasesandarticles/Corporatenewsreleases/2004/nr0445.htm)

2 CHAPTER TWO: TECHNOLOGIES FOR THE PORTABLE INTERNET

In the past century, the term "wired" has taken on the meaning of feverishly excited.[1] However, much of the recent feverish excitement over Internet access has centred on "wireless" technologies. Existing and evolving wireless technologies and standards are expanding the places where we can have access to the Internet and other information networks..

Wireless Internet technologies will play an integral role in developing and developed economies alike, although possibly for different uses. In the developing world, the new wireless technologies of the portable Internet will bring basic telecommunication infrastructure to areas that have never had access to even a simple dial tone. In developed telecommunication economies, wireless/mobile technologies will play a vital role in developing a seamless information network for users.

This chapter explores the technologies that will make the portable Internet a reality. Many of these technologies, such as Wi-Fi and IMT-2000, have already been commercially deployed. Others are on the verge of entry into global markets.

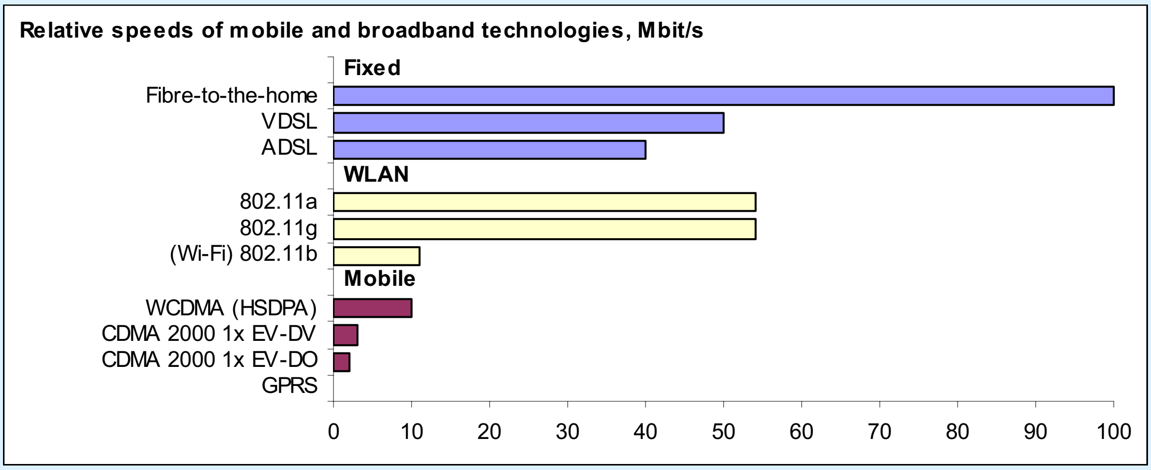
2.1 Taking broadband wireless

2.1.1 Wired broadband

Until now, broadband has been mainly a "wired" phenomenon. Broadband delivered over wireless technologies made up less than five per cent of the world's broadband subscribers in 2003. Currently, around 60 per cent of broadband subscribers access the Internet using existing telephone network via xDSL lines. The other nearly 35 per cent use cable modem technologies. While these ratios are slowly changing with the evolution of wireless broadband, fixed-line connections will still play a key role in the portable Internet for some time to come.

Wired broadband connections offer the fastest connection speeds at the lowest cost. Relative speeds of mobile and broadband technologies are shown in Figure 2.1. Currently, broadband subscribers in Japan can subscribe to ADSL at 47 Mbit/s for roughly USD 26 a month. Even faster connections are available via fibre optic lines, with subscription rates for 100 Mbit/s in Japan and Korea as low as USD 30/month.

Figure 2.1: Relative speeds of mobile and broadband technologies
Fixed connections are among the fastest connections available; WLAN technologies offer high-speed connectivity within a very small area of mobility and IMT-2000 (3G) technologies offer the lowest speeds with the highest degree of mobility



Source: ITU

At the present time, wired broadband technologies can transport much more data than wireless technologies. Fibre optic technologies are currently capable of 10 Gbit/s over one wavelength, and fibre should be able to support multiple wavelengths. Wireless technologies, available to consumers, have recently been shown to reach 54 Mbit/s but only over short distances, and still with nearly 200 times less bandwidth than a single fibre strand.

The vastly superior speeds of wired connections mean they will continue to play a key role in providing high-bandwidth applications. Wired connections, where they are available, will be a vital element for high-volume and low-cost data transportation. For the foreseeable future, wired and wireless technologies are likely to be complementary, at least in the urban markets of the developed world (see Box 2.1).

Box 2.1: How wired connections fit into the portable Internet
Wired connections will not disappear with the advent of the portable Internet

Wi-Fi has often been called a wireless broadband connection. However, the majority of Wi-Fi implementations are actually last-metre connections from an xDSL or cable modem connection. Residences subscribe to broadband via a fixed connection but then share the connection within the house or apartment via Wi-Fi. Businesses using WLANs almost always rely on wired infrastructure to reach their ISP.

Therefore, instead of Wi-Fi competing against fixed-line broadband infrastructure, the two work together as complementary technologies. Fixed broadband connections become more cost effective and attractive to users when they can be shared and Wi-Fi makes this possible. Therefore, the portable Internet may need only evolve as a wireless network long enough to reach the nearest wired connection.

Source: ITU

Broadband has been very successful in many economies around the world. Consumers have adopted broadband for its high download speed and always-on connection. Providers have found broadband to be a profitable venture in an otherwise difficult period for operators. However, broadband was initially available as a “wired” connection to the Internet, thereby leveraging existing infrastructure. Therefore, many economies with low fixed-line or cable TV penetration rates have effectively been left behind with broadband (see Box 2.2). On the other hand, portable Internet technologies may offer an effective way for countries without extensive fixed-line infrastructure to catch up, and possibly “leapfrog” over other countries in terms of total connectivity.

2.1.2 Portable Internet technologies

The properties of radio frequency modulation impose trade-offs on mobile communications. These trade-offs are highlighted by the different types of radio technologies available for data communication, each tailored to a different use. Lower frequency radio communication can penetrate objects and travel long distances, but at very low data rates. Higher frequency radio communications can transport high-speed data but only over short distances and often requiring line of sight.

The portable Internet will make use of a wide range of technologies, each serving different demands on speed and range. The remainder of this section is structured according to the range of the technology, i.e. long, medium and short.

2.2 Long-range technologies

Long-range technologies are defined as those that provide connectivity with a minimum range of two kilometres and a maximum range on a nationwide or regional basis. These services include cellular mobile phone networks, fixed wireless, and satellite. Each of these networks will be in more detail below. Long-range wireless networks are typically used both for access networks and as backbone connections for telecommunications. They connect networks in different areas, villages, or cities via wireless links. Traditionally, telecommunication providers have used microwave technologies to transport data. Long range connections are especially important to "extend the backbone" and deliver a connection that can then be distributed to users in a given area.

While long-range wireless networks have historically provided backbone infrastructure, there is increased interest in using longer-range technologies to solve last mile broadband problem and to deliver data to mobile users.

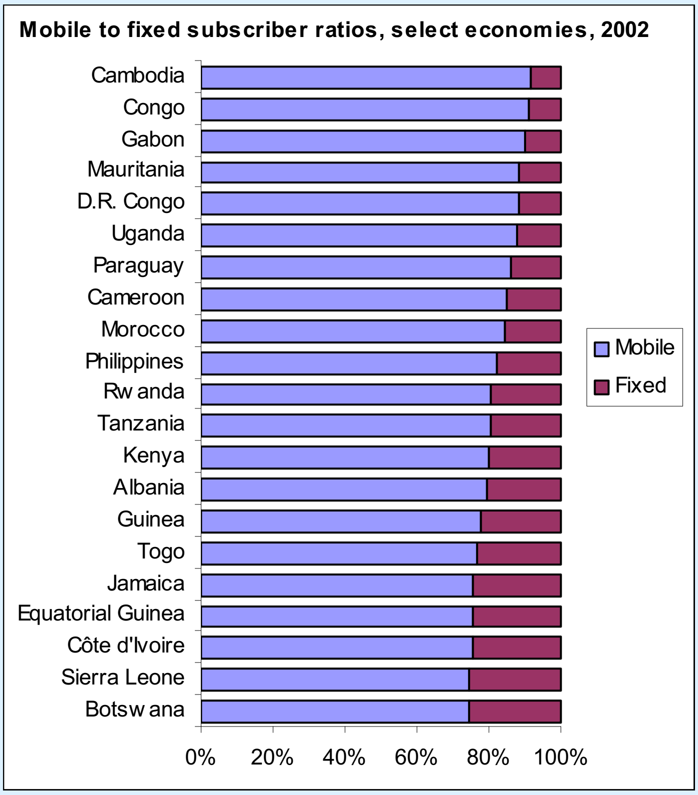
Box 2.2: The correlation of fixed lines and broadband

Wireless broadband technologies will be a vital element of the future information society of developing economies.

In 2002, the R^2 correlation coefficient between fixed-line telephones and broadband penetration was 0.75 (where a score of 1 would be perfect correction). This poses problems for telecommunication users in developing economies who want access to broadband but whose economy doesn't have substantial fixed-line infrastructure. For many users, the best alternative to PC Internet access over a fixed line connection may be a mobile phone.

Since mobile phones already account for the vast majority of telephone lines in many economies, the mobile phone would be an excellent candidate for delivering Internet connectivity to the widest range of users as possible (see figure).

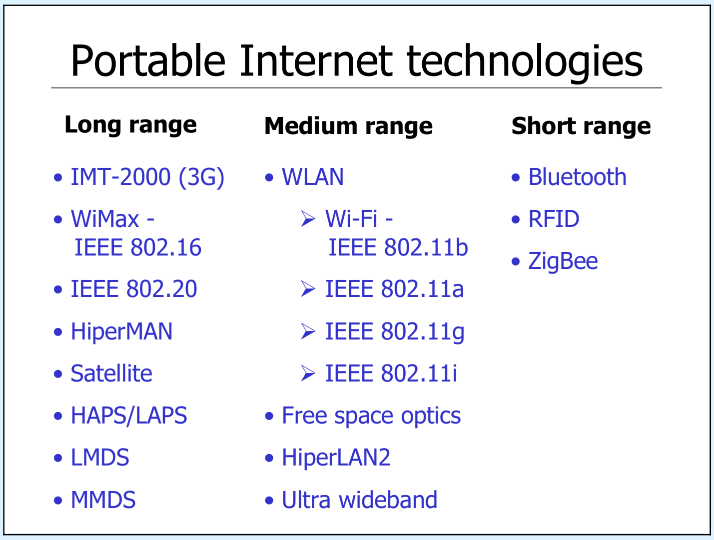
Many mobile phone operators are beginning to include new, larger screens in their mobile phones that would be able to display more Internet text. In addition, new technologies offering fast, broadband-type access to mobile devices are on the verge of becoming a reality.



Source: ITU World Telecommunication Indicators Database

Figure 2.2: Portable Internet technologies, by range

The portable Internet will involve a wide range of technologies for different speed and mobility needs



Source: ITU

2.2.1 Cellular mobile

IMT-2000 or third-generation (3G) mobile technologies

The number of mobile phone users in the world overtook the total number of fixed line subscribers in 2002. With this tremendous growth of mobile communications comes the possibility that the world's vast mobile networks can offer the most promising method of delivering the portable Internet to users. The great majority of the world is still using second-generation mobile networks, but IMT-2000 (3G) networks have begun to make their impact: there were 118 million 3G users in the world by mid-2004.

In terms of Internet access, the data speeds for 2G networks were too slow to allow efficient connectivity for mobile phones. In addition, a large number of inoperable mobile standards has made universal roaming throughout the world impossible. With these two issues in mind, the ITU started work on a new, global standard for third generation mobile communication. This work culminated in the development of the IMT-2000 "International Mobile Telecommunications-2000" standard.

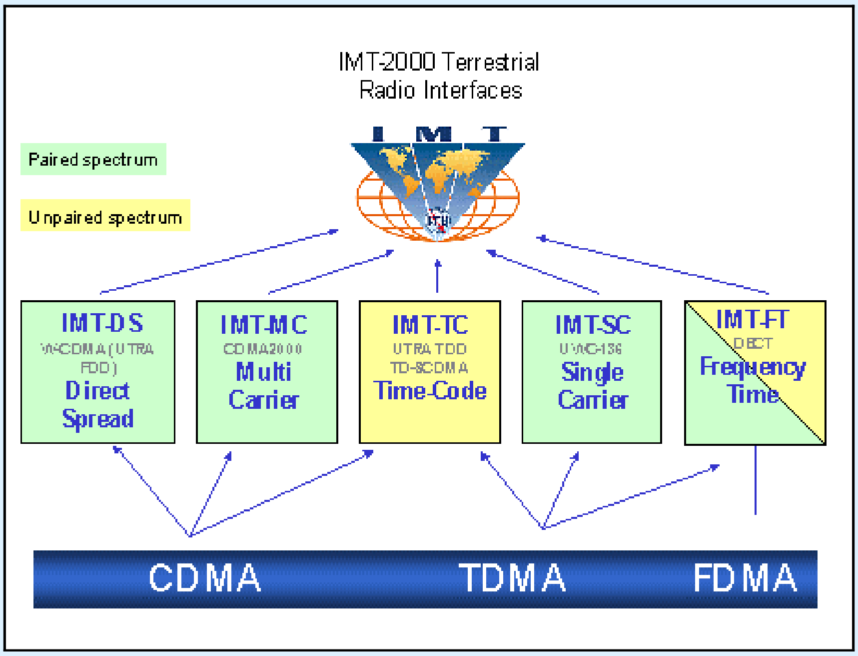
The goal of the IMT-2000 project was to harmonize third-generation mobile network radio interfaces into a single standard, and three main approaches evolved. The IMT-2000 family encompasses three different access technologies (CDMA, TDMA, and FDMA) through five different radio interfaces (see Box 2.3). However, most deployments have centred around two main interfaces, CDMA2000 and W-CDMA (also known in Europe as UMTS).

CDMA2000 and W-CDMA networks have been the choice for mobile operators to deliver third-generation voice, although other radio interfaces are starting to be used for dedicated data delivery. Recently, the home-grown Chinese standard, TD-SCDMA, has been receiving increasing industry attention.

Box 2.3: IMT-2000 (3G) and beyond

Looking towards the next generation of networks

The IMT-2000 project harmonized the standards for third-generation networks with three different access technologies using five different radio interfaces (see graphic below). However, even as network operators proceed with rolling out IMT-2000 networks, work in also proceeding to develop faster, higher capacity networks for future mobile connectivity, known as "Systems beyond IMT-2000" or 4G. The World Telecommunications Standardization Assembly (Montreal, 2000) created a Special Study Group (SSG) to study of four questions regarding network signalling and protocols that can enable next-generation mobile services. Future work on Systems beyond IMT-2000 will help ensure that mobile networks will provide fast data access and reliable multimedia transmission at high mobile speeds.



Note: For acronyms, see Glossary.

Source: ITU

W-CDMA (Wideband CDMA), IMT-DS

The early choice for GSM operators to evolve to 3G has been W-CDMA, which promises high data rates and improved voice quality. Yet, W-CDMA networks have been relatively slow to appear in the market due to the costs of building an entirely new infrastructure to support them. Many operators, particularly in Europe, spent large sums of money to obtain 3G licenses, making investment in new infrastructure a challenge. W-CDMA is able to provide voice and data at theoretical rates of 2 Mbit/s in close, stationary environments and 384 kbit/s over longer ranges. W-CDMA carrier signals are 5 Mhz wide.[2]

While the original W-CDMA specification allowed for 2 Mbit/s connectivity, a new specification, High Speed Downlink Packet Access (HSDPA), has upgraded the data download rates on W-CDMA networks. HSDPA allows for a theoretical data transfer rate of 14 Mbit/s.[3]

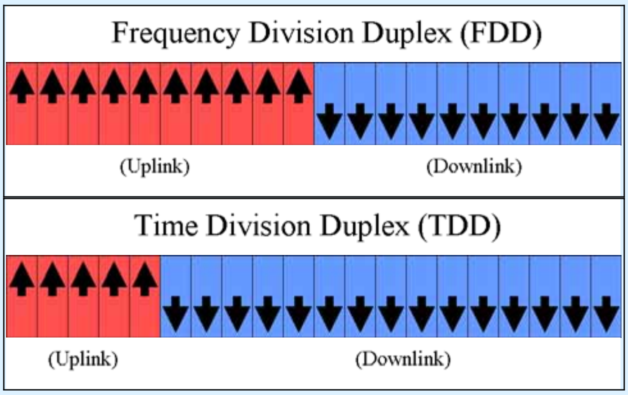
CDMA2000, IMT-MC

CDMA2000 technologies have been the surprise winner throughout the world in terms of IMT-2000 deployment. This is mainly because second generation CDMA IS-95 networks could be relatively easily, and inexpensively, upgraded to CDMA 2000 1x networks. This has allowed for operators with existing CDMA networks to jump rapidly to the next generation.

The CDMA2000 standard has also evolved to allow for faster data transfer. CDMA2000 1x EV-DO (evolution-data only) allows for much faster data-only speeds (700 kbit/s – 2 Mbit/s). The Republic of Korea has the world's most extensive CDMA2000 1x EV-DO network and is doing commercial trials of the second iteration of the standard, CDMA2000 1x EV-DV (Evolution-Data and Voice). EV-DV should enable speeds of up to 3.1 Mbit/s for users.

Of the five radio interfaces for IMT-2000, W-CDMA and CDMA2000 have proven the most popular, though they are not necessarily optimal networks for dedicated data access. W-CDMA and CDMA2000 both use Frequency Division Duplex, which separates the uplink and downlink on different frequencies. For example, when a user on a W-CDMA or CDMA2000 network speaks, their voice is transported over one swath of frequencies while the voice of their interlocutor uses a different band of frequencies. The uplink and downlink channels are the same size since voice conversations require the same amount of bandwidth in both directions (see Figure 2.3).

Figure 2.3: Symmetric or Asymmetric data on IMT-2000 network
Data uplinks and downlinks on FDD and TDD networks



Source: ITU adapted from: http://www.itu.int/ITU-D/tech/imt-2000/warsaw/pdf/2_1_Menzel.pdf

These equally-sized uplink and downlink channels, while fairly well suited for voice, are not optimal for mobile Internet use, which is typically asymmetric in nature. In the broadband world, ADSL technologies have allowed operators to offer faster download speeds in return for slower upload speeds by repositioning some of the unused, original upload frequencies to the download side. Since mobile networks using FDD have fixed upload and download channel sizes, they may not be ideal for data-heavy portable Internet applications. These limitations were highlighted in the Republic of Korea when the leading mobile operator, SKT, launched a video-on-demand service over a CDMA2000 1x EV-DO network (see Box 2.4).

Box 2.4: Lack of bandwidth killed the mobile video star
SKT's service so popular it brought traffic to a standstill

SKT, one of the three main cellular mobile operators in the Republic of Korea, learned quickly in 2003 about how important pricing is to network health when it launched its "JUNE" EV-DO video-on-demand service. JUNE subscribers paid a monthly flat rate of US$ 17 (20'000 Won) for video data traffic and then USD 0.85 (1'000 Won) for each movie they watched. The users were essentially paying a dollar for each movie and then a flat rate for the data connections the movies floated over. Mobile subscribers couldn't resist being able to watch their favourite movies during their long commutes and the service was an astounding success.

While strong consumer interest is usually good news for mobile providers, SKT's network began to buckle under its own success. There were simply too many users who were downloading movies and videos at USD 0.85 each and too little bandwidth in the spectrum to accommodate them.

SKT was forced to discontinue the service under the existing pricing plan and move to a per packet charge on the video data. The USD 0.85 "rental charge" remained the same but data charges jumped from USD 17 per month unlimited to roughly USD 60 per movie. Because the change in policy was so swift, some users didn't realize the price of watching a movie had jumped astronomically and received huge bills the following month.

SKT has not given up on the idea of flat-rate pricing for movies. However, any new flat-rate pricing plans will most likely have an upper limit similar to the broadband bit caps common in some parts of the world.

Source: SKT

TD-SCDMA

The third IMT-2000 radio interface, TD-SCDMA, addresses inherent problems with data downloads over a mobile network by using Time Division Duplex (TDD) rather than FDD for data. The carrier frequency on a (TDD) system is used for both the uplink and downlink. This is possible by alternating time slots for sending and receiving data and allows an asymmetric transmission flow that is much better suited to typical Internet applications.[4] TD-SCDMA is closely related to W-CDMA, differing mainly in the division duplex method. TD-SCDMA networks have not yet appeared in production networks but many some carriers around the world, especially in China, have expressed keen interest in the technology.

EDGE, IMT-SC

Throughout the GSM world, users have been introduced to mobile data via General Packet Radio Service (GPRS). GPRS, a 2.5G standard, offers maximum speeds of up to 171.2 kbit/s by combining up to 8 time slots simultaneously to send packet switched data.[5] However, these theoretical speeds were practically out of reach of individual users on a single cell, making high-speed mobile data over GPRS difficult. Instead, GSM operators are increasingly turning to a technology known as Enhanced Data rates for GSM/Global Evolution (EDGE) as a way to provide higher-speed mobile data over both high-speed circuit switched data (HSCSD) and GPRS connections. EDGE essentially offers a way to triple the amount of data that can be sent simultaneously.[6] EDGE services are beginning to appear in countries around the world as the basis of mobile Internet services and are often sold separate from mobile voice services. They offer individual users between 150-200 kbit/s data transmission, usually for a flat rate (see Box 2.5).

There are two main ways EGDE networks are being marketed. In many developed ICT economies, EDGE services are sold as mobile Internet connectivity for laptops and PDAs. Instead of subscribing to a mobile phone service, users simply subscribe to wireless connectivity, the same way they may subscribe to Wi-Fi services. In many developing economies, EDGE services may play a larger role in delivering faster data to mobile phones. EDGE cards may also be used in fixed, desktop computers to offer Internet connectivity.

One of the biggest benefits of EDGE is it can be implemented on both TDMA and GSM networks, offering a unified path towards IMT-2000 data delivery.

Box 2.5: Ghana – On the cutting EDGE in Africa

How a new mobile wireless technology in Ghana will provide mobile Internet connectivity

Ghana's Scancom is currently preparing to build Africa's first 3G network based on EDGE technology. The current GSM radio network will be upgraded to support EDGE and allow users fast mobile data. The new network will be available on EDGE enabled phones as well as PC LAN cards for computers. The fast connections should be a boon for Ghanaians looking for mobile data access.

EDGE services such as Scancom's will most likely be built around densely populated areas or rural areas bordering urban centres. However, if initial trials are successful, services should expand into more rural locations.

Source: http://www.ghanaweb.com/GhanaHomePage/NewsArchive/artikel.php?ID=54599.

2.2.2 Fixed wireless access

IMT-2000 technologies will cover the highly mobile but lower speed portions of the portable Internet while fixed wireless technology will fill the niche of high-speed, long distance, but stationary connectivity. Microwave connections have traditionally been used as backhaul connections between cities by telecommunication providers. However, fixed wireless connections are currently being promoted as replacements for wired broadband connections. The key role of fixed wireless technologies in the portable Internet will probably remain as a cost-effective high-speed backhaul connection to a city, village, or even a community access centre.

Currently, the bandwidth of fixed wireless technologies is determined by the allocation of the radio spectrum, a finite resource. Typically, 1 Hz of spectrum can yield 1-4 bit/s of throughput, depending on various factors (such as modulation technique and environmental conditions).[7] Most fixed wireless systems use a band of frequencies between 900 Mhz to 40 Ghz. The inherent trade-off for fixed wireless systems is distance vs. speed. Higher frequencies carry far more data but cannot travel as far as lower frequencies, often requiring line of sight. Higher frequencies also require more complex equipment that can be more expensive. Lower frequencies on the other hand, travel further and are cheaper, but cannot transmit large amounts of data.

Fixed wireless systems have been slow to gain ground when compared with traditional, wired high-speed connections. This is due to several factors including the lack of standardized fixed wireless equipment and variations in spectrum allocations among countries. As a result, the most promising technologies of several years ago, Local Multipoint Distribution Systems (LMDS) and Multi-channel Multipoint Distribution Systems (MMDS)[8], have been relegated to small, highly specialized rollouts.

However, a new set of technologies is promising to change wireless adoption the same way Wi-Fi has changed localized Internet access. Two promising new developments, IEEE 802.16 and IEEE 802.20 are competing to become the new standard for fixed wireless. In fact, both are promising something that previous fixed wireless technologies have not allowed, that is to say mobility.

IEEE 802.16 (WiMAX)

WiMAX or "Worldwide Interoperability for Microwave Access" may revolutionize the way the developing and developed world access information. A new fixed wireless technology that promises to reduce the need for wired long-haul, high-capacity Internet connections, WiMAX, is expected to be able to transmit a full 70 Mbit/s over a range of 50 Km. Higher frequencies would require line-of-sight but could transmit the most data. At lower frequencies, the distances could be increased but overall speeds would be reduced.[9]

WiMAX can utilize either a point-to-point or a point-to-multipoint architecture. The initial version (IEEE 802.16) was developed to meet the requirements for broadband wireless access systems operating between 10 and 66 GHz. A recent amendment (IEEE 802.16a) does the same for systems operating between 2 and 11 GHz.

The WiMAX Forum is hoping to replicate the astounding success of a shorter-range wireless technology, 802.11b or Wi-Fi. In line with the work of the Wi-Fi Alliance, the WiMAX working group includes leading companies in many industries whose clout in their individual markets could help promote a common standard.[10] Second, the WiMAX Forum will also offer a "stamp of approval" that one manufacturer's equipment will interoperate with other certified products, further helping to create a single common standard.

WiMAX was initially destined to be a fixed wireless standard. However, recent developments—including the relatively slow rollout of third-generation mobile data services—have left a strong demand for inexpensive mobile data untapped. As work on the 802.16 standard evolved, the working group introduced the ability of 802.16 to accommodate mobility, through 802.16e. In the Republic of Korea, researchers are currently on the cutting edge of developing a practical mobile WiMAX solution called WiBro (see Box 2.6).

Box 2.6: Korea's WiMAX vision - WiBro

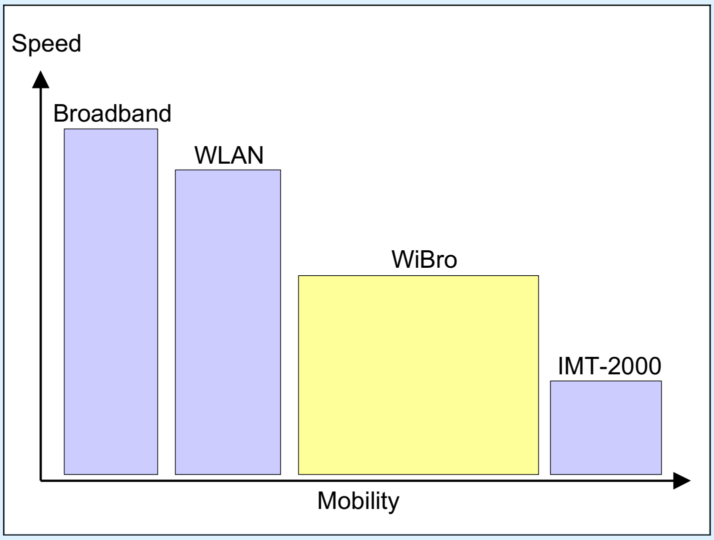
Korea's appetite for mobile Internet applications fuels development of a WiMAX-based wireless technology

Korea's policy-makers, broadband providers, and mobile operators have come up with a plan to develop a new data network that is more efficient at offering mobile data than current broadband or mobile networks. This plan is called WiBro for "Wireless broadband" and is based on the IEEE 802.16e standard using the 2.3 GHz frequency band. WiBro is a technology that fits well between WLAN and IMT-2000 in terms of mobility and speed (see below). It would offer a 512 – 1024 kbit/s connection to users for a flat monthly fee. Operators have not said how much they will charge but industry watchers assume the prices will be about USD 15.

All major telecommunication players in Korea have plans for the 2.3 GHz frequency allocation that was finalized in February 2004. KT, for example, has already introduced a "seamless" offering through its Nespot Swing, a bundled package that where users can roam between Wi-Fi hotspots and the CDMA2000 1x EV-DO network, when out of Wi-Fi range. Including WiBro coverage is the next practical step for the service.

WiBro has several advantages over WLAN and IMT-2000 for delivering data. While Wi-Fi is limited to a range of roughly 100 meters, WiBro will be accessible in a 1 km radius around a base station with connection speeds of 512 kbit/s guaranteed to moving vehicles at 60 km/h (see figure below right). Mobile carriers are especially interested in WiBro because of their significant investment in cell towers throughout the country that can quickly be leveraged to offer WiBro services. This upgrade can be effectuated simply by adding a second set of radios on the towers.

About WiBro



WiBro at a glance	
General	
Frequency:	2.3 GHz
Licenses:	Awarded by ministry
Bandwidth	
Per user:	512 - 1024 kbit/s
Total:	100 MHz
Maximum accessible speed for users:	
Practical:	60 km/hour
Theoretical:	250 km/hour
Pricing estimates	
Flat rate pricing:	15 USD/month, est.

Source: ITU case study: Republic of Korea at http://www.itu.int/osg/spu/ni/futuremobile/general/casestudies/koreacase-rv4.pdf

The benefits of the new WiMAX standard could be reaped by both developing and developed economies alike. First, WiMAX will be a boon to developing economies that have been unable to develop extensive fixed-line infrastructure. Second, economies with extensive infrastructure can leverage WiMAX as a more cost-effective method for delivering mobile data.

Box 2.7: WiMAX on the train in the United Kingdom

How the anticipated 802.16e standard can bring Internet connectivity to trains

Nomad Digital Rail (NDR) in the United Kingdom supplies trains with networking equipment to allow passengers access to the Internet during their ride. Equipped trains can offer riders access to the Internet during the journey via a Wi-Fi connection inside the cars, and a WiMAX connection supplying the Internet backbone to the moving train.

This high-speed data network won't just be used for Internet access. The WiMAX/Wi-Fi combination allows for train operators to deliver on-board television, security surveillance, and real-time vehicle monitoring.

WiMAX is a very promising technology for train operators but may still be difficult to implement. The Korean adaptation of an 802.16e technology, WiBro, will offer only 512 kbit/s at 60 km/hour. This could pose problems for trains that travel considerably faster.

Source: Nomad Digital http://www.uknomad.com/pageb3.htm and
"WiMAX Trials Speed Up" at: http://www.theregister.co.uk/2003/12/09/WiMAX_trials_speed_up/

IEEE 802.20

WiMAX began as a fixed wireless technology with extensions to allow for mobile access. However, the "fixed" roots of WiMAX may leave it with legacy elements that inhibit efficient connectivity at high speeds. As a result, a new technical standard, named IEEE 802.20, is evolving that focuses solely on long-range, high-speed mobile connectivity.[11]

The new 802.20 standard is much more flexible with the amount of spectrum it requires. As a fixed wireless protocol, WiMAX requires large swaths of spectrum, of which most of the optimal bands are already occupied. The 802.20 standard is designed to work in much smaller bands that can be scavenged amidst existing spectrum allocations.

IEEE 802.20 was designed from the beginning to be a mobile technology while WiMAX began was originally envisioned as fixed wireless broadband. However, as with many technologies, particular strengths and weaknesses of a technology do not always dictate which one will survive or flourish in the market. Much of the success of standards is tied to clever marketing and organization. Wi-Fi has been a phenomenal success while one of its competitors, HyperLAN, has had a difficult time gaining a foothold in the market. This is interesting given one of the key benefits of HyperLAN, quality of service, is lacking in Wi-Fi and is considered one of Wi-Fi's greatest flaws.

WiMAX already has considerable backing through industry leaders such as Intel, Fujitsu, Proxim and Seimens. The backers of IEEE 802.20 include Flarion and ArrayComm. Several network operators are running trials of early 802.20-type services (see Box 2.8). However, WiMAX appears to have a much stronger marketing push at this time.

2.2.3 Satellite technologies

The longest-range wireless connections are achieved via satellites. Satellite data services cover a vast area of the globe and can provide access in areas where no other services are available. Satellites provide essential connections in remote areas (oceans, mountains) as well as densely populated areas that are not served by other telecommunication providers.

Satellite technologies offer the longest range but are expensive for even small data streams. They can also suffer from latency problems (the delay between a signal being sent and received)[12], which can make time sensitive transmissions, such as voice, problematic.

In the past, communication satellites[13] have provided radio, telephone and television links around the world. Communication satellites have traditionally been launched in a geostationary orbit. Like other geostationary satellites, they orbit at the same rotation rate as the Earth, thus appearing to be stationary. A fleet of three geostationary satellites can provide complete global coverage. However, their orbital height of 35'650 km and resulting power requirements have made broadband access for consumers and mobile devices relatively impractical.

Box 2.8: Early 802.20 trails in the United States

Nextel is making a gamble on FLASH-OFDM technology over 802.16

Nextel communications has built a new network based on networking equipment from Flarion, one of the main proponents the IEEE 802.20 standard, which is still under development. The network is based on proprietary Flash-OFDM technology to deliver data to users. While the IEEE 802.20 standard has yet to be decided, the technology Flarion is using is considered a very likely candidate.

In the test area of Raleigh/Durham, South Carolina, in the US, users can choose between plans ranging in price from USD 34.99 to USD 74.99, depending on speed. At the lower price points, users can download at 700 kbit/s and upload to the network at 200 kbit/s. Users who pay more have access to higher speeds, roughly 1.5 Mbit/s and up to 3 Mbit/s in short bursts. These speeds put Nextel's service in the range of CDMA 2000 1x EV-DO.

Users signing up for the service are only required to buy either a Flarion PCMCIA card or modem for around US$ 50 when they sign up. The majority of people signing up for the service have indicated they value the use their Internet connections "on the go." Data transfers have been tested up to 110 km/h.

One of the most interesting aspects of the network is the ability to offer different priority levels to different levels of subscribers. Users paying higher subscription fees will have first packet priority on the network, ensuring a higher quality of service for uses such as video streaming. Other users may prefer lower fees in exchange for a lower priority on the network.

While Nextel's initial trail has now expanded to commercial service, there are still questions about the future of the network. First, the network could be a risk for Nextel since the standards have not be formally adopted. Industry watchers also fear that by choosing a new, unproven standard, Nextel may repeating the same scenario that doomed MMDS and LMDS systems.

Source: http://wifinetnews.com/archives/cat_80220.html and http://www.nextelbroadband.com/about_the_trial.html

In the past decade, a number of companies invested heavily in building networks of non-geostationary satellites that orbit much lower in the sky. These low-earth orbit (LEO) satellites orbit between 650 km and 2'575 km above the Earth. Each LEO satellite is only in view for a few minutes, and rotates around the world every few hours. This means multiple LEOs are required to maintain continuous coverage by having at least one satellite in "sight" at all times. LEO constellations have the advantage of shorter transmission delays and less power requirements because they are much closer to the Earth's surface. However, they also require more complicated handsets and equipment on the ground that are capable of synchronizing among many satellites to maintain a connection.

While satellite technology has been proven, the economics of many satellite systems have not, with some earlier attempts to build extensive LEO satellite networks ending in failure. Examples include narrowband Global Mobile Personal Communications by Satellite (GMPCS) systems, such as Iridium and ICO, as well as broadband systems such as Teledesic - Teledesic's initial plan for a constellation of 840 LEO satellites was eventually downgraded and cancelled before a single satellite had been launched.[14]

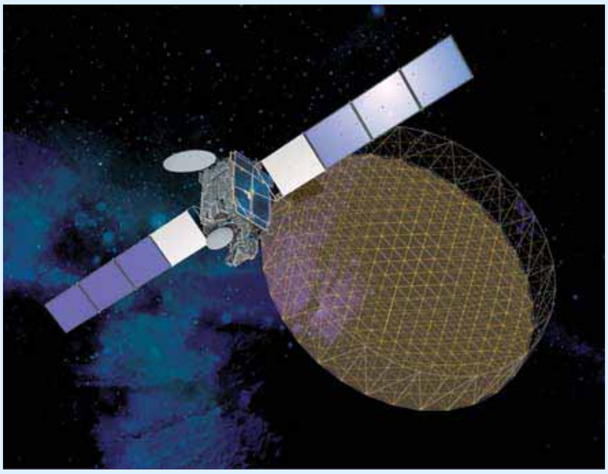
The future of satellites in the portable Internet may well revert back to a service where satellite technologies have proven superior: one-way broadcast video. Japanese and Korean operators and mobile phone manufacturers are embracing digital media broadcasting (DMB) via satellite. With DMB, a mobile phone or PDA becomes a receiver for satellite subscription television. Mobile phone and PDA users will be able to subscribe to services and watch broadcast programs on the move, in the same way they use digital satellite TV while at home. Ideally, services should be offered on a monthly flat-rate basis.

Box 2.9: Satellite audio and video come to portable devices

Japanese-Korean joint venture will enable high quality video/audio to be streamed to portable users in East Asia

Japan and Korea successfully launched a new communication satellite on March 13, 2004 that will provide digital video and audio to users in both countries this year on a subscription basis. Users will be able watch satellite TV on a host of mobile terminals, including mobile phones, PDA's, home theatres, and on equipment installed in cars, buses, trains, and ships.

Devices will only require a small antenna (built into new devices) to receive the signals since satellite will broadcast on frequencies in the 2.6GHz range. This eliminates the need for a precisely aligned satellite dish, which is required for current digital TV services. Samsung is currently building a mobile phone with the specialized receiver built in.



The satellite is co-owned by Korea's leading mobile operator, SK Telecom (35 per cent) and a consortium of Japanese companies called MBCO (65 per cent). Korean subscribers should have access to 40 channels while Japanese users should have close to 70 channels. The satellite is expected to have a life span of 12 years and services are should to appear in 2004.

*Source*s: http://www.infoworld.com/article/04/02/06/HNsamsungcell_1.html,
http://www.spacedaily.com/news/satellite-biz-04zk.html
http://www.casbaa.com/news_releases/news_content.asp?news_id=372
http://www.ssloral.com/html/products/programsdbsmbsat.html (image)

While satellites have long been used to reach areas on earth inaccessible to other types of communication, they are now also used increasingly to provide access on airplanes. Portable Internet services are now being deployed on commercial and business aircraft around the world. There are two main providers of mobile data services in aircraft vying for market share: Tenzing and Connexion. Each has focused on a different set of usage patterns for passengers. Tenzing has focused on low-cost, low bandwidth messaging solution while Connexion is focused on high-speed broadband connectivity.

Tenzing's services work with phones already installed in the seats of many airlines, or via a USB port in the aircraft seat. Users connect their laptop and can send e-mail via the air. Tenzing also offers services where users can use any instant messaging client or send SMS messages to mobile phone users. These messages are sent via lower cost cellular networks over land in the US example, but rely on satellites for communication over oceans. Tenzing is hoping to carve out a niche in text communication, which it assumes is the most useful to passengers and also the most cost-effective service to provide. Future upgrades of the service should allow unlimited broadband connectivity.[15]

Boeing's vision of in-flight data demands involves a seamless broadband experience, similar to what users would have available on the ground. Boeing's new service takes advantage of a decision at the ITU World Radio Conference 2003 which allowed for aeronautical mobile-satellite services in the 14-14.5 GHz frequency band.[16] The airplane uses a satellite broadband connection to transfer data between the Internet and the aircraft. The connection onboard is shared via Wi-Fi. The Connexion service allows users full, real-time access to the Internet at broadband speeds, making VoIP, video/audio streaming, and high-speed web browsing possible (see Box 2.10).

Box 2.10: The cost of Internet access in the sky
How pricing varies based on the amount of connectivity and the duration of the flight

Connexion

Flat rate pricing (unlimited)

- USD 29.95 for long-haul flights (greater than 6 hours)
- USD 19.95 for medium-haul flights (3 – 6 hours)
- USD 14.95 for short-haul flights (less than 3 hours)

Metered pricing

- USD 9.95 for 30 minutes and $0.25 per minute thereafter

Tenzing

Flat rate pricing (unlimited e-mail)

- USD 9.95 for e-mail service for flights in the US
- USD 19.95 for e-mail service internationally.

Flat rate pricing (instant messaging)

- USD 5.95 for US flights.

Source: http://www.tenzing.com/passengerinfo/faq.php
http://www.boeing.com/news/releases/2004/q1/nr_040325j.html
http://www.connexionbyboeing.com/ (graphic)

HAPS/LAPS

High and low altitude platform stations (HAPS or LAPS) offer the coverage benefits of satellites at costs closer to fixed infrastructure. HAPS and LAPS are balloons or other low and high altitude platform stations that can provide data services over a large area for relatively low cost. Balloon systems are typically tethered via a cable and hover at an altitude of around 3 Km. A fibre optic cable runs alongside the tether cable up to the balloon which then uses radio frequencies to send and receive data traffic from users on the ground. Untethered systems hover at much higher altitudes of 21 km above the ground and rely on radio communication for traffic between users and the HAPS as well as between the HAPS and the ground station's Internet connection.

Several companies are developing different types of HAPS and LAPS technologies in an effort to provide satellite-type coverage at a fraction of the cost. SkyTower has developed a solar-powered, unmanned aircraft that can hover at an altitude of 18 kilometres for 7-14 days and for more than 6 months at lower altitude, covering a range between 50-250 miles on the ground. Another company, Skylinc has a proposal to deploy 18 tethered air balloons across the United Kingdom that will hover 1.5 kilometres in the sky and supply access within an 80 km footprint.

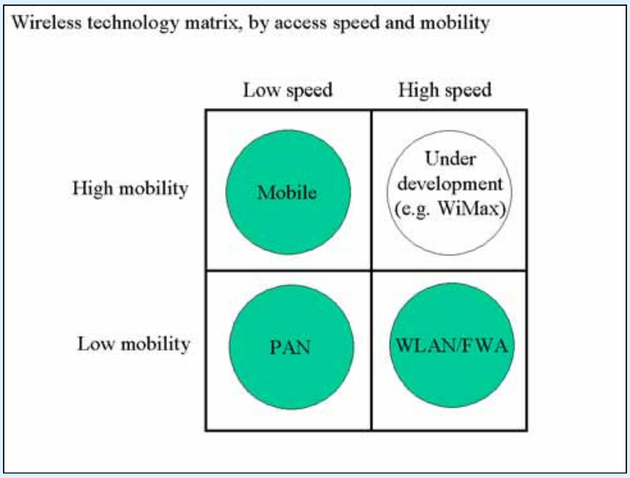
The key market for LAPS and HAPS will likely be rural and developing areas that are underserved by traditional infrastructure. However, they could also play a key role for newer wireless technologies such as WiMAX. Since LAPS and HAPS are underlying platforms for delivering a range of wireless connectivity, their radio equipment could make use of the most current technologies to provide fast connectivity within line of sight. Since the line of sight requirement could be met for many applications, the frequencies and corresponding transmission speeds could be much higher.

2.3 Medium-range technologies

Communication becomes easier as objects move closer to each other. The shorter distance between medium-range technologies allows transmissions with less power, higher frequencies, and higher throughput. Portable Internet users will likely gravitate towards the closest connection available, since it should also be the fastest. As a result, medium range technologies will play a key role in connecting end-user devices to the network.

While medium-range technologies offer higher bandwidth it comes at a cost, reduced mobility. Medium-range technologies are often given the name “portable” rather than “mobile” since they are essentially a fixed connection that can be transported. Medium-range connections can be used within a large radius of a transmitter, making the connection portable. However, the ability to easily maintain a connection while moving (mobile) has been elusive (see Figure 2.11).

Figure 2.4: Wireless tradeoffs
Wireless technology matrix



Note: Portable Internet technologies have traditionally fallen into a matrix of mobility and transmission speeds. Mobile (long range) technologies allow much greater freedom of movement but at the cost of reduced data speeds. Medium-range technologies such as WLAN offer higher speeds but restrict movement. The trade-off between speed and mobility is apparent in the fourth quadrant where no current technologies offer high mobility and high speeds simultaneously. However, engineers are working to add mobility to new long-range technologies.
Source: ITU

Many medium-range technologies are already popular around the world. One striking example is the promulgation of Wi-Fi hotspots. This section will examine some of the most promising, medium-range technologies and explore how they will interact in the portable Internet world.

2.3.1 WLAN (Wireless Local Area Networks)

Fixed-line broadband connections offer the fastest speeds but are confined to wired connections. However, a subset of wireless technologies, WLANs, is expanding the reach of broadband in the 100-metre range. By definition, a WLAN or wireless local area network is defined as a local area network of which at least one segment uses electromagnetic waves to transmit and receive data over short distances. In a typical WLAN configuration, mobile devices tie into a wired, broadband network via an "access point". The radio in the mobile device communicates with another radio in the access point to pass data back and forth. It is worth noting that the phrase “wireless LAN” is somewhat of a misnomer, given that the wireless network typically extends the reach of a “wired” LAN, to which it is connected.

As mentioned earlier, the typical range of a WLAN connection is roughly 100 meters. This means that WLAN implementations typically branch off of a wired Internet connection. Indeed, WLAN technologies have been extremely popular with home users who use them to share one household broadband connection with several computers and devices. WLAN technologies are designed to spread a network connection over a short range but they are increasingly being used as backbone telecommunication infrastructure in developing economies with great success.

The WLAN market is currently dominated by one technological standard, IEEE 802.11b (commonly known as Wi-Fi), though several new variations are quickly gaining popularity.[17] This section will briefly examine Wi-Fi, as well as other promising technologies that make up the WLAN family.

802.11b (Wi-Fi)

IEEE 802.11b is the most popular WLAN technology in the world and is the choice for public hotspot access. IEEE 802.11b is known by its common name, "Wi-Fi" even though Wi-Fi is a certification trademark for devices that are tested and proven to pass interoperability criteria.

Wi-Fi equipment uses the 2.4 GHz frequency band that is set aside in many countries for unlicensed use. The 2.4 GHz frequency range allows for transmission through objects (e.g. walls, ceilings) while also allowing high data throughput. In direct line-of-sight scenarios, Wi-Fi has a range of 100 meters. However, inside offices and residences, Wi-Fi's range is much lower. Directional antennas and amplifiers can be used to extend the range of 802.11b products provided the total power radiated does not exceed what is allowed by nationally applicable regulations.

802.11b is a half duplex protocol, i.e. transmissions can either be sent or received at one given time, but not simultaneously. Interference can also be an issue as the 2.4 GHz range is also used by many cordless phones, microwave ovens and some wireless local loop (WLL) radio systems. Wi-Fi allows for a throughput speed of 11 Mbit/s under optimal conditions. As the amount of interference or distance between radios increases, the maximum connection speeds also decrease.

Table 2.1: Wi-Fi ranges
The various ranges of Wi-Fi in different environments

	Range	
Environment	**Maximum**	**at 11Mbit/s**
Outdoors / open space with standard antenna	225-300 m	45-100 m
Office / light industrial setting	75 - 100 m	30-45 m
Residential setting	40-60 m	20-25 m

Source: The Wi-Fi Alliance at: http://www.weca.net

While Wi-Fi is surely one of the key technologies of the wireless Internet, the standard has some drawbacks that may hinder faster development of some portable Internet applications. First, Wi-Fi offers no quality-of-service guarantees for users. Essentially, Wi-Fi does not have a way to guarantee that transmissions arrive at a certain time or with a dedicated amount of bandwidth. This causes problems for applications such as voice and video that require dedicated and continuous streams. In times of congestion or interference, synchronization problems can disrupt voice and video communication.

In addition, Wi-Fi was inherently insecure due to a fault in implementation of the RC4 encryption scheme. This flawed implementation means that the original security scheme could be broken in less than a day of heavy traffic using freely available programs on the web such as AirSnort or WEPCrack[18]. The Wi-Fi Alliance has released a new security scheme that enhances the security of Wi-Fi. The new technology is called Wi-Fi Protected Access (WPA) and allows for much stronger encryption while “plugging” the hole left by the flawed original RC4 implementation[19]. Despite the promise of WPA, researchers have demonstrated that they have been able to break the new scheme, using techniques which have nothing to do with the protocol itself. In the end, WEP and WPA can only be seen as one level of a multilevel security implementation that should also include additional encryption such as Remote Authentication Dial-In User Service (RADIUS) protocol and Point-to-Point Tunneling Protocol (PPTP).

Finally, Wi-Fi radio equipment has higher power requirements than than many other wireless technologies, including CDMA and W-CDMA. This means that while portable Wi-Fi equipment may offer faster speeds than mobile phones, the amount of time a user can talk on a Wi-Fi enabled phone may be reduced due to reduced battery life (see Box 2.11).

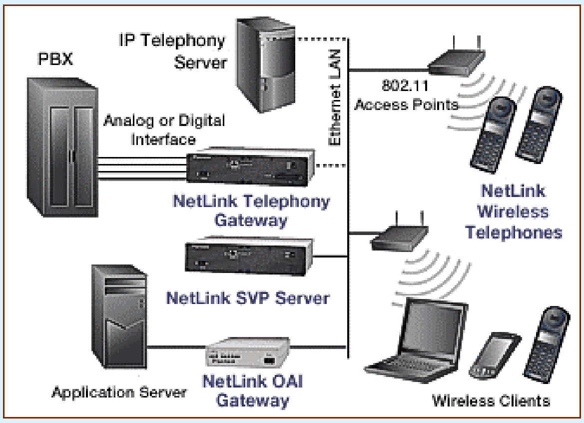
Box 2.11: Wi-Fi is coming to a cordless phone near your office
Wi-Fi phones appearing as desktop telephone replacements

Enterprises around the world have discovered the benefits of Wi-Fi for offering Internet connectivity to employees throughout their buildings. Historically these connections were used to access e-mail, files, and general Internet browsing. However, Wi-Fi's available bandwidth is increasingly used for voice calls and video monitoring within businesses.

SpectraLink has developed several Wi-Fi phones for use in an office environment. The phones work in a traditional PBX but replace the wired connection on the desk with a Wi-Fi connection. This allows the phones to be used anywhere throughout the building as long as there is a Wi-Fi connection. The phones resemble cordless phones commonly used in households.

Another benefit of Wi-Fi phones is the ability to use Push-to-talk (PTT) to communicate with other users. Some Wi-Fi phones use the same network to pass on walkie-talkie messages between employees.

Gone will be the days when office workers can leave a message that they've just "stepped away from their desk" because they can take their phone with them.



Source: http://www.spectralink.com/products/nl-wts.html.

802.11g

While Wi-Fi (802.11b) is the most popular and widespread WLAN protocol, a faster variation of the technology is starting to take the place of original Wi-Fi equipment around the world. 802.11g uses the same 2.4 GHz unlicensed band of spectrum as Wi-Fi but incorporates a different modulation technique to send data. 802.11g uses Orthogonal Frequency Division Multiplexing (OFDM) and allows for much faster transmissions due to more efficient spectrum use. 802.11g networks have a maximum speed of 54 Mbit/s in contrast to 11 Mbit/s on traditional Wi-Fi networks. In addition, 802.11g equipment is backwards compatible with Wi-Fi, allowing "g" users to connect to "b" networks. However, 802.11g throughput speeds are only possible if both the access point and the user's system both use the "g" standard. Otherwise the network runs as fast as its slowest component.

As the price of 802.11g equipment approaches that of 802.11b products there should be a gradual shift from "b" to "g" products to take advantage of the increased speeds and better spectral efficiency of the standard

802.11a (Wi-Fi5)

Both 802.11's "b" and "g" variants work in the unlicensed 2.4 GHz band but 802.11a, sometimes referred to as WiFi5, mainly takes advantage of the less-congested 5 GHz range. The "a" variant of the standard is not as common as Wi-Fi but has been mainly adopted by enterprise for its fast speeds. Both Wi-Fi and Wi-Fi5 share a common heritage but are incompatible with each other. In addition to operation in a different frequency range, the modulation techniques of the two technologies are different. 802.11a makes use of Coded Orthogonal Frequency Division Multiplexing (COFDM), which sends data in parallel streams to increase capacity[20]. This allows for speeds nearly five times as fast as Wi-Fi.

Table 2.2: A vs. B vs. G
The tradeoffs between different 802.11 technologies

	802.11a	802.11b	802.11g
Number of channels	Superior		
Interference	Superior		
Bandwidth	Superior		Superior
Power consumption		Superior	Superior
Range/penetration		Superior	Superior
Upgrade/compatibility			Superior
Price		Superior	Superior

Source: Adapted from Network World Fusion at: http://www.nwfusion.com/details/466.html.

Currently, 802.11 "b" and "g" products are less expensive and much more prevalent that 802.11a technology, with the majority of hotspots opting for "b" and "g" based networks in the 2.4 GHz range. However, 802.11a may succeed in the end due to the open spectral space it occupies. As the 2.4 GHz range become more crowded, users may gravitate towards "a" equipment to avoid interference. A decision by the ITU World Radio Conference in July 2003 to release additional spectrum for WLAN use in the 5 GHz range may also add to its popularity. Also, the introduction of combination "a", "b", and "g" wireless cards on the market should also help spur demand for "a"-based networks.

Upcoming IEEE 802.11 standards

802.11i

IEEE 802.11i is a new security standard intended to bring much higher levels of security to 802.11 wireless networks[21]. The standard has not yet been finalized but is based on WPA, a new security implementation for legacy equipment, and Robust Secure Network (RSN) for new devices. The WPA will moderately boost the level of protection for legacy products (e.g. 802.11a, b, and g). RSN dynamically negotiates the authentication and encryption algorithms to be used for communications between WAPs and wireless clients, which means that as new threats are discovered, new algorithms can be added. As mentioned in the Wi-Fi section, WPA encryption can also be broken when the passphrases used to generate keys are not sufficiently strong. This reiterates that secure WLAN implementations will require at least one more level of security for sensitive data.

802.11n

The 802.11 group is also working on a future standard, "n", that should allow for WLAN speeds up to 100 Mbit/s, the speed of traditional wired 100-base-T networks and typical end-user fibre optic connections. IEEE is currently working on defining the standard but "n" offers insight into how engineers envision speeds from the next generation of Wi-Fi.[22]

802.11h

A decision at the ITU World Radio Conference[23] held in Geneva, Switzerland in 2003 on the 5 GHz band of spectrum has made it possible for an amendment to the IEEE 802.11 standard to safely use more spectrum globally. This amendment, IEEE 802.11h, has two main elements: dynamic frequency selection (DFS) and transmit power control (TPC). Dynamic frequency selection detects the presence of a primary service and switches the WLAN to a clear frequency. Transmit power control reduces the total power on a Wi-Fi network. The Wi-Fi Alliance plans to add interoperability testing for 802.11h mitigation measures to its certification program in 2004.

HiperLAN/2

While IEEE standards for WLAN clearly dominate the market, the European Telecommunications Standards Institute (ETSI) has developed a competing WLAN standard called High Performance Radio Local Area Network or HiperLAN/2. The standard is very similar to IEEE 802.11a and operates in the same 5 GHz frequency band. The theoretical maximum data speeds are 54 Mbit/s as a result of orthogonal frequency division multiplexing (OFDM).

The greatest advantage HiperLAN/2 has over 802.11a is quality of service (QoS) provision. This makes it a better technology for time-sensitive applications such as voice and video within WLAN range. While the implementation of QoS should have made HiperLAN/2 a popular choice, the technology has struggled to gain popular acceptance. ETSI is hoping this second generation of HiperLAN can be successful but the momentum of 802.11 adoption may have already left HiperLAN adoption far behind.

Table 2.3: Wireless networking technologies
Overview of wireless networking technologies: speed, range and frequency

Name	Speed	Range	Frequency	Notes
802.11b (Wi-Fi)	11 Mbit/s	100 m	2.4 GHz	Most popular and widespread
802.11a	54 Mbit/s	50 m	5 GHz	Newer, faster, higher frequency
802.11g	54 Mbit/s	100 m	2.4 GHz	Fast, backwards compatible with Wi-Fi
802.16 (WiMAX)	70 Mbit/s	50 Km	10-66 GHz	QoS, Very long distance, line of sight req.
802.16a (WiMAX)	70 Mbit/s	50 Km	2-11 GHz	QoS, Very long distance, robust trans.
802.16e (WiMAX)	70 Mbit/s	50 Km	2-11 GHz	Mobile version.
802.2	(NA)	(NA)	(NA)	Mobile to 200 km/h, sm. spectrum bands
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
HiperMAN	NA	50 Km	2-11 GHz	European, compatible with 802.16a
Bluetooth	1 Mbit/s	10 m	2.4 GHz	Cable replacement technology, good QoS.
Infrared LAN	4 Mbit/s	~20 m	350'000 GHz	Same room only, no negative health effects
ZigBee	250 kbit/s	10-60 m	868, 915 MHz 2.4 GHz	M2M communication. Long battery life

Note: 802.11b arrived before 802.11a but the letters refer to the order in which the different standards were proposed.

Source: ITU, updated from *"Birth of Broadband",* 2003

2.3.2 Free space optic (FSO) technologies

Most wireless technologies use radio waves to send and receive data. However, one medium-range, wireless technology makes use of lasers to transmit data. The technology is free space optics (FSO) and is based on the same principle of fibre optics, but without the fibre. A laser forms a connection between two pieces of equipment within direct line-of-sight. Once calibrated, the laser transmits data into the air by switching on and off at very high speeds. The receiving equipment then can decode these flashes of laser light into data.

FSOs can be used effectively to form backbone infrastructure between buildings in the same city. One key advantage is they do not require an allocation of spectrum and can transmit at very high speeds, up to 1 Gbit/s. They can be very cost effective in areas without wired infrastructure. The niche market for FSOs will likely be developed areas with high infrastructure building costs as FSOs eliminate the need to dig up existing roads to lay infrastructure. The FSO backbone can then be used to pass traffic back and forth between other wireless and wired networks. FSOs are particularly useful in conjunction with wireless networks because they do not cause interference with each other.

While an FSO network is relatively inexpensive and quick to set up, there are drawbacks to the technology that can hinder its performance. For example, atmospheric disturbances can affect transmissions. Humidity and fog disrupt the laser since tiny fragments of water in the air can slow down or momentarily block transmissions. Second, the lasers and reception equipment must be absolutely immobile and calibrated to ensure reception by lens on the other end of the connection. The tall buildings that are best equipped for unobstructed line-of-sight transmissions also have a tendency to sway in the wind, which can be problematic.

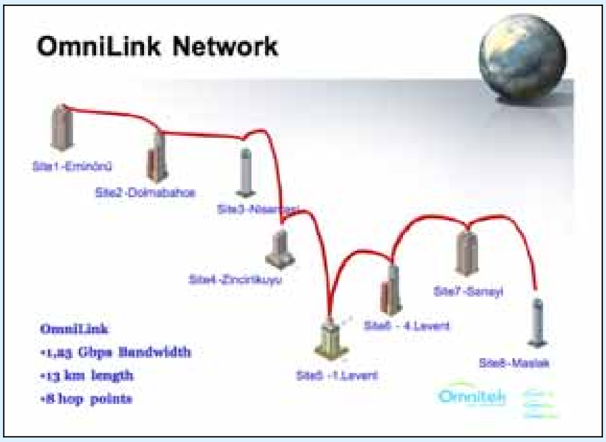
Although FSO transmissions require fixed and calibrated connections to transfer data, they may still be used as backbone infrastructure for the portable Internet. They could be used to backhaul traffic between Wi-Fi hotpots or mobile towers in areas where fixed line infrastructure would be too costly. Another key benefit of FSO technology is it can be taken down when no longer needed (e.g. when fibre lines are available) and reinstalled in another location.

Box 2.12: Lasers passing data in Istanbul

Free space optic technology provides high-speed connectivity in Turkey's largest city

Businesses in Istanbul now are benefiting from increased competition for connectivity due to a new FSO network in the city. The backbone network connects 8 buildings, each 1.2 – 2.3 kilometres apart, over a 13 kilometre stretch of the Maslak-Eminönü route of the city. Each of the eight "node" buildings then disperses connectivity to other surrounding buildings via optical wireless spurs.

Omnitek built the network as a way to offer high-speed connectivity to businesses located in the area. They chose to locate their main transmitters/receivers on buildings with the most prospective subscribers of high-speed connectivity. Buildings in the surrounding area are not excluded from service though. They can be connected to the main line via wireless spurs.



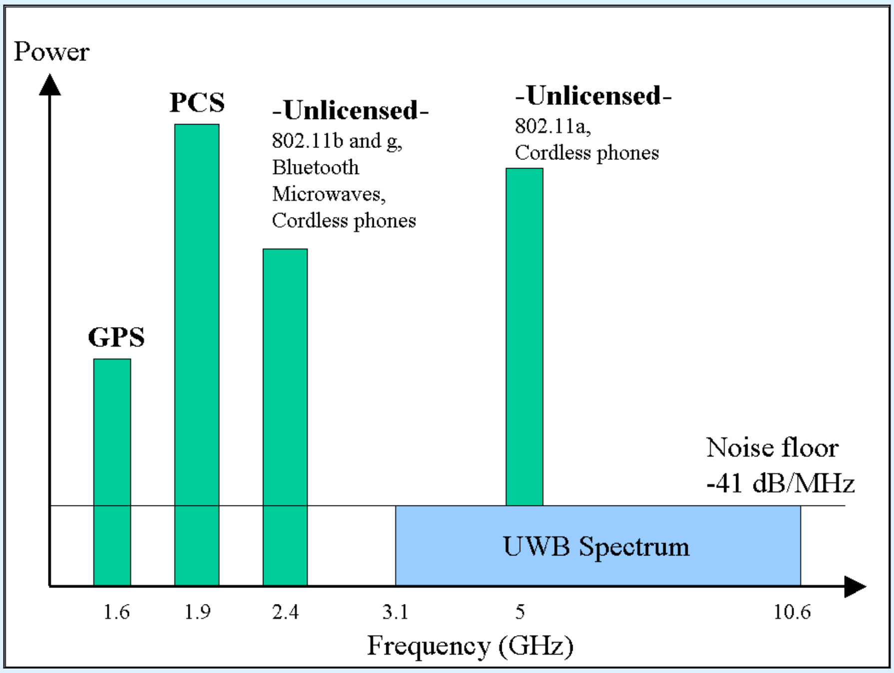
Source: http://www.omnitek.com.tr/tr/default.asp and fSONA at http://www.fsona.com

2.3.3 Ultra-wide band

Ultra-wide band (UWB) is one of the most anticipated radio frequency technologies and also one of the most contentious. Other portable Internet technologies transmit with a powerful signal over a small range of frequencies. UWB takes the opposite approach by sending a very low power transmission over a wide range of frequencies (see Figure 2.5). The UWB power levels are so low that UWB equipment should be able to transmit even in licensed frequency ranges for other devices. Any UWB transmissions are simply seen as low-level noise in the channel. UWB has the potential to offer extremely high bandwidth connectivity among devices in small areas, such as homes. However, some current licensees, especially those who have paid considerable amounts for spectrum, may not be willing to allow other devices, or other service providers, to use their allocated bands. However, as the benefits of UWB may be significant, governments around the world are starting to formulate UWB policies. In addition, the International Telecommunication Union (ITU) has been conducting studies through a Task Group to examine ways in which UWB can co-exist with other radiocommunication services[24].

UWB is a very effective use of radio spectrum and offers great improvements in reception. By employing a wide range of frequencies, UWB allows for effective transmission through objects, including walls and the ground. UWB can penetrate obstacles that would severely hamper communication using traditional higher-powered, narrow band radio waves. This is especially important for radio applications that suffer from multipath problems.

Figure 2.5: UWB operating below the "noise floor"
UWB power use is so low that it is indistinguishable from ever-present "noise" in the channel



Source: ITU adapted from Intel at http://www.intel.com/idf/us/fall2003/presentations/F03USIRDS75_OS.pdf

UWB uses a different method of transmitting data than typical radios. Traditional radio technologies use various carrier waves to send data information. The carrier wave is tuned to a specific frequency and the data is superimposed on the wave by adjusting either its frequency or amplitude. Typical examples are FM and AM radio. UWB is different because, unlike the carrier example of FM and AM radio, it instead uses very fast pulses to represent the zeros and ones of digital communication. In order for receivers and transmitters to effectively communicate, they must be precisely timed to send and receive pulses within an accuracy of a trillionth of second.[25]

The role of UWB in the portable Internet will likely be similar to other WLAN technologies. It will bridge the gap between a very fast, wired connection and a multitude of devices inside a home. Examples include the streaming of high-definition television (HDTV) signals throughout a residence for all televisions and computers. UWB may also be used as a wire replacement between DVD players and television sets, due to its high speeds and robust connectivity. Once the technology has advanced further, it may be possible to use it at high power levels, enabling outdoor use.

2.4 Short-range technologies

Short-range technologies will play a key role in the portable Internet by transmitting data over short distances to end-user devices. In some cases, short-range technologies such as Bluetooth will be used as cable replacements between devices. Other short-range technologies such as RFID and ZigBee will be used to store and transmit small pieces data such as product codes, network status or logistical information.

Short-range technologies are usually slower than their mid-range counterparts such as Wi-Fi. This is because of the trade-offs between power, speed, cost and battery life. Short-range devices only need to transmit a signal over a short distance and thus require only a fraction of the power required by longer-range devices. This significantly reduces battery demands and the resulting size and complexity of the device. Two of the most promising short-range technologies for the portable Internet are Bluetooth and ZigBee, and are discussed below.

2.4.1 Bluetooth

Bluetooth is a short-range wireless standard that was designed to replace proprietary cables between a wide range of computing and communication devices. Bluetooth operates in the unlicensed 2.4 GHz range of spectrum and is capable of transmitting at a speed of 1 Mbit/s over a range of 10 metres. Bluetooth uses a combination of packet and circuit technologies, allowing quality-of-service guarantees for transmissions such as voice and video, while giving less priority to general data packet transmissions. Bluetooth also allows for symmetrical and asymmetrical data transfer, depending on the type of connectivity required.

Bluetooth devices establish network connections by listening for other Bluetooth enabled devices within range and then initiating contact. Common examples include Bluetooth wireless headsets for mobile phones and wireless keyboard/mouse combinations for computers. When more security is required, Bluetooth will require a PIN code to establish a connection with another device. For example, users who make mobile payments via a Bluetooth-equipped mobile phone at a vending machine must type in their PIN to allow the sale to proceed.

One of the most promising aspects of Bluetooth is the ability for a wide range of devices to communicate via a common standard. Similar to the Wi-Fi stamp of interoperability, Bluetooth-certified devices must pass interoperability testing. Some analysts have predicted that this interoperability could enable Bluetooth to finally complete the ultimate merger of mobile and fixed line technology. A Bluetooth-enabled mobile phone could function on a W-CDMA or CDMA2000 network outside, but would quickly revert to a "cordless" fixed-line connection when the user was in the office or at home. Bluetooth could also bridge the gap between telecommunication devices and other electronic devices we use everyday (see Box 2.13).

Box 2.13: Bluetooth in the car

Bluetooth helps keep hands free for driving

Several car manufacturers have found Bluetooth an effective method for extending the mobile phone experience in the car. Acura (Honda's luxury model in the United States) has unveiled a new model that allows Bluetooth enabled phones to connect wirelessly to the car to make calls. Once the phone and the car have made an initial pairing, controls on the steering column can actually activate the phone and dial preset numbers (See left graphic). In addition, users can speak the phone number and voice recognition software in the car will dial the number.

The status of the call is displayed in the dashboard of the car, including the number dialled/calling, signal strength, and battery power of the phone (See right graphic). The voice of the person on the other end of the call is then routed through the sound system of the car as a hands-free speakerphone conversation.

Finally, the car's GPS navigation system provides real-time location-based information about restaurants, hotels, movie theatres, garages and other services in the area, which can be dialled by the car over the Bluetooth connection with the simple click of a button.

Source: http://www.acura.com.

2.4.2 RFID (Radio Frequency Identification)

An RFID tag is a small device that is capable of transmitting information about itself via radio frequencies. The tags are usually composed of a microchip with a coiled antenna and can be embedded in a wide rage of items from household product packaging to clothing. The chip stores pieces of information that can be read quickly by an RFID reader using electromagnetic waves. While ordinary bar codes require a close optical scan to be read, RFID tags can be read without a direct line of sight.

RFID readers, called interrogators, send out a radio signal to which the RFID can respond with identifying information or even more complex data.[26] Most RFID tags are passive so they have no power source (e.g. no batteries) and simply bounce information back to receivers using the receiver's original transmission power. A new generation of passive tags is emerging that use "energy harvesting" where the chip gathers power the magnetic wave of the interrogator, stores it momentarily and then sends it out on another frequency. [27]

Another benefit of RFID is the stored information can be changed at subsequent steps in the production or sales chain. This could be beneficial for tracking the life of an item (such as a recalled toy) but also raises the ire of privacy advocates.

RFID will play a part of the portable Internet as a way to track things in physical space and to quickly access relevant information. Portable devices such as phones, laptops, and PDAs could be "aware" of all types of items around them. This could allow portable Internet users to instantly look up the current price of a jacket their friend is wearing or download information about an entire decorated showroom of furniture instantly via their mobile device. RFID and its current applications are discussed further in Chapter six.

2.4.3 ZigBee

While RFID technology is an excellent tool for determining what kind of items are in the vicinity and storing information, a new technology ZigBee can pinpoint more precisely where an item is. As an example, a postal delivery driver could use an RFID reader to simultaneously gather information on all the packages in the back of a large truck. However, using a ZigBee reader, the driver could find the exact location of a specific package in a fully loaded truck.

ZigBee is a niche wireless technology that does not offer fast speeds (20-250 kbit/s) or long-distance (10-60 m) connectivity. However, it has been optimized for the specific application of tracking and controlling items in a small area.

A ZigBee network is made up of three types of devices: network coordinators, full-functioned devices (FFD), and reduced-function devices (RFD). The devices performing network coordination require more power and processing ability while reduced function devices are the most basic and least power consuming elements on the network. The ZigBee network functions as a mesh network since all network coordinators and full-function devices route traffic around the network. Reduced-function devices, due to explicit limitations on their complexity and cost, do not route traffic but are capable of passing their own information (see Figure 2.6). Data traffic is sent over license-exempt blocks of spectrum, including 2.4 Ghz (worldwide), 915 Mhz (Americas), and 868 MHz (Europe)[28].

One of the most important benefits of ZigBee is its extremely long battery life (up to five years)[29]. This is due to the fact that the ZigBee transmitter stays in "sleep" mode until it needs to pass any traffic. Currently, ZigBee prices are in the USD 3-6 dollar range, making them cost effective for smoke detectors, lights, and other remote-controlled objects in a home (see Box 2.14).

Box 2.14: Portable light switches
ZigBee-enabled fluorescent lights soon to come with their own portable switches

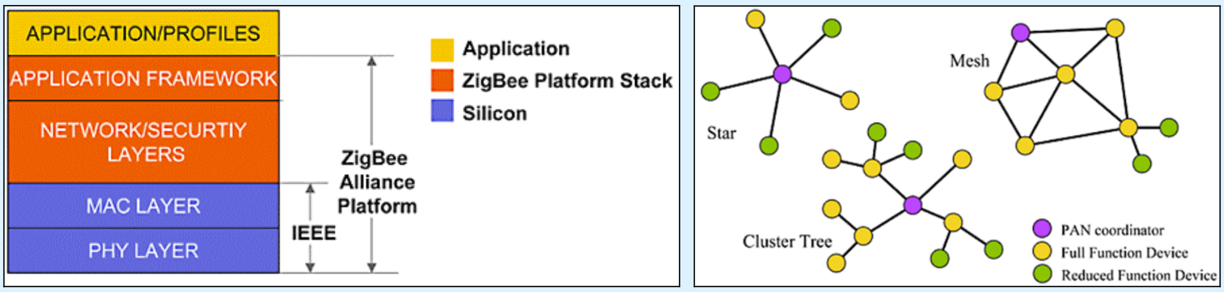
One of the most simple but profound uses of ZigBee may be for light switches. ZigBee light switches will be portable and can be placed within easy reach of where people spend most of the time. The simple ZigBee remote control actually communicates directly with a sensor on the fluorescent bulb, telling it to switch on and off. New bulbs will come with switches that can be placed within arm's length (e.g. near the couch, bed, or TV).

While home users may benefit immensely from placing a light switch on their nightstands, it is businesses that stand to benefit the most from the technology. Typical buildings put all fluorescent lights in a given area on one switch that is usually turned on at one location or triggered by movement. Since the lights cannot easily be turned on individually over a each cubicle, the lone late-night worker in the cubicle requires the lights to be on in a much wider area. ZigBee lamps could be controlled by each cubicle in the office and would not require a whole floor to be lit for just a few workers at their desks. In addition, Zigbee enabled lights could each sense the amount of ambient light and reduce their power accordingly. The cost saving for businesses should be significant.

Source: http://www.networkmagazine.com/shared/article/showArticle.jhtml?articleId=18900058&pgno=2
http://www.nwfusion.com/techinsider/2004/0315techinsiderwiwi.html

ZigBee could play an important role in the portable Internet because it will be the network that allows everyday items to communicate with mobile phones and the Internet. For example, a ZigBee-enabled smoke detector could notify a home network and send an e-mail/SMS to the owner of the house when it detected smoke. The network could then send out another ZigBee command to all lights in the house to start flashing on and off to attract attention.

Figure 2.6: Networking with ZigBee
The ZigBee Alliance adds additional requirements to the standards set by IEEE 802.15.4



Note : Each ZigBee network needs at least one higher-functioning coordinating device to operate. However, devices on the outer edges of the network can use very inexpensive, simple chips to receive and transmit information about their state
Source: http://www.techonline.com/community/tech_group/36561

2.5 Logistics of the portable Internet

Although the various technologies underlying the portable Internet hold much promise, network architects have a difficult task ahead pulling together these different technologies under the umbrella of one converged network. While the future composition of the portable Internet is not yet clear, many are looking to mesh networks as a way to accomplish the goal of connectivity anytime, anywhere.

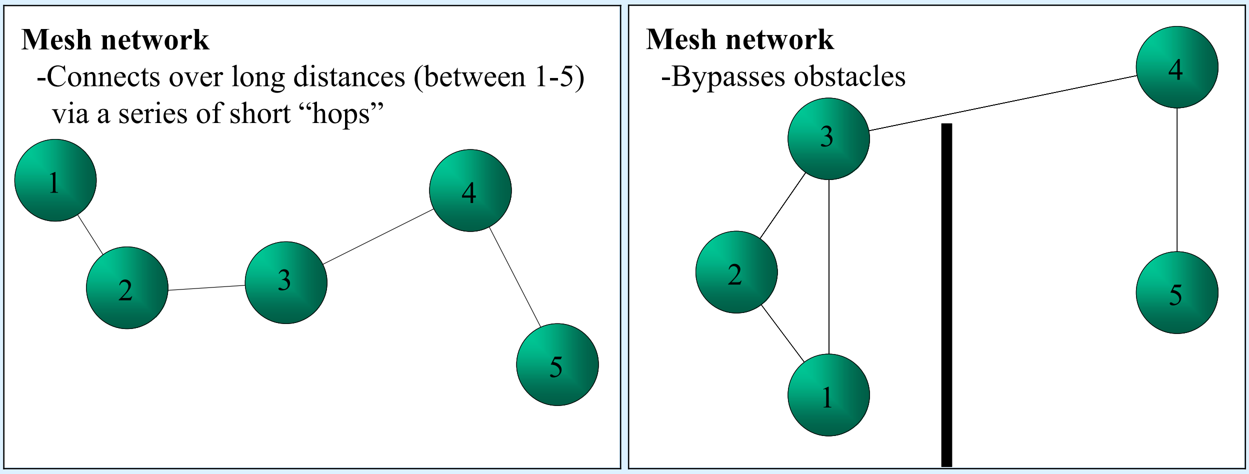
2.5.1 Mesh Networks

Current wireless technologies are based on either point-to-point or point-to-multipoint technology. However, a new wave of technologies, called "mesh networks", is emerging that will enable multipoint-to-multipoint networking. Mesh networks rely on each node to route or broadcast in the network. Technically, each subscriber access point then becomes part of the network routing infrastructure – acting as a relay for traffic destined to users further out from the source of the transmission (see Figure 2.7, left). This topology offers incredible benefits for quickly expanding network access. As users are added to the network, the capacity and reach of the entire network expands.

One area where mesh networking could make significant inroads is rural access. A mesh network provider based in a metropolitan area could offer services in remote areas by "piggybacking" connectivity over a series of subscribers in the direction of the end-user. Data traffic on the outer edge of the network in a remote village would only need a wireless connection strong enough to reach the next, closer subscriber to the metropolitan area. This second subscriber would then pass the traffic to another, closer subscriber and the process would continue until the traffic reached the backbone Internet connection. By using all subscribers as transit points, the mesh network can quickly reach distant areas with relative ease.

An important benefit of mesh networks is that they do not require line of sight. Many fixed-wireless systems at high frequencies require line of sight in exchange for faster data transfer rates but mesh networks can "walk" around or "dodge" obstacles by essentially routing to bypass them (see Figure 2.7, right). This significantly extends the reach of the network and increases capacity with each new device.

Figure 2.7: Passing traffic in a mesh network
Each device (e.g. cell phone, PDA) in a mesh network can pass along other users' traffic across the network

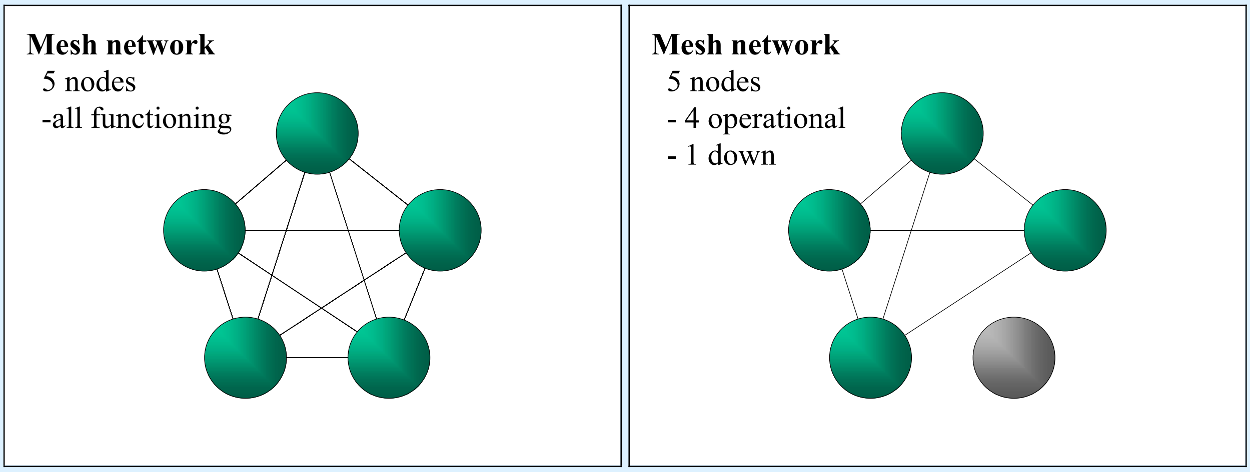


Source: ITU

Another key feature of mesh networks is their resilience to the failure of a node. Just as the Internet can reroute traffic around problem areas, a mesh network can quickly reconfigure and network around trouble spots. This could be critical for developing areas where electricity power supply is not constant and nodes are commonly down (see Figure 2.8).

Figure 2.8: Mesh networks can re-route past problem nodes

A fully-functional network where all nodes can pass traffic (left figure) and a network which can still function when a node fails (right figure)



Source: ITU

Box 2.15: Building mesh networks with WLAN

Multiple WLAN technologies can form backbone and delivery connectivity for new mesh networking technologies

BelAir Networks has developed a mesh network that makes use of two WLAN technologies to deliver broadband connectivity. The hotpots (shown at the right) are mounted externally and can provide Wi-fi (802.11b) access to computers up to 1 km away. The hotspots are then connected to each other in a mesh using 802.11a for the backbone connectivity. Since the two technologies work in different spectral bands, there is no interference from the backbone network transmissions and connectivity to users.

Currently the hotspot mesh uses 802.11a technology as the backbone transport but future versions will likely use WiMAX for its longer range and higher throughput.

Ottawa, Canada has begun rolling out the mesh network in association with Telecom Ottawa. However, some of the most promising applications of the mesh network should be in developing economies. A developing economy can use a satellite connection for international Internet connectivity. Then the VSAT terminal on the ground can disperse the connection over a mesh network of access points using WLAN technologies.

Source: BelAir Networks
http://www.forbes.com/personaltech/2004/06/14/cx_ah_0614tentech.html

The true benefits of mesh networking become apparent in remote or hard-to-reach areas. Technologies such as WiMAX can bring the backbone connectivity over long distances (see Box 2.15). At the local level, the mesh network can then be built out from one central point in the community. As users connect from more and more distant areas, they simultaneously increase capacity and range of the network.

2.6 Conclusion

This chapter has examined a wide range of technologies, each specialized for different distances, bandwidths, and levels of power consumption. However, most of these technologies are unable to pass a connection from one technology to another.

Many envision the portable Internet as one seamless, converged network that provides IP connectivity. But the coordination required to make that possible is not a simple task. A number of standards groups are working on finding a way to make the portable Internet a reality, including a new ITU Focus Group on Next-Generation Networks.[30] The World Radio Standardization Assembly of 2000 also created a Special Study Group (SSG) on systems beyond IMT-2000, which is working on standards for future mobile core networks[31].

While standards organizations are working on coordinating global standards, many industry players have started offering converged services on their own. Operators that own both mobile and WLAN networks have started bundling Internet access packages that are compatible with networks. Swisscom, for instance, will soon be offering combined WLAN, W-CDMA and EDGE services with one subscription. As mentioned earlier, this type of service is already available in Korea via KT's Nespot Swing service, where users can seamlessly roam between Wi-Fi and CDMA2000 1x EV-DO networks. In Japan, a similar service is offered by NTT DoCoMo.

As Korean, Japanese and Swiss operators have demonstrated, technologies do exist for pulling disparate networks together. However, the mere existence of good technology has never ensured market success. Thoughtful regulation and efficient market dynamics will play a vital role in giving users true unfettered access to the portable Internet.

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1 See http://www.m-w.com/ under the word "wired".

2 See http://searchmobilecomputing.techtarget.com/sDefinition/0,,sid40_gci505610,00.html for a brief explanation of W-CDMA.

3 Although theoretical maximum speeds cited may vary, it is expected that the effective speed of HSDPA will be closer to 2Mbit/s. See Nokia's article "High Speed Downlink Packet Access (HSDPA) for WCDMA" at http://www.nokia.com/nokia/0,,53713,00.html for more information.

4 See the TDD definition at http://www.mpirical.com/companion/Multi_Tech/FDDDuplex.htm

5 See GSM World at http://www.gsmworld.com/technology/gprs/intro.shtml#1 for detailed information on GPRS.

6 This is done through a modulation scheme that can represent 3 bits at any given time, rather than the one bit building block of digital transmission. See http://www.mpirical.com/companion/GSM/EDGEEvolution.htm for a brief explanation.

7 See http://networkcomputing.com/netdesign/bb2.html for more detailed information.

8 This acronym is sometimes used with "microwave" replacing "multipoint".

9 See the WiMAX Forum at http://WiMAXforum.org/tech/tech.asp

10 The WiMAX forum has detailed information on 802.16 at http://WiMAXforum.org/tech/tech.asp

11 More information on the 802.16 and 802.20 comparisons is available at http://www.wirelessweek.com/article/CA403412?text=gohring&stt=001

12 For more information, see Intelsat's presentation at the ITU Promoting Broadband workshop at http://www.itu.int/osg/spu/ni/promotebroadband/presentations/14-fischer.pdf

13 For a short introduction to satellite communications see http://www.infoplease.com/ce6/sci/A0813065.html

[14] See “Teledesic backs away from satellite push”, Oct 3, 2002, for more information: http://news.zdnet.co.uk/story/0,,t298-s2123287,00.html

[15] See http://wifinetnews.com/archives/003226.html for more information.

[16] See the press release “Connexion by BoeingSM Receives Boost from International Telecommunications Union Approval of Global Spectrum Allocation” at http://www.boeing.com/news/releases/2003/q3/nr_030707j.html

[17] See the official Wi-Fi site at http://www.weca.net/OpenSection/index.asp

[18] See http://www.airscanner.com/pubs/wep.pdf for more of the weaknesses with WEP.

[19] See http://www.wi-fiplanet.com/tutorials/article.php/2148721 for more information about the benefits of WPA implementation.

[20] For more information on 802.11a’s modulation technique see http://www.nwfusion.com/details/465.html

[21] For more information on 802.11i security enhancements, see http://www.nwfusion.com/news/tech/2003/0526techupdate.html

[22] More information on IEEE 802.11n is available at http://www.eweek.com/print_article/0,3048,a=115038,00.asp

[23] The ITU World Radiocommunication Conference website is: http://www.itu.int/ITU-R/conferences/wrc/wrc-03/index.asp

[24] See http://www.itu.int/ITU-R/study-groups/rsg1/rtg1-8/index.asp

[25] From the Ultra-Wideband working group’s FAQ at http://www.uwb.org/faqs.html

[26] See http://www.rolltronics.com/glossary.html for a good definition of RFID.

[27] See http://www.rfidjournal.com/article/articleview/207 for a detailed FAQ on RFID technologies.

[28] Different frequency ranges around the world to accommodate national regulatory structures. More information on the IEEE’s approval of ZigBee is available at http://www.electronicsnews.com.au/articles/2c/0c01902c.asp

[29] More information is available at http://www.nwfusion.com/techinsider/2004/0315techinsiderwiwi.html

[30] Information on ITU’s focus group on next-generation networks can be found at http://www.itu.int/ITU-T/ngn/fgngn/index.html

[31] The Special Study Group has been successful in defining switching and signalling requirements and protocols, and addresses the high-level end-user needs outlined in the ITU long-term vision for Systems Beyond IMT 2000, specified in ITU-T Recommendations Q.1701. ITU envisages the systems defined in these specifications will be in place by about the year 2010. The vision and framework for future mobile telecommunications networks are described (ITU-T Recs. Q.1702 and Q.1703), and principles and initial requirements for the convergence of fixed and existing IMT-2000 systems are laid out in ITU-T Rec. Q.1761. These address the mobility side of Next Generation Networks. See http://www.itu.int/ITU-T/studygroups/ssg/index.asp

3 CHAPTER THREE: MARKET TRENDS

3.1 Global markets

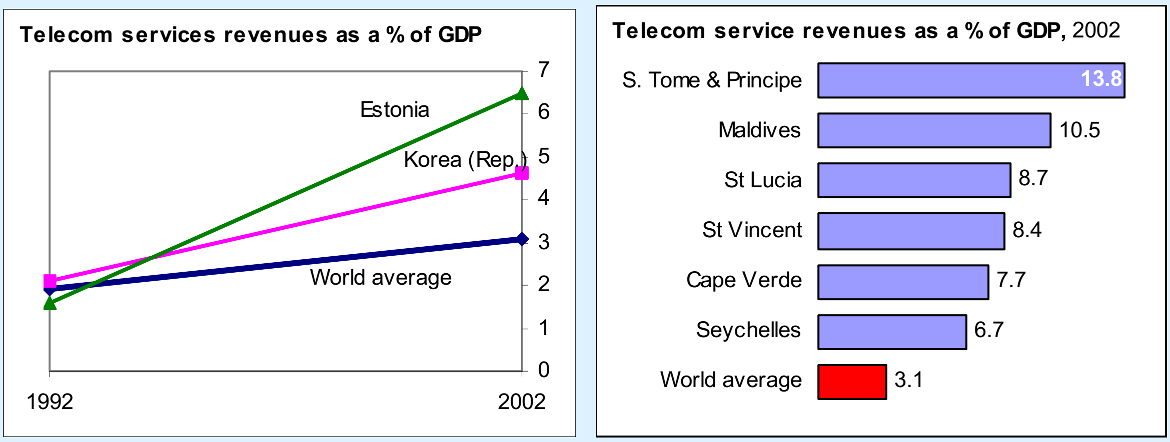
The telecommunication services sector, as defined here, covers the provision of voice, data, video and text services to the public, from both fixed and wireless platforms. The market value of the sector passed the symbolic USD 1 trillion mark in 2002 and in 2003 amounted to an estimated USD 1.1 trillion. To put that into context, it is equivalent to the national GDP of a nation such as Italy. Furthermore, it accounts for 3.1 per cent of GDP globally, or USD 31 for every USD 1'000 of the world's wealth (see Figure 3.1, left chart).

Those numbers are impressive enough, but to the USD 1.1 trillion it would be reasonable to add the USD 300 billion or so generated in sales of telecommunication equipment. And if one wanted to take an expansive view of the information and communication technologies (ICT) sector, why not add also the computer industry (hardware and software) and the broadcasting sector? This would quickly bring the total value to over USD 2.5 trillion. Looking even further a field, to the broader information sector, which would include the media, cinema, video games, music, consumer electronics, online entertainment etc, one could easily double that figure and arrive at an economic activity, based around the collection, processing, storage and display of information, which amounts to between 10-15 per cent of global wealth, depending on how narrowly or widely the industry is defined.

Definitional issues aside, it is clear that telecommunication services lie at the heart of the information economy, both as a direct creator of wealth, and as an enabler of wealth creation in related service sectors. During the course of the decade from 1993 to 2003, the telecommunication services sector has grown from a market value of below USD 0.5 billion to around USD 1.1 trillion. This market has grown, in revenue terms, by an average of 8.8 per cent per year over the last decade, and a slightly slower rate of 6.1 per cent year since the bursting of the dot.com bubble in 2000 (see Figure 1.3). Those countries that have been most successful in tapping into the potential of the information economy—such as the Republic of Korea, which is the global leader in broadband, or Estonia, which has made building an information society a national economic priority—have succeeded in growing their information economies at a much faster rate than the global average (see Figure 3.1, left chart).

Figure 3.1: Information society winners

Telecommunication service revenues as a percentage of GDP, for the world, Estonia and Korea (Rep), 1992 and 2002, and in selected island economies, 2002



Source: *ITU World Telecommunication Indicators Database*

Perhaps the biggest winners of the information society are those small island states that have used the power of information to transform their economies (Figure 3.1, right chart). Small Island Developing States (SIDS) have been traditionally disadvantaged by their remoteness, the small size of their economies and the higher costs of importing and exporting produce. But these disadvantages are much less significant in the information economy. For those island states highlighted in the chart[1], including St Lucia (see Box 3.1), the telecommunication service revenues generated—by their residents, by tourists and, in the case of São Tomé & Principe by being a haven for international premium rate numbers—have provided a considerable boost to their economies. In each of these islands, telecommunication service as a percentage of GDP is more than twice the global average.

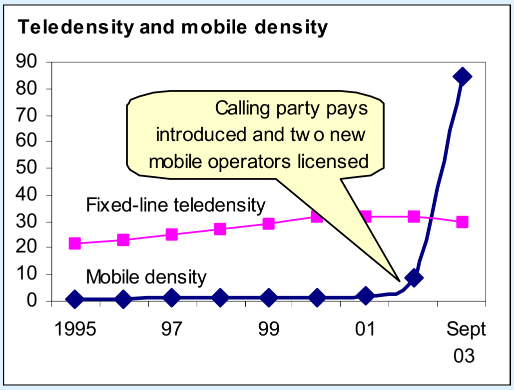
Box 3.1: Caribbean island not too small to support competition
The case of St. Lucia

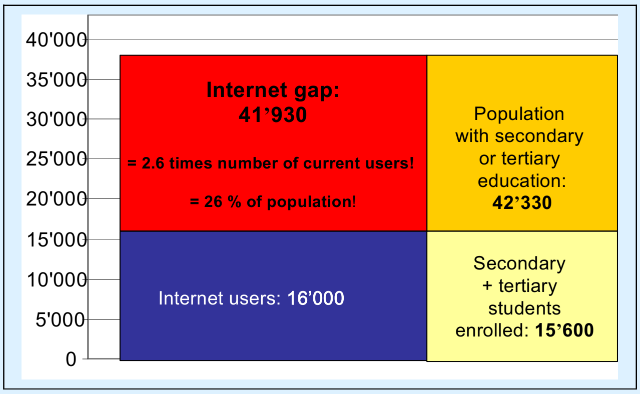
In considering the market potential for the portable Internet, it is tempting to look no further than the large developing economies of China, India, Pakistan, Bangladesh etc. In these countries, the market is indeed huge. But the portable Internet could be just as effective at the opposite extreme, in small island states. Take the case of St. Lucia in the Eastern Caribbean, the newest ITU Member State, with just 156’635 inhabitants at the last census. Surely such a small territory would not be big enough to support competing telecommunication service providers? Well, actually, yes it is.

St Lucia has had mobile phone service since the introduction of the “Boatphone” analogue service in 1992. But it was only with the threat of competition that mobile phone penetration reached beyond a small percentage of the population and tourists. Interestingly, the introduction of digital service (CDMA) and pre-paid in late 1999 did little to promote growth. Rather, it was the licensing of two new mobile operators (Digicell and AT&T Wireless), announced in 2002, that spurred the incumbent, Cable & Wireless Caribbean Cellular, into action. Combined with a shift from CDMA to GSM, and a move to calling party pays (in August 2002), the advent of competition (in September 2002) saw the penetration rate shoot up to reach over 80 per cent of the population within a few months (left chart below).

What is the potential for the portable Internet in St Lucia? ITU research conducted in December 2003 revealed an Internet user population of just 16’000, but a likely user population (based on the population with secondary or tertiary education) of at least 42’000 (see right chart below). Again the potential for market growth is likely to depend on market liberalisation, as C&W still holds an effective monopoly as the only ISP on the island. For any new market entrant, a solution based on, say, a WiMAX backbone and Wi-Fi hotspots, could prove cost-effective, and relatively easy to deploy given that the island is only 43 kilometres long and 23 kilometres wide. In a small territory, where many potential users are boat-owners and/or tourists, an Internet service that is “portable” is probably the only type worth having!

If we can grow the market for mobile cellular, can we also grow it for Internet?
Mobile and fixed-line teledensity, Jan 1995-Sept 2003, and the market potential for Internet growth, St Lucia





Source: Adapted from ITU Country Case Study *ICT in the Eastern Caribbean: Saint Lucia Case Study*, June 2004, available at: http://www.itu.int/ITU-D/ict/cs/stlucia/material/CS_LCA.pdf

In terms of telecommunication services revenue, as of 2003, mobile services now provide just under 40 per cent of the total (see Figure 1.3) while Internet services, including broadband, provide a further 10 per cent. So the addressable market for portable Internet technologies is worth just over half a trillion US dollars, for carriage alone. To this can be added a potentially huge market for content, especially for those services (like location-based information or tracking services) that cannot be provided from fixed locations.

These numbers provide a ballpark estimate for the size of the market opportunity for the portable Internet. But to refine that number, it is necessary to look at the existing ICT market in more detail.

3.2 Identifying the market opportunity for the portable Internet

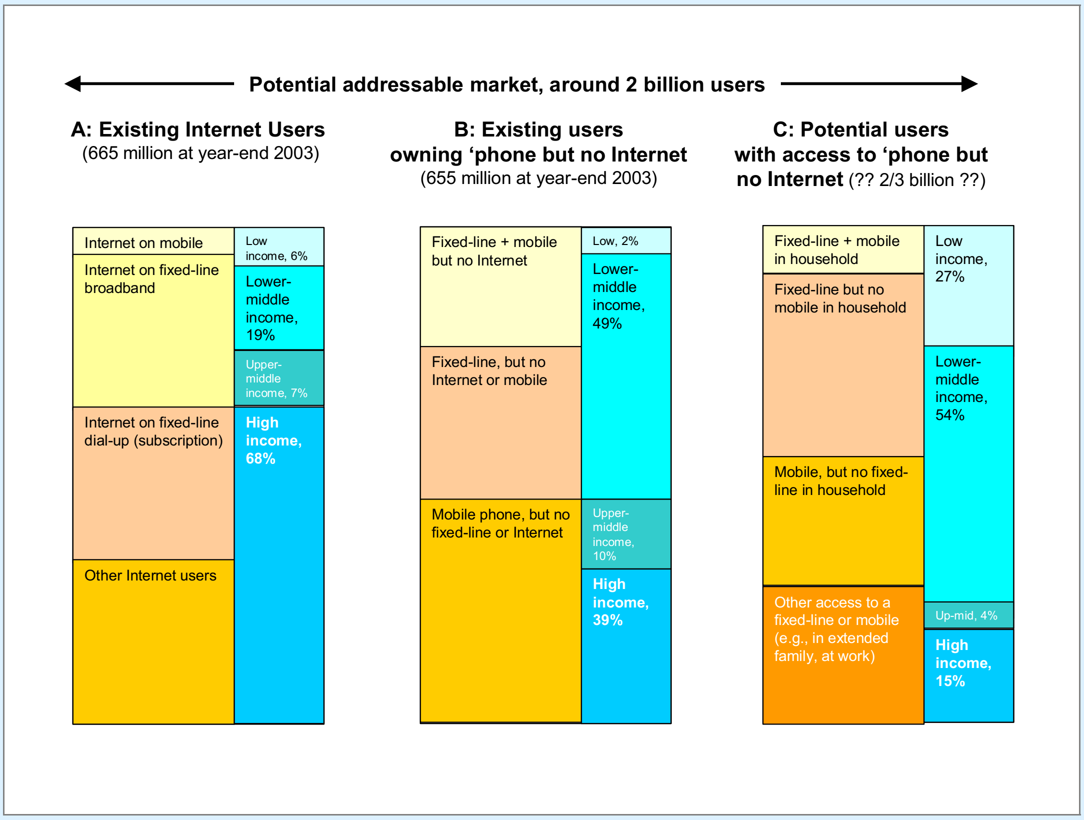
The potential worldwide market opportunity for portable Internet technologies, over the next ten years or so, might be segmented into three blocks of potential users, each composed of around two-thirds of a billion people, making two billion in total (see Figure 3.2):

A) The first block is composed of **existing Internet users**, of which there were around 665 million at the end of 2003. This category can be further segmented into those that access the Internet primarily from their mobile phone, those who access it from a fixed-broadband connection, subscribers who access it from a dial-up connection, and other casual Internet users that may have access to the Internet, for instance, from their school, from a cyber-café, from work etc.

B) The second block is composed of existing **owners of either a fixed-line telephone or a mobile phone** (or both) but not an Internet connection. There are almost twice as many mobile phones worldwide as Internet users, so it can be assumed that the *minimum* number of users in this category is at least 655 million (global mobile phone users minus global Internet users), though it is almost certainly higher as some of the Internet users included in category A) probably do not own a fixed-line phone or mobile (e.g., students who access the Internet from school or university).

C) The third block is composed of **potential users** who currently have access to a telephone or a mobile phone (for instance, in the household, at work/school, or at a relative's house) but do not "own" one personally. The main constituents of this category are young people, who are tomorrow's users. Also in this category are the partners of phone owners who might reasonably be expected to acquire one themselves as their household income increases or as the cost of ownership decreases.

Figure 3.2: Estimating the potential market for the portable Internet
Broken down by type of usage category and by income category of country in which the potential portable Internet user lives



Note: Values are indicative and estimated rather than accurate. There is no particular correspondence intended between the categories shown on the left of each block and the breakdown by income category, shown on the right. There may be some double-counting of individuals, for instance, those that have Internet connections at work (or school) and at home.
Income categories refer to the citizens of countries ranked by their World Bank-defined income status (see Data Notes).
Source: ITU

A second way of segmenting the market is in terms of different stages of socio-economic development. Some two-thirds of existing Internet users (category A) are to be found in the high income countries that account for around 16 per cent of the world's population. By contrast, as many as half of the category B users are either in low or lower-middle income countries (notably in India and China), while for category C potential users, this proportion rises to more than 80 per cent. In other words, as one moves from the existing to the potential new market for ICTs, potential new users are increasingly likely to be found in the developing world.

Another dimension to this issue, in addition to developed/developing economy status, is the current installed base of mobile versus fixed-line users. It is likely that the market opportunity for the portable Internet will be greater in those economies where mobile users already outnumber fixed-line users. As Figure 3.3 (left chart) shows, if one plots economies according to their distribution of mobile users and fixed-line users, the resulting scatter gram takes the form of a comet. The "head" end is composed of a cluster of developed economies that have both high fixed-line and high mobile penetration. The "tail", comprising mainly developing economies, is more scattered. There are a declining number of economies that still have more fixed-line telephones than mobile phone users (e.g., Cuba, Belarus, Libya etc) but many more have a higher number of mobile phone users than fixed-line phones. Some of the extreme cases are illustrated in Figure 3.3 (right chart).

In order to analyse the different starting points of the economies in the chart (Figure 3.3, left chart), it is useful to break it into four quadrants, using the break points of greater than, or fewer than, 10 fixed lines or mobile phones per 100 inhabitants:

- In quadrant A (fixed-line penetration greater than 10; mobile phone penetration below 10), there are some 12 economies, accounting for around 3.1 per cent of the world's population. Of the 12 economies in this quadrant, several are former Soviet Republics (Armenia, Belarus, Kazakhstan) and several others are Arab States (Egypt, Libya, Syria, Tunisia). One would imagine that this segment of the market would be the least likely to adopt the portable Internet. But things can change quickly. St Lucia was in this quadrant until mid-2003, but by the end of the year it had moved into quadrant B (see Box 3.1).

- In quadrant B (fixed line and mobile phone penetration both greater than 10) are to be found the developed and newly-industrializing economies that together compose just over half the world's population. This is likely to constitute the highest value potential market for the portable Internet, with usage being mainly on a complementary rather than a substitutive basis relative to existing services. Economies in this quadrant include all of the OECD economies plus newly-industrializing economies like Argentina, Brazil and China.

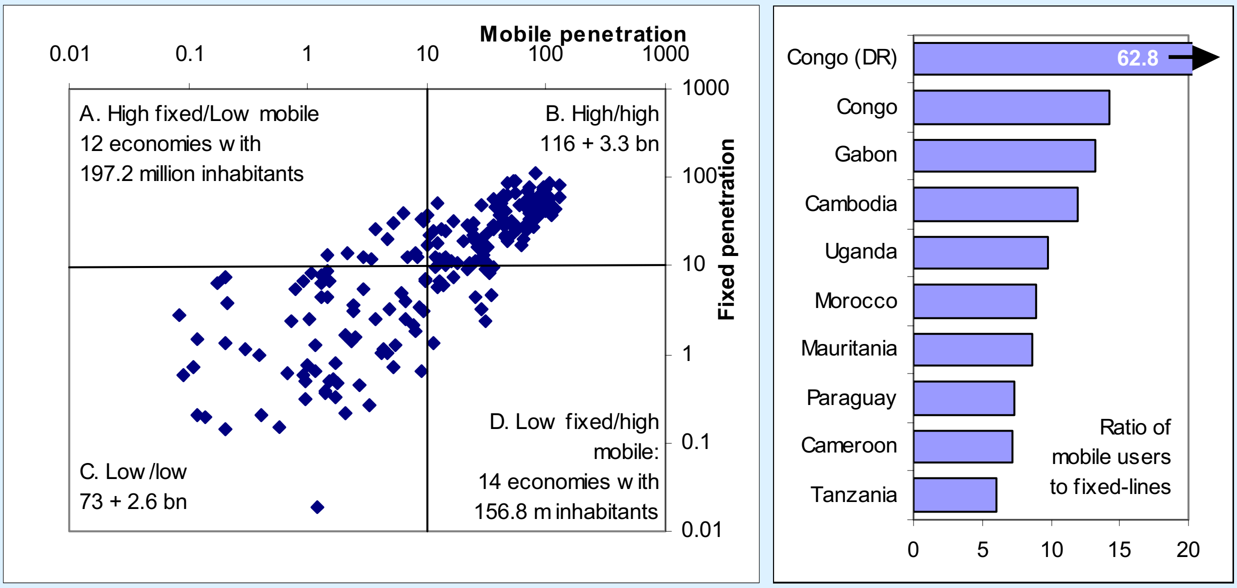
- In quadrant C (fixed line penetration and mobile penetration both below 10) are the developing countries of the world that make up around 42 per cent of the world's population. In this segment of the world's population, the scope for portable Internet is mainly as a substitutive technology, in providing the best new hope for roll-out of the network. The most populous countries in this segment include India, Indonesia, Pakistan, Bangladesh and Nigeria. In these countries, a high percentage of the population lives in rural areas. Thus, a portable Internet solution may represent the only viable way of providing high-speed Internet access.

- In quadrant D (fixed-line penetration below 10; mobile phone penetration greater than 10), there are some 14 economies, accounting for the remaining 2.5 per cent of the world's population. This quadrant includes a clutch of Latin American economies (Bolivia, Guatemala, Guyana and Paraguay), a few from Africa (Botswana, Gabon, Morocco) and from Asia-Pacific (Mongolia and Philippines). This quadrant constitutes the prime market opportunity for the portable Internet, as these are all economies where there is a high level of demand for telecommunication services that the fixed-line operator was unable to meet. Guatemala is a case in point, and the government there has taken a highly innovative approach in allowing the secondary trading of spectrum, which is likely to further promote portable Internet type solutions.[2]

But what is the likelihood that the actual and potential users in each category will move over to the portable Internet? In answering that question, it is useful to consider three sub-questions, which are tackled below:

- What are the substitutable alternatives for the portable Internet?
- What pricing strategies are likely to be effective?
- What corporate strategies are likely to be adopted?

Figure 3.3: Plotting the market opportunity for the portable Internet
Penetration of mobile phone users and fixed-line subscribers, worldwide, 2003, and a selection of economies with a very high mobile-to-fixed ratio



Note: Each dot on the graph represents a single economy. A logarithmic scale is used.
Source: ITU World Telecommunication Indicators Database

3.3 Complementarity and substitutability of the portable Internet

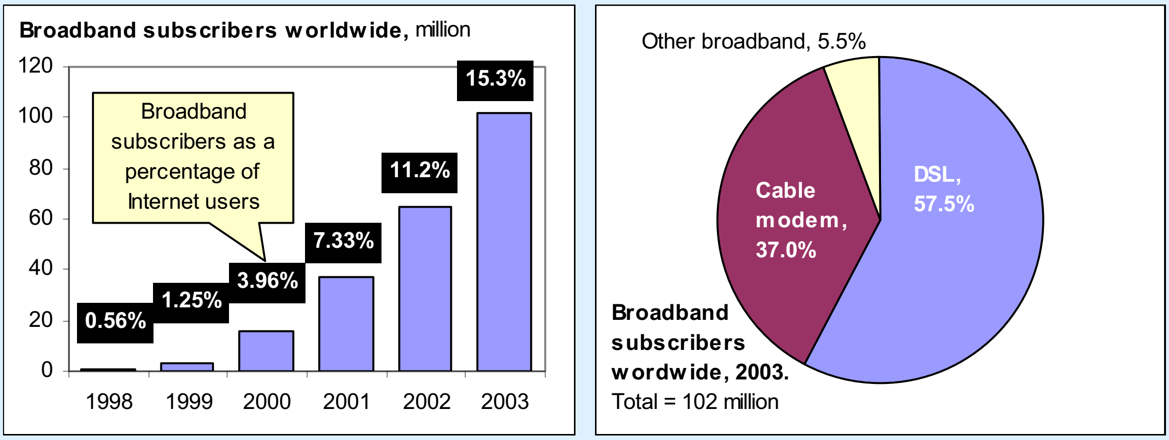
3.3.1 Fixed-line broadband

The set of technologies that make up the portable Internet, as described in chapter two, are potentially substitutable over a wide range of existing product and service markets. The most obvious of these is fixed-line broadband; delivered either over digital subscriber line (DSL), cable modem or other technologies[3]. Around the world, there were around 102 million broadband subscribers at the start of 2004, up from some 65 million a year earlier (Figure 3.4). This represents a growth rate of more than 50 per cent, and broadband continues to be one of the fastest growing consumer markets in history. Broadband users now constitute around 15 per cent of total Internet users and around one in three Internet subscribers. In the leading broadband economies, such as those illustrated in Figure 3.5, the majority of Internet users have broadband access to broadband and other slower means of Internet access (such as dial-up or ISDN) have been almost virtually eliminated from the market. This is the case, for instance in the Republic of Korea, the global market leader in broadband, where dial-up and ISDN combined make up less than five per cent of the national market (Figure 3.5).

To what extent are alternative portable Internet technologies likely to be substitutable for fixed-line broadband? It may be substitutable, especially in those areas that have still to rollout broadband connectivity. These areas include many developing countries (outside the capital cities) and low-population density regions of developed countries. For these areas, a technology like WiMAX, for instance, may provide a cheaper way of provisioning high-speed Internet access than either cable modems or DSL, which are currently the dominant broadband access technologies (see Figure 3.4, right chart).

Figure 3.4: Broadband worldwide

Broadband subscribers worldwide, 1998-2003, and broken down by access technology, 2003



Note: "Other broadband" includes fibre to the home, metro Ethernet, wireless LANs, broadband by satellite etc.

Source: ITU World Telecommunication Indicators Database, OECD

However, it is much more likely that the portable Internet will be *complementary* to fixed-line broadband. As an example, many companies selling broadband also offer wireless LAN routers for home use.[4] For users, this offers the convenience of being able to connect several PCs and laptops around the house at the same time, with freedom to wander away from fixed telephone sockets. For the service provider, it offers a chance to provide an integrated service linking local fixed-line broadband with nationwide public Wi-Fi hotspot access (see the case of Korea Telecom, illustrated in Box 3.2).

Box 3.2: Allowing broadband users to "roam"

Korea Telecom's NESPOT Service

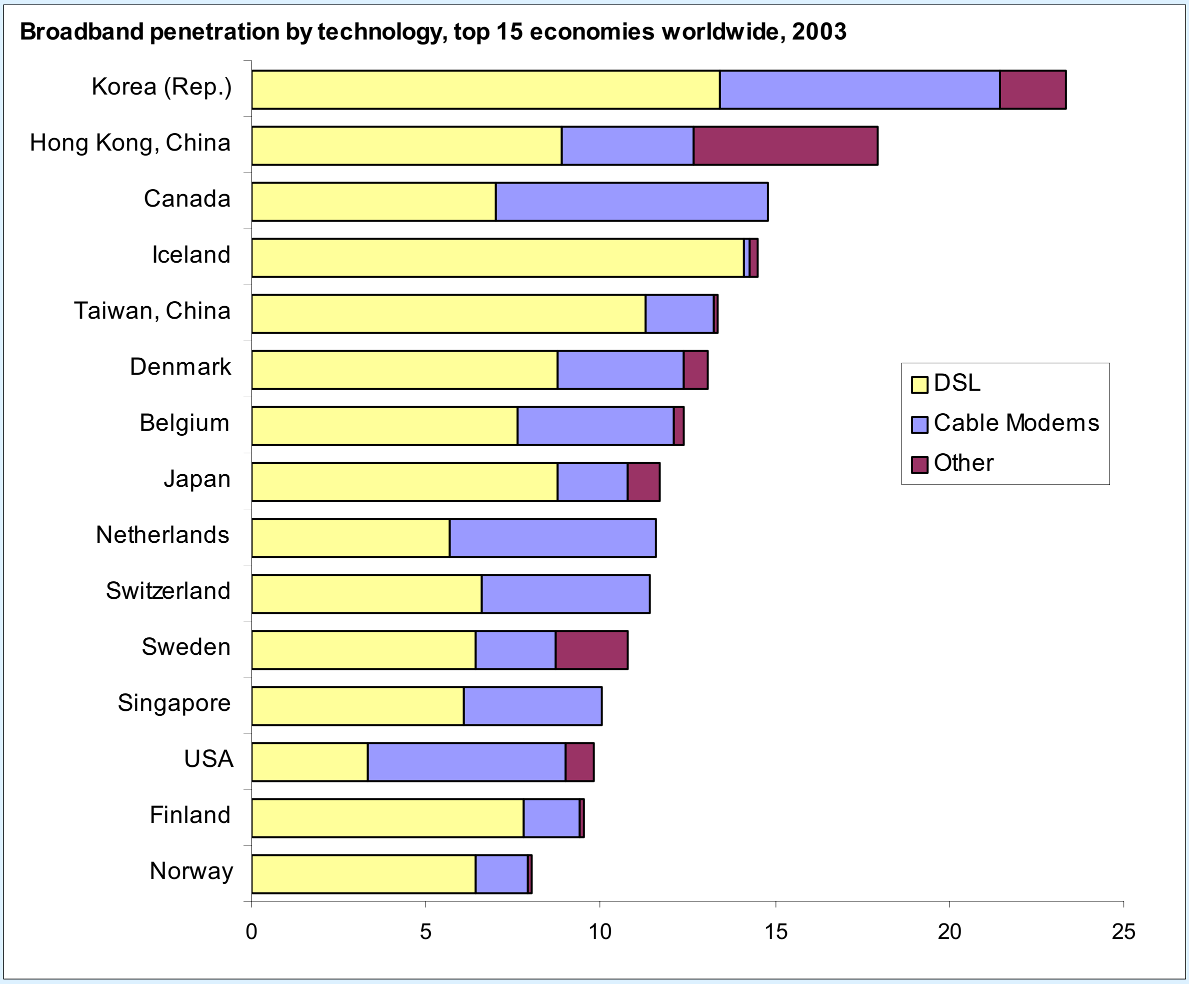
In the Republic of Korea, KT's NESPOT service offers wireless LAN access (Wi-Fi) in 10'000 areas around the country. Wi-Fi access points are located in areas such as universities, hotels, exhibition halls and other public areas. In addition, NESPOT subscribers around the country have their own Wi-Fi access points at home, which extend the reach of the overall wireless network. KT expects the network to grow quickly as more and more users join and become nodes. Already, by the end of 2003 KT had acquired 360'000 NESPOT subscribers.

There are several ways to access the NESPOT network in Korea. KT's existing xDSL (Megapass) subscribers can pay an extra US$ 8.40 (10'000 Won) a month for unlimited NETSPOT usage at home and from any of the country's access points. Non-KT subscriber, tourists, and others can also pay by the minute or hour to access the network where there is coverage. The hourly charge is US$ 2.80 (3'300 Won) while the daily charge is US$ 11 (13'200 Won) a day.

Source: KT (www.kt.co.kr) and ITU country case study *Shaping the Future Mobile Information Society: The Case of the Republic of Korea,* available at: http://www.itu.int/osg/spu/ni/futuremobile/general/casestudies/index.html

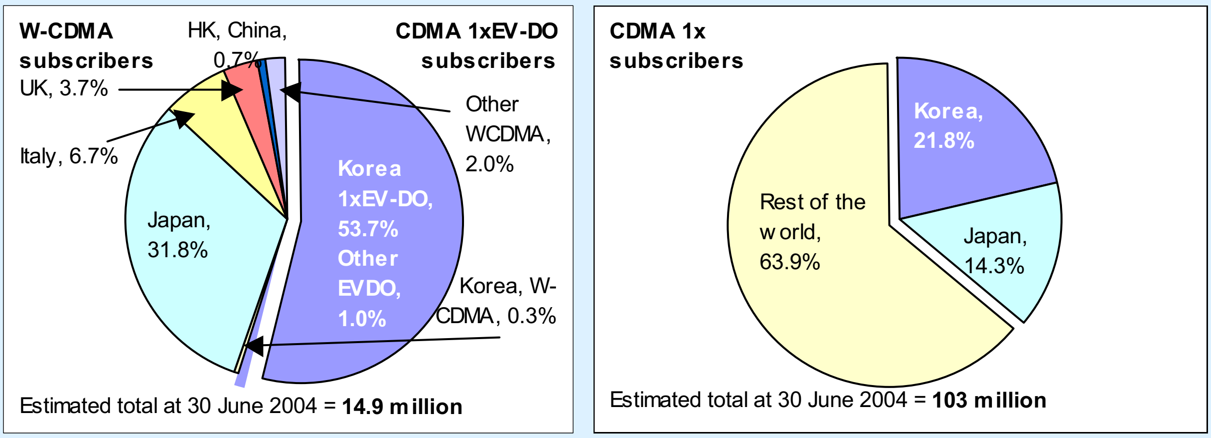
The potential alliance between fixed-line broadband service providers and Wi-Fi hotspot providers (often the same company) is likely to position them in competition with pure-play mobile service providers. Thus, to quote again from the case of Korea, it is the fixed-line operator, KT, which is the main proponent of Wi-Fi rather than the mobile service providers, KTF, SK Telecom or LG. By the same token, there is a natural alliance between cable TV providers and Wi-Fi. For instance, a cable TV provider may service one or more apartment blocks from the same cable head-end. That would provide a logical place to locate a Wi-Fi or WiMAX base station. Whereas a fixed-line operator may try to keep its revenue streams for voice and data separate, to avoid high-value voice traffic travelling over a low-price data network, a cable TV provider would have no qualms in offering basic, switched voice over its network.

Figure 3.5: Top 15 broadband economies worldwide
As measured by penetration rate per 100 inhabitants, 2003, and broken down by technology



Note: This chart may differ from that in Annex Table 7 because of differences in reporting dates between economies.
Source: ITU World Telecommunication Indicators Database, OECD

Figure 3.6: 3G market shares
Division, by country, of 3G subscribers worldwide at 30 June 2004, broken down by technology



Source: ITU World Telecommunication Indicators Database, www.3Gnewsroom.co.uk, www3Gtoday.com

The level of substitutability between portable Internet technologies and fixed-line broadband is therefore likely to depend critically on the existing state of development of high-speed networks and degree of market openness. Substitutability is likely to be higher in developing economies with low levels of existing broadband penetration, but a relatively open market. On the other hand, it is likely to be lower in more developed economies (see Box 3.3) and/or in economies with higher regulatory barriers to entry for new players. Thus, in terms of the market segmentation presented in Figure 3.2, the level of substitutability of portable Internet technologies increases as one moves to the right in the chart, but the level of complementarity increases towards the left.

In addition to the developed/developing country dimension, the portable Internet is also likely to be a potential substitute for broadband in areas of low population density (rural areas) than high population density (urban areas). That is because the per-subscriber costs of provisioning DSL or cable modems rise as population density falls. Not only do the costs of providing the network and laying the cables rise, but so also do the distances from the central office switch, or cable head-end. Although distance limitations can be overcome for both DSL and cable modem technologies, there is a higher cost in doing so. By contrast, in wireless-based networks, the logical response to lower population densities is simply to increase the average cell size. Thus the portable Internet is an attractive solution in those countries where a high percentage of the population live outside urban areas.

3.3.2 IMT-2000 (3G) mobile networks

The second area of possible competition of newer portable Internet technologies is with third generation (3G or IMT-2000) mobile. As of mid 2004, there were around 118 million 3G subscribers worldwide (compared with around 58 million a year earlier). This figure can be broken down into some 15 million subscribers to Wideband CDMA and CDMA 1xEV-DO services and 103 million subscribers to the slower CDMA 1x service (see Figure 3.6). The two leading national markets are Republic of Korea and Japan, which collectively account for 86 per cent of the market for W-CDMA and CDMA 1xEV-DO and 36 per cent of the market for CDMA 1x.

Outside the Republic of Korea and Japan, in other countries where 3G is still to take off, cellular service providers may be particularly vulnerable to substitution by newer portable Internet technologies for a number of reasons:

- Some of the functionality that 3G offers is very similar to that which could be potentially offered by portable Internet technologies, though 3G may still be preferred for use in fast moving vehicles.
- 3G service providers in Europe have paid considerable sums of money to gain a licence. Although a licence fee is necessary to enter the market, it is effectively a type of spectrum fee, or tax. In some cases (notably UK and Germany) this amounts to more than USD 500 per citizen. By contrast, most of the main portable Internet technologies operate in license-exempt or “free” spectrum. This means that 3G services are inevitably priced at a higher level that for the portable Internet, in order to recoup pre-start-up costs.
- Furthermore, although 3G may offer better coverage, the start-up costs of providing nationwide coverage for 3G are likely to be much higher than a hybrid portable Internet solution based on a WiMAX backbone and a Wi-Fi local loop. The main difference affecting the cost is the size of cells (much smaller for 3G than for WiMAX) and the requirement for cell-handover in a 3G network.
- The high costs of acquiring licences and rolling out the network are part of the reason why 3G has been slow to arrive, at least outside the pioneer countries of Japan and Republic of Korea (see Figure 3.6). There are many reasons for the delays in launching 3G, not least the problems in building handsets in bulk at an attractive price. But even when services and handsets are available, customer take-up has sometimes been sluggish. Slow and troublesome launches have affected the reputation of Wideband-CDMA, especially in Europe.
- But the main area of competition relates to tariff structures (see pricing discussion below). Mobile operators approach the provision of Internet services from the starting point of per-minute voice tariffs, whereas portable Internet service providers approach it from the starting point of “always-

on", flat-rate Internet tariffs. In any like-for-like competition, flat-rate tariffs are always likely to be preferred in the marketplace over per-minute pricing strategies. This is one of the reasons why 3G service providers, notably in Japan (see Table 3.2) are moving towards flat-rate tariffs.

On the other hand, mobile network operators have the distinct advantage of a large installed customer base and direct billing relationship with potential new users of the portable Internet. Moreover, the personal and portable mobile phone and its future variations will most likely remain the user device of choice for some time to come.

Box 3.3: Broadband Asia

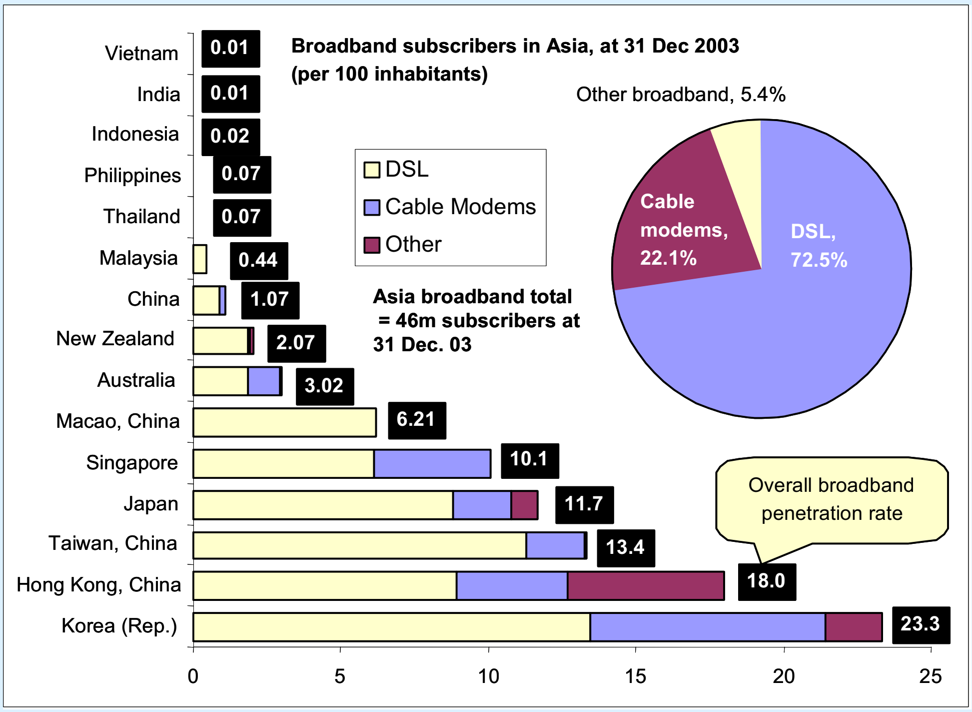
High-speed leader

Just under half of the world's broadband subscribers (and a majority of DSL users) are based in the Asia-Pacific region. Three of the top five broadband economies worldwide are from Asia (Figure 3.5), including the two broadband leaders, the Republic of Korea and Hong Kong, China. Furthermore, the region is also home to the soon-to-be number one broadband nation: China had an estimated 31 million broadband users in mid 2004, according to the China Internet Network Information Centre[5], and will soon overtake the United States in terms of its broadband subscriber base, as it has already done in terms of fixed lines and mobile phones. Another Asian economy, Japan, offers the world's lowest prices per Mbit/s per month (see Table 3.1) thanks to the intense competition between NTT, KDDI and Yahoo BB!

It is not surprising then that broadband is a hot topic in Asia, and that there is intense national rivalry between countries in terms of who is top dog in the region. Asian economies are always the first to report their latest broadband user statistics to ITU and are always keen to know what each other has reported. Broadband and ICT development was the topic of a ministerial-level meeting held under the auspices of Asia-Pacific Telecommunity in Bangkok, 1-2 July 2004. The meeting made a commitment, in the *Bangkok Agenda*[6], to five action areas:

- Raising awareness;
- Creating an enabling environment to encourage broadband and ICT investment;
- Improving access and encouraging broadband and ICT usage;
- Increasing confidence and security for broadband and ICT usage;
- Strengthening international cooperation.

Broadband subscribers in Asia



Source: *ITU World Telecommunication Indicators Database*, and APT (www.aptsec.org)

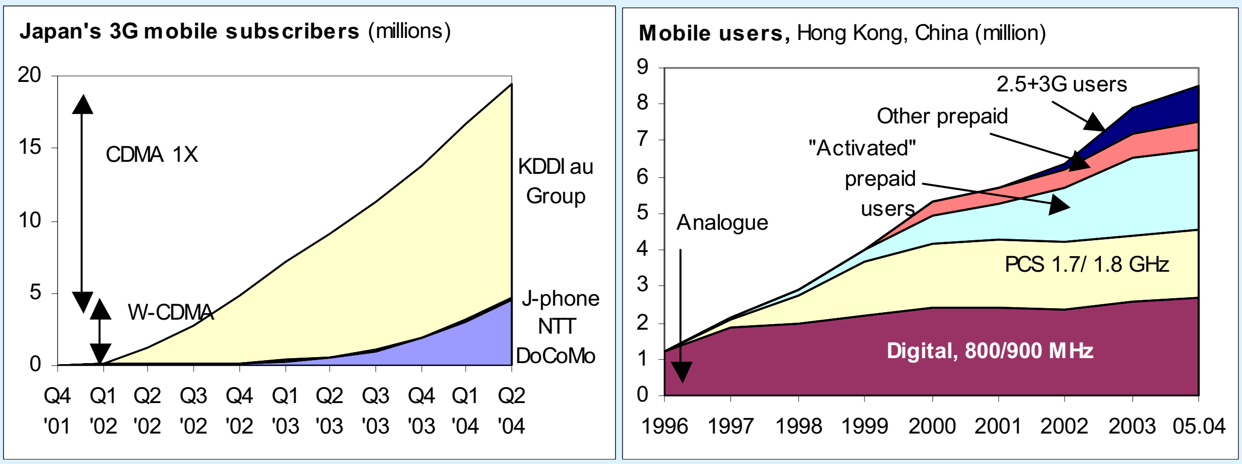
The early lessons from the transition from 2G and 2.5G (e.g. GPRS) to IMT-2000 services is that it is an evolutionary process, which is triggered, at least in mature markets, by the replacement cycles for handsets. This is driven as much by new features in handset design (e.g., colour versus black and white handsets; or the ability to send and receive photos) as by a radical shift in the nature of the underlying network or the services available. The case of 3G in Japan illustrates this well. Although the three operators (NTT DoCoMo, J-phone and KDDI au Group) have been jockeying for position—with the two W-CDMA operators slowly catching up on the early dominance of the CDMA 1x operator (see Figure 3.7, left chart)—the actual market progression has been steady at around 600'000 new subscribers per month throughout the period since 3G was launched in September 2001. This corresponds to the regular replacement cycle for handsets. Similarly, in the case of the Hong Kong, China (shown in Figure 3.7, right chart), the adoption of 2.5 and (since January 2004) 3G handsets has also been following a steady progression. At the end of May 2004, the number of 2.5G and 3G users in the territory exceeded one million for the first time, and can be expected to continue to grow steadily as more handsets are replaced with newer models.

What does this imply for the growth of the portable Internet?

In developed country markets, it implies that the main market opportunity is both in complementary and substitutable services, and that this market is likely to grow in rhythm with replacement cycle for handsets and other portable devices. Insofar as substitution does occur, it is likely to be at the level of service revenue (i.e., subscribers choosing to route their Internet traffic over a Wi-Fi connection rather than over and IMT-2000 network) as much as at the level of the device itself. But the precise way in which this plays out will depend on what to extent handset manufacturers allow interworking between high-speed mobile networks and other portable Internet technologies, and whether cellular service providers also encourage this.

In developing country markets, it implies that the main opportunity is for substitutable services, especially where the existing fixed-line network is poorly developed, where the 2G mobile network has not yet been transitioned to higher speeds, or where higher-speed IMT-2000 services have not yet been licensed. In particular, a technology like WiMAX may hold the most promise for delivering access in developing economies and to rural areas of developed ones.

Figure 3.7: Growing the mobile market
Growth of 3G mobile, Japan 3Q 2001 to 2Q 2004, and growth of overall mobile market, Hong Kong, China, 1996 to May 2004



Source: ITU World Telecommunication Indicators Database, MPHPT Japan, OFTA Hong Kong, China, www.3Gnewsroom.co.uk

3.3.3 Voice

Both broadband and IMT-2000 mobile networks can be used to carry voice as well as data. Thus if the portable Internet is be used for carrying voice as well as high-speed Internet service, it is likely to be more fully substitutable. Customers are generally much more willing to pay for voice (because they have always paid for it) than for data (which they may be accustomed to having free of charge, for instance at university). But it is also a market that is increasingly commoditized and price sensitive.

There are a number of experiments in developing countries with offering voice over Wi-Fi and WiMAX. For instance, in Bhutan, an operational project linking a number of remote villages provides voice over wireless LAN (VoWLAN).[7] Equally, in developed country markets, there are projects underway, such as BT's Project BluePhone[8] in the United Kingdom (see Box 3.4), to exploit the portable Internet for voice. Although technically unexciting, voice remains a must-have service and a large market, worth more than USD 750 billion (fixed and mobile voice combined) worldwide.

Box 3.4: The everywhere phone- a taster of the future
BT's "BluePhone"

BT's *BluePhone* is a multi-network handset, compatible with 3G networks, traditional GSM networks, and with Wi-Fi and fixed-line networks, and able to transparently switch between them. When the user is in range of a Wi-Fi base station, the *BluePhone* will connect to the network that way using VoIP. When the user is in range of a Bluetooth-enabled fixed-line network (for instance, at the user's home or work), it will automatically use that network. When out of range, it will automatically search for compatible 3G networks, and if none are found will fall back to any traditional GSM network found, automatically picking the strongest connection.

The *BluePhone*, which BT markets as the "everywhere phone", is a taster of a future in which the least cost routing software, previously only available on expensive central office switches, is now available on the user's handset. For the user, the advantage is that it offers a single phone number (and phone bill) rather than separate numbers for fixed and mobile phones, or for home and work phones. It also provides the lowest-cost calling from any particular location. For the fixed-line service provider, like BT, it provides a chance to win back some of the revenue that is currently being lost to mobile service providers. In particular, it offers a potential opportunity to reduce the payments currently being made for calls from the fixed-line that terminate on a mobile phone, which continue to be notoriously expensive, especially in Europe.[9]

Source: British Telecom

3.3.4 Other products and services

As indicated in chapter one, the portable Internet is potentially complementary or substitutable over a wide range of products and services, of which fixed-line broadband and cellular mobile are just the most obvious. The following is an illustration of a number of other areas in which the portable Internet technologies, including 3G, could potentially provide:

Hard drive players: In recent years, hard drive music players, such as Apple's iPod or Sony's Network Walkman, have become top-selling consumer products. This has grown in tandem with paid-for downloaded music (pioneered by Apple's iTunes, but now joined by Napster, Virgin Digital, Musicmatch and many others). Hard drive music players allow users to download songs in a standard MP3 format or a proprietary format, such as Sony's ATRAC, and then to organize play-lists and to play the music back, over portable or fixed devices. Downloading currently takes places via a fixed Internet connection or from a mobile phone. But this is a clear market opportunity for portable Internet technologies to allow for downloading of music directly to the device, without a requirement to pass through a different medium. Furthermore, as the market for hard drive players shifts from music to video, it is likely that the speed advantages that portable Internet technologies offer will make it even more attractive.

In-car vehicle navigation systems: Another booming market is the one for traffic navigation systems, which combine route information (usually available on a CD-ROM) with location information (usually provided by the satellite-based Global Positioning System; GPS). The missing element which portable Internet could provide is real-time updating, for instance on road closures, traffic congestion, parking availability etc.

Congestion charging: A number of countries (like Switzerland, Singapore and Germany) as well as individual cities (like London) now have congestion charging systems for traffic[10]. For instance, in Switzerland, it is used to tax the passage of heavy goods lorries through the country while in London it is used to tax traffic passing through Central London and to provide a subsidy to public transport. Again, there is a market opportunity for portable Internet technologies, both in the identification and billing of vehicles and in the mechanism for payment.

Portable medical devices: In modern medical practice, there is a trend towards involving patients more closely in their own care. For instance, through the monitoring of pulse rates, insulin levels, pollen levels etc, it is possible for individuals to have more control over their own health care. There are a number of applications in this field that could benefit from radio-based communication (see discussion in chapter seven) and here again there is an opportunity for portable Internet-based technologies.

Home entertainment systems: In the digital home, there is an increasing need for different entertainment systems to interact. For instance, showing holiday pictures on the television screen might be a desirable option. Or could music downloaded onto a broadband-enabled PC be played over a home stereo system? All of this can be done, of course, with fixed-connections. But when the devices are in different locations around the house, a wireless system is more opportune. Bluetooth is the currently preferred solution for inter-device networking, but its range is limited. Again there is an opportunity here both for Bluetooth and other portable Internet technologies.

The markets shown above are just a small sample of the potential markets that could be addressed with portable Internet technologies. Nevertheless, they show the size of the market opportunity. However, exploiting that opportunity successful will depend crucially and pricing strategies and overall corporate strategies for positioning this new market.

3.4 Pricing strategies

If the portable Internet is going to be a success, it needs to be priced at a level that is affordable to users. In particular, for a new service to take off, as a rough rule of thumb it needs to be at least 15 per cent cheaper and/or 15 per cent better (more powerful, more reliable, faster, more convenient etc) than alternative offerings on the market in order for customers to choose to make the effort to switch. In a networked industry, like telecommunications, where fixed costs are high and investment depreciation cycles are typically long, it is more normal therefore for technological progress to be evolutionary rather than revolutionary. The 15%/15% rule, cited above, is hard for new market entrants to achieve, and still make a profit.

3.4.1 Fixed-line pricing strategies

Can proponents of the portable Internet make it worthwhile for customers to choose this technology, either in addition to or as a replacement of the ones they are currently using? And will the portable Internet ever be cheap enough to achieve a mass-market status in the developing world?

The answer to both of those questions is "Yes, if ….". In the case of the first question, much depends on achieving the right price point relative to fixed-line broadband. Over the past five years, broadband price trends have been affected by a general reduction in prices but also by a rise in the typical speeds offered. Thus, the price per 100 kilobits per second (kbit/s) per month, which is the preferred method for making broadband price comparisons, has fallen markedly.[11] Between mid-2003 and mid-2004, the average price worldwide fell by 30.8 per cent from USD 97.10 to USD 67.16.[12] This measure is based on a simple average of prices (each country reporting prices counting as one, without weighting for volume).[13]

However, in order to get a better idea of price levels, it may be more meaningful to look at the levels that pertain in the top 15 broadband economies (as ranked by penetration; see Figure 3.5). A summary of "best deal" prices for these economies is given in Table 3.1. For the top 15 economies, 12 recorded reductions in the price per 100 kbit/s between 2003 and 2004, averaging a price cut of around 36 per cent. But among the "best practice economies (defined as the top 3 of the 15; or the best 20 per cent: namely Korea, Japan and Sweden) the average price reduction was 48 per cent.

If the portable Internet is going to be competitive among the leading broadband economies, then, in line with the 15%/15% rule, it would need to offer a performance that was around 15 per cent higher than the average (say around 9 Mbit/s), at a price which was 15 per cent cheaper (at around USD 44 per month). To be competitive in the top three economies, the price point equation would be 35 Mbit/s at USD 35 per month.

Table 3.1: Mirror, mirror on the wall, who is the cheapest of them all?
Comparative prices for broadband, top 15 broadband economies, July 2004, ranked by USD per 100 kbit/s

Economy	*Company*	*Technology*	*Speed (kbit/s)*	*Price per month (USD)*	*Price per 100 kbit/s*	*Change, 2003-04*
Japan	KDDI	DSL	47'000	25.85	0.06	-44.1%
Korea (Rep.)	Hanaro	DSL	20'000	47.86	0.24	-4.0%
Sweden	Bredbandsbolaget	FTTH/DSL	24'000	58.63	0.24	-97.4%
Taiwan, China	Chunghwa	DSL	8'000	35.30	0.44	n.a.
Hong Kong, China	Netvigator	DSL	6'000	51.03	0.85	-33.2%
Canada	Bell	DSL	3'000	34.05	1.13	-66.6%
Belgium	Belgacom	DSL	3'300	48.40	1.47	19.6%
Singapore	StarHub	Cable	3'000	46.50	1.55	-31.3%
Switzerland	SwissCom	DSL	2'400	77.88	3.24	-73.3%
USA	Comcast	Cable	3'000	52.99	1.77	-50.0%
Netherlands	Wanadoo	DSL	1'120	42.35	3.78	5.5%
Finland	Sonera	DSL	2'048	82.28	4.02	-53.6%
Iceland	Vodafone	DSL	500	21.00	4.20	-37.1%
Denmark	Tele2	DSL	2'048	86.32	4.21	-32.1%
Norway	Tele2	DSL	1'024	62.95	6.15	-11.0%
Average			**8'429**	**51.56**	**2.22**	**-36.3%**
Best practice (top 20%)			**30'333**	**44.12**	**0.18**	**-48.5%**

Source: ITU Research (See Annex Table 7)

The performance target is attainable, given the current speeds on offer with Wi-Fi and WiMAX. The price too is attainable, if the service provider is willing to accept that it many not be possible to make a profit at this level straight away and has sufficient funds to remain operational until the market reaches a critical mass. But it will be difficult to sustain. As the price of fixed-line broadband continues to fall and speeds get faster around the world, this price point for the portable Internet would need to become increasingly more attractive too.

A more realistic scenario is that portable Internet technologies will be sold as an “add-on” to existing broadband subscriptions. So, for instance, KT’s NESPOT unlimited Wi-Fi service retails at USD 8.40 per month as an add-on to KT’s MegaPass service, which ranges between USD 25 and 42 per month, at speeds ranging from 1.5 to 13 Mbit/s. In other words, portable Internet as an “add-on” in Korea is retailed at between a third and a fifth of the base service price. This type of ratio would seem about right. It would suggest that, in the top 15 broadband economies, the appropriate pricing for portable Internet as an “add on” service would be between USD 10-15 per month, on top of fixed-line broadband subscription prices.

Table 3.2: Comparative prices for mobile data services
Price per Mbit/s, for selected operators in selected countries, June 2004, in USD, at different monthly usage thresholds, compared with NTT DoCoMo’s unlimited usage monthly price

Operator (country)	*Technology*	*1 Mbit/s*	*10 Mbit/s*	*100 Mbit/s*	*1 Gbit/s*
Orange (France)	GPRS	1.46	1.22	1.22	1.22
T-Mobile (Germany)	GPRS	10.68	2.62	2.09	0.23
TIM (Italy)	GPRS	1.82	1.82	1.82	1.82
Telefonica (Spain)	GPRS	7.29	7.29	1.46	1.46
Vodafone (UK)	GPRS	13.71	3.86	2.15	2.15
NTT DoCoMo (Japan) (package)	W-CDMA	9.14	3.92	1.35	0.07
NTT DoCoMo (flat-rate)	W-CDMA	35.00	3.50	0.35	0.04

Source: 3G Mobile, ITU Research

3.4.2 Mobile pricing strategies

Alternative portable Internet technologies are more likely to be complementary than substitutive for fixed-line broadband. However, some argue that for cellular mobile, there is a higher risk of substitution. There is a very simple reason for this: although bucket pricing is becoming increasingly available, cellular mobile services have historically been priced on a per minute basis, with data priced on a per message (SMS) basis. That is because mobile tariffing has been optimised for voice and for short messages, but not for data, or for continuous data. The Internet, by contrast, has traditionally been priced on a flat-rate basis.[14]

Of course, for many low-volume users, Internet usage priced on a per Mbit/s basis may still be cheaper than a flat-rate tariff. But as usage goes up, a flat rate tariff becomes increasingly attractive. In Japan, NTT DoCoMo set the price point for 3G mobile prices when it announced a flat-rate price of 3'900 Yen (around USD 35) per month for unlimited data usage. Table 3.2 compares NTT DoCoMo's *Pake-Houdai* flat-rate tariff with the price per Mbit/s paid under NTT DoCoMo's alternative price package and a series of GPRS services in Europe. The flat-rate tariff becomes interesting at a monthly usage of 10 MB and for a monthly usage of 100 MB it is by far the most attractive tariff. On this basis, a portable Internet service offering unlimited monthly downloads, priced at USD 35 per month for a 35 Mbit/s service, would be an unbeatable option. Although NTT DoCoMo's Wide-band CDMA FOMA service does match this on price, it could not do so on transmission speed, as its top speed is less than one-thousandth of this.

There is the opposing argument, however, that these two 'flavours' of the portable Internet are aiming to achieve different objectives: existing IMT-2000 mobile networks provide on-the-go, personalized communications and global coverage, whereas new higher-speed advanced wireless services will further extend and facilitate broadband access around the globe. But it remains to be seen whether mobile operators will embrace these technologies or fight them. Similarly, will future providers of technologies such as WiMAX wish to work together with existing mobile service providers?

3.5 Corporate strategies

3.5.1 Service markets

It is difficult to be certain which corporate players will emerge as the main movers and shakers in the portable Internet market. But they are more likely to be fixed-line players than mobile ones (as the latter have more to lose) and more likely to be data players than voice ones (again, because voice is more likely to be substitutable than data).

On that basis, those same companies that are already emerging as the major players in broadband may be the best placed ones for an attack on the portable Internet market. Table 3.3 shows the top 20 broadband players worldwide, ranked by number of subscribers at the end of 2003. Although there were only two newcomers to the top 20 during 2003—the fast-growing BT (UK), which shot into 14th position, and CableVision (USA), which evicted Telefónica (Spain) and PCCW (Hong Kong, China) from the list—the market remains relatively fluid. One indicator of this is that the top 20 companies account for only 57 per cent of the total world market, which is a relatively low level of concentration for such a new market. Another indicator is the fact that, within their domestic markets, only four of the twenty have a market share greater than 80 per cent (in France, Germany, Italy and Taiwan, China; each of which are markets where liberalisation has come relatively recently). By contrast, half of the top twenty companies have a market share of below 25 per cent in their domestic market, which does not equate to significant market power.

The fastest riser in the list is China Telecom, which, in the early months of 2004, overtook Korea Telecom as the world's largest broadband service provider. China Telecom's rise reflects the continuing emergence of China as a global ICT powerhouse. But it also suggests that if companies like Korea Telecom are to expand, they need to look beyond their borders for new growth.

Table 3.3 Who is leading in broadband?
Top 20 broadband service providers worldwide, year-end 2003 (ranked by number of subscribers, million)

Rank '03	Rank '02	Operator	Broadband subscribers Q4 2003 (M)	Percentage change 2002-2003	As % of domestic broadband subscribers
1	1	Korea Telecom	5'656	14.9%	50.6%
2	8	China Telecom	5'630	200.4%	41.6%
3	2	Comcast (USA)	5'284	46.8%	21.0%
4	3	Deutsche Telecom	4'000	29.0%	86.5%
5	11	Yahoo! BB (Japan)	*3'600*	*139.4%*	*26.1%*
6	7	SBC (USA)	3'516	59.8%	14.0%
7	6	NTT (Japan)	3'500	45.8%	25.4%
8	13	France Telecom	*3'361*	*146.1%*	*93.9%*
9	5	Time Warner Cable (USA)	3'228	24.2%	12.9%
10	4	Hanaro (Korea, Rep.)	2'700	-6.2%	24.2%
11	9	CHT (Taiwan, China)	2'430	27.2%	80.9%
12	10	Verizon (USA)	2'319	28.8%	9.2%
13	19	Telecom Italia	2'200	158.8%	95.0%
14	--	BT (United Kingdom)	2'000	207.7%	62.7%
15	12	Cox (USA)	1'989	41.2%	7.9%
16	15	Charter (USA)	1'566	30.5%	6.2%
17	17	Bell South (USA)	1'462	43.2%	5.8%
18	16	Bell Canada	*1'396*	*25.8%*	*30.0%*
19	14	Thrunet (Korea, Rep.)	1'300	-0.2%	11.6%
20	--	Cablevision (USA)	1'057	37.3%	4.2%
					% of world market
		Top 20	**58'193**	**51.4%**	**57.1%**

Note: Numbers shown in italics are estimates or represent a date earlier than year-end 2003.
Source: ITU research

3.5.2 Equipment markets

But the service side of the portable Internet market may turn out to be a sideshow compared to the potential for growth in the equipment side of the market. Taking lessons from the Wi-Fi market, it is clear that it has turned out to be more of a hardware market than a service market. Estimates for the number of Wi-Fi users worldwide at the end of 2003 range from 9 million (Gartner Group) to 12 million (Pyramid Research), but the total number of potential users is much greater, because of the practice of laptop manufacturers of providing the service as a standard feature of most new laptops sold. Yet, outside of the Republic of Korea (see Box 3.2), few companies have made much of a business out of selling Wi-Fi subscriptions. That is because, most Wi-Fi users are happy to use the service when it is free of charge (at work, in hotels, in conference centres, in some airports etc) but baulk at paying for the service.

Thinking ahead to the rollout of other portable Internet access technologies—such as WiMAX, Bluetooth or UltraWideBand—there is a strong motivation for equipment manufacturers to build this functionality into future mobile handsets, laptops and other devices. However, there is less of a motivation for service providers to rollout infrastructure, at least until there is a sufficient installed base of potential users and/or there are proven business models. This is particularly the case for mobile service providers who, as shown above, have the biggest potential for loss of revenue, especially for minutes of voice traffic. If the portable Internet does develop first as primarily an equipment-driven market, the likely main players would be equipment manufacturers of today's mobile handsets (e.g., Nokia, Samsung, Ericsson), PC laptops (e.g., Dell, IBM, Toshiba), portable digital assistants and hard drive music players (e.g., Palm, Apple, Sony) and, above all, chip manufacturers (such as Intel, AMD or NEC). Thus, it is not surprising, say, that among the 114 members of the WiMAX Forum[15], all but a handful are equipment and component manufacturers rather than service providers.

Is it possible for a market that starts off being driven by equipment manufacturers can evolve into a subscription-driven service market in the longer term? Yes, most certainly. As the installed base grows, the demand for services will grow. But it is also possible that the portable Internet will remain largely as a (hardware-driven) "application" rather than a (subscription-driven) "service", albeit an application that cannibalises many existing service markets. One of the factors that will determine the course of this trajectory is the approach that regulators take in different national markets. This is the subject of the next chapter.

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1 Three of these island economies in the chart, Cape Verde, the Maldives and St Lucia, as well as several others not shown, such as Fiji and Mauritius, have been the subject of recent ITU country case studies of Internet diffusion, available on the ITU website at http://www.itu.int/ITU-D/ict/cs/. The case of St Lucia is profiled in Box 3.1.

2 For more detail on the Guatemala case, in particular the use of secondary spectrum trading, see the case study: "Spectrum Management for a Converging World: Case study on Guatemala", available online at http://www.itu.int/osg/spu/ni/spectrum/guat-rsm.doc

3 Fixed-line broadband was the subject of the 2003 edition in the ITU Internet Reports series, entitled *Birth of Broadband*, ITU, Geneva, 200pp.

4 See, for instance, the SwissCom (BlueWin) broadband offer for residential consumers in Switzerland offers a wi-fi router as a standard package and offers new users a couple of free per-paid cards for SwissCom's public wi-fi hotspots. See http://www2.bluewin.ch/services/zugang/adsl/endgeraete_f.php

5 See the China Internet Network Information Centre (CINIC) website at http://www.cnnic.net.cn/en/index/0O/index.htm. The figure of 31 million broadband users is generated from the twice-yearly Internet Survey carried out by CINIC, and is from an estimated Internet user base of 87 million. However, the measure "broadband users" is broader than the measure "broadband subscribers" which is used elsewhere in this report. At the start of 2004, China had 13.5 million broadband users.

6 See http://www.aptsec.org/meetings/2004/Ministerial-Summit/BKK%20Agenda-final.doc

7 See country case study: "Bhutan: Wireless IP-based rural access project", on the ITU website at http://www.itu.int/osg/spu/ni/futuremobile/technology/bhutancase.pdf

8 See announcement at http://www.btplc.com/Innovation/Mobility/everywhere/

9 For a discussion of fixed-to-mobile termination rates, see http://www.itu.int/interconnect

10 For a description of the UK system of congestion charging, and the technology in use, see http://www.cfit.gov.uk/congestioncharging/factsheets/guide/. For a more general description, see "The road tolls for thee", The Economist, June 14 2004, at http://www.economist.co.uk/science/tq/displayStory.cfm?story_id=2724381

11 For a recent comparison of broadband prices, see "Benchmarking Broadband Prices in the OECD area", OECD, Paris, 97pp, at http://www.oecd.org/dataoecd/58/17/32143101.pdf

12 These statistics come from the ITU's survey of broadband prices, carried out in July/August in 2003 and 2004 and reported in the ITU Internet Reports. In this edition, broadband prices are reported as Table 7 in the Statistical Annex.

[13] These numbers are based on a simple comparison of the price data collected by ITU, and reported in Table 7 of this report. Please note, however, that the number of countries reporting has increased since the 2003 survey. Also note that the prices are somewhat inflated by the fact that some developing countries market leased line services to businesses as "broadband", in some cases even as "ADSL".

[14] In the history of Internet pricing, the shift from per-minute to flat-rate pricing came in December 1997 when AOL, the then market leader, announced a flat-rate price of US$19.99 per month.

[15] The WiMAX Forum has 114 members, as listed on its website at http://www.WiMAXforum.org/about/roster/ (viewed on 30 July 2004).

4 CHAPTER FOUR: POLICY AND REGULATORY ASPECTS

From a policy and regulatory perspective the provision of portable Internet services straddles a wide and diverse range of issues, reflecting the converged nature of its services and technologies. Important areas of policy and regulatory concern include spectrum management, licensing, interconnection, addressing and numbering as well as content and consumer protection. This chapter looks at some of these key aspects.

4.1 Licensing

In most countries, licenses have traditionally been the primary vehicle for government regulation of the telecommunication market. By setting down conditions for entry into a given market, the development and implementation of national licensing policy determines the structure of the market, the number and type of operators, the degree of competition between them and the terms under which services are provided to the public.

While conditions for market entry have been traditionally stringent in the case of the public provision of voice telephony, the market for Internet and data services are generally more liberalized and open.[1] Nevertheless, regulatory procedures and requirements for market entry in these markets can remain a significant hurdle to an operator seeking to deploy portable Internet technologies and provide related services. Complicated, restrictive and prolonged licensing procedures for operators seeking to provide telecommunications services increase both the cost of market entry as well as add significant delay to the introduction of services. As a result, an increasing number of regulators are introducing more liberalized and simplified licensing regimes.

4.1.1 General authorizations and class licensing

In an effort to reduce the barriers to market entry, a number of regulators have introduced licensing regimes which rely largely on "general authorizations" or "class licensing". Here, the granting of operator licences to provide certain telecommunications services are automatic on notification or registration. "General authorizations" and "class licences" are usually extended to categories of services such as directory services, messaging services and more significantly Internet access services.[2] Countries extending "general authorizations" or "class licensing" to an increasing number of telecommunications services include the recent example of Japan[3] and an increasing number of European Union member countries (see Box 4.1). Nevertheless, licences that exploit the use of scarce resources such as radio spectrum and numbers typically remain subject to more stringent licensing requirements (see section 4.2).

Box 4.1: Facilitating the development of new electronic communications and services
The EU Authorisation Directive

A new EU regulatory framework for the electronic communications sector was agreed upon by EU Member States in December 2001 and came into effect on 25 July 2003. The new Framework, which is based on five principal directives, entailed significant administrative changes in procedures in the licensing authorities in each Member State.

With the aim of facilitating the development of new electronic communications and services, the Authorisation Directive provides for the replacement of individual licences with standardised authorisations of all electronic communications networks and services without the requirement of any explicit decision or administrative act by the national regulatory authority and by limiting any procedural requirements to notification only in most cases.

The granting of specific rights may continue to be necessary for the use of radio frequencies and numbers, including short codes, from the national numbering plan.

Source: http://europa.eu.int/information_society/topics/telecoms/regulatory/new_rf/documents/l_10820020424en00210032.pdf

4.1.2 Technology neutrality and convergence

In addition to reducing the cost of procuring a licence and removing the need for a lengthy licence approval process, regulators have also sought to reflect the phenomenon of convergence and the principle of technology neutrality in licensing. With this aim in mind, a number of regulators have sought to remove the licensing uncertainty typically associated with the need to acquire licences in the specific telecommunications service category of interest (see Box 4.2). This simplification plays a key role in facilitating the market entry of portable Internet service providers who aim to provide a full range of converged services such as VoIP, data transmission and Internet access.

Box 4.2: Licensing for convergence
The case of Malaysia

Under its old regime, telecommunications and broadcasting operators in Malaysia were required to obtain licences in specific service or technological categories. In effect, this meant that an operator who wished to provide a range of services across different technology platforms required multiple licences and covering this range. For example, an operator seeking to provide Internet services as well as voice telephony would require a licence for each. With rapid changes in technology and the market, these licences had to be constantly updated to ensure their relevance, resulting in an increased administrative burden on both the regulator and the licensees. As a result, licensees were migrated onto a new licensing regime pursuant to Maylasia's 1999 Communications and Multimedia Act (CMA) which allowed telecommunications and broadcasting operators to freely select the types of networks or services they wished to provide within broad activity groups.

Instead of classifying licensable activities under conventional labels, the CMA organizes them into four generic activities; the provision of network facilities (NFP), network services (NSP), applications services (ASP) and content application services (CASP). Within these categories, there was a division between individual and class licences depending on the degree of regulatory oversight required.

In effect, the new regime streamlined and reduced the number of licences an operator required. For example, the 11 licences held by incumbent telecommunications operator Telekom Malaysia were reduced to three following the implementation of the new regime while its operations remained the same.

Source: Malaysian Communications and Multimedia Commission, "*The Migration of Licenses: A Paradigm Shift 1999-2001*"available at www.aptsec.org/meetings/2004/ PRF/documents/License%20Migration-MLA.DOC

Going one step further, some countries are re-examining licensing models with a view towards reflecting fixed-line and wireless convergence. Such a unified licensing regime would allow operators to maximize the use of their existing infrastructure as well as capitalize on technology developments that allow integrated service provision. A small number of regulators, such as TRAI in India, have begun implementing a concept of "unified licensing" which would see the removal of all licensing distinctions between services provided over wired and wireless means (see Box 4.3).

4.2 Radio-spectrum management

While simplifying the process of obtaining regulatory approval is important to promote the market entry of portable Internet service providers, ensuring access to sufficient radio spectrum (or "spectrum" for short) remains an absolute prerequisite for the provision of their services. As portable Internet services expand in terms of both range and size, the number of users that are added will continue to climb. This growth will put increasing demands on a limited amount of spectrum available for wireless services. In many urban areas, in both developed and developing countries, spectrum congestion has already become a major concern. In order to safeguard the development and expansion of portable Internet services, it has become an imperative for regulators to develop and adopt spectrum management practices that promote greater economic and technical efficiency in spectrum use.[4]

Box 4.3: "Unified Access Licensing" and "Unified Licensing"
Review of licensing regime in India

Following technological and market developments reflecting the increasing overlap between telecommunications services provided over fixed and wireless means, the Telecommunications Regulatory Authority of India (TRAI) felt that there was a need to review its licensing regime. Accordingly, a Consultation Paper on Unified Access Licensing for basic and cellular services was issued on 16 July 2003 by the authority. On 27 October 2003, TRAI produced a blueprint for a unified access licensing (UAL) regime that provided for a single licence category for fixed-line and cellular operators. On 11 November 2003, the Government sanctioned this plan. As a result, both Basic and Cellular Mobile service providers were given the freedom to offer basic and/or cellular mobile services using any technology.

Although the UAL regime is only currently limited to access networks, TRAI's intention is to extend the UAL regime into a unified licensing regime for all services including services such as national long distance, international long distance, and Internet access. As envisaged, the unified licensing regime would allow for the automatic licensing or authorisation of any service provider subject to notification and compliance with published regulatory guidelines. Spectrum charges would be determined by a different mechanism.

Preliminary consultation papers on the unified licensing regime were issued on 15 November 2003 and 13 March 2003 in order to obtain further input. Based on the comments received, TRAI released their draft recommendations on a unified licensing regime on 6 August 2004.

Source: TRAI

4.2.1 Spectrum assignment and allocation

Spectrum management primarily involves two basic steps: (1) the allocation of specific blocks of frequencies for particular uses, e.g. TV, mobile, defence, satellites, etc. and (2) the assignment of specific frequencies within the blocks to specific "licensees" who use these frequencies to provide telecommunications services. Due to a number of practical constraints such as interference management, public policy considerations and the needs of harmonisation, spectrum has historically been managed by centralised administrations that use a command and control approach to spectrum allocation and assignment. This approach, however, is coming under increasing scrutiny and pressures. In the current environment of fast paced technological and market change, which has characterized the development of the portable Internet, some are of the view that the centralized management of spectrum is too slow, inefficient and biased towards the status quo and incumbent interests.[5] Furthermore, the centralized management of spectrum is geared towards the presumption of spectrum scarcity, which is a limitation that is changing thanks to technological change[6]. With the advent of the portable Internet, a single platform founded on IP-based technology can be used to deliver a wide range of services such as mobile voice telephony, Internet access and broadcasting, which have traditionally been regarded as separate radiocommunication services involving different spectrum allocations.[7]

Faced with increasing pressures from unpredictable markets and rapid technological change, a growing number of countries have adopted, or are considering adopting, a range of approaches designed to give market-forces a larger role in the determination of how spectrum resources are allocated and assigned. Key market-based approaches that countries have taken include the introduction of spectrum auctions, tradable spectrum rights, spectrum leasing, market-based spectrum licence fees and licence-exempt spectrum use.

Spectrum auctions

Since their introduction in 1989 in New Zealand, auctions (see Box 4.4) have been introduced in some other countries as a mechanism to assign commercial spectrum licences for which there is a high demand. For example, by 2002, 13 out of the 33 countries that had assigned spectrum for UMTS services by 2002 had used auctions.[8] Auctions have been claimed as one method of ensuring equitability and transparency and, in some cases, have also been used as a way to decrease the administrative costs and delays associated with the spectrum assignment process. At the same time, economic theory dictates that licences will be put to their most productive use as they are competitively assigned to users who value these licences the most. Although expectations might have been too high, licence proceeds have also become a lucrative source of income for government treasuries as 3G auctions in many parts of the world have demonstrated.[9]

Box 4.4: By any other name…
Auctions in their many forms

Auctions may take various forms, including:

- the English auction, where the auctioneer increases the price until a single bidder is left;
- the first-price sealed bid auction, where bidders submit sealed bids and the highest wins;
- the second-price sealed bid auction, where bidders submit sealed bids and the highest bidder wins but pays the second highest amount bid;
- the Dutch auction, where the auctioneer announces a high price and reduces it until a bidder shouts "mine"; and
- the simultaneous multiple round auction, where there are multiple rounds of bidding for a number of lots that are offered simultaneously. The highest bid on each lot is revealed to all bidders before the next round when bids are again accepted on all lots. The identity of the high bidder may or may not be revealed after each round, but is revealed at the auction's close. The process continues until a round occurs in which no new bids are submitted on any lots. This variant is more complex than single-round auctions but offers bidders greater flexibility to combine lots in different ways, and, because it is more open than a sealed bid process, limits the impact of the *winner's curse*, allowing bidders to bid with more confidence.

Source: ITU

However, auctions have introduced their own set of ancillary difficulties.[10] Despite the large body of work dedicated to the study and application of good auction design, the variables that need to be considered, such as weighing future demand and impact of technological developments, can render the effects of auctions unpredictable. Furthermore, auctions also operate in the rigid framework of administrative spectrum allocations where if too little spectrum is allocated for a particular use or for a particular region, the auction results might lead to artificial scarcity premium for the government. While this may be seen as having achieved their targets in terms of revenue generation for governments, examples of unintended auction results include a number of 3G auctions in Europe and 2G auctions in Africa, where overbidding has generated serious financial difficulties for some operators and a wider recession in the ICT industry. In some cases, this has led to delays in network roll-out or the return of auctioned licences. This in turn has resulted in delays in the rollout of infrastructure and services as well as placing pressure on industry to consolidate, leading to a corresponding reduction in competition. In response, some countries have adopted mitigating measures such as a hybrid approach that combines elements from auction methods and traditional "beauty contests". For example, the 3G auction in Hong Kong, China involved multiple stages. A pre-qualification exercise was held to select bidders who would then participate in an auction similar to a simultaneous, multiple round format. It also adopted a royalty payments approach in the auction to avoid the upfront debt problems encountered earlier in the United Kingdom and Germany. Four bidders for four licences paid the reserve price of HK$ 50 million per annum or 5 per cent of total revenue whichever would be the greater for the first five years, with the percentage rising for the duration of the licence thereafter.

Tradable spectrum rights

While a well-designed auction or a meticulous "beauty contest" can assign spectrum resources efficiently at the onset, it will not continue to ensure that the assigned spectrum will continue to be used in an economically efficient manner in the future. In order to allow spectrum resources to be used by those who value it the most and for the purpose it is valued for the most, a few countries have allowed spectrum users the flexibility of trading their spectrum rights in a secondary market (see Box 4.5).

Presently, in most countries, the transfer of ownership of a spectrum licence to another party after the initial assignment can only be effected in very limited and difficult circumstances. However, by facilitating the transfer of spectrum rights, economic efficiency could be more easily achieved as licensees are exposed to the opportunity cost of their spectrum. If the value a licensee places on the spectrum is lower than that placed on it by another party, a transfer of the spectrum rights to the other party may in some cases result in a gain in economic efficiency. Allowing transfers would also lower barriers to entry into the market, firstly, by reducing risk through the possibility of resale, and secondly, by allowing prospective market entrants easier access to spectrum on the market instead of having to lobby or apply for spectrum to be administratively assigned to them.[11]

Box 4.5: Trading for flexibility

Modes of secondary trading in the United Kingdom

In its consultation document on the implementation of spectrum trading, the former Radiocommunications Agency (RA) in the United Kingdom identified four major trading modes that reflect different degrees of flexibility that could be allowed to spectrum licensees[12]:

- mode 1: change of ownership;
- mode 2: change of ownership and reconfiguration (covering partition and aggregation);
- mode 3: change of ownership, reconfiguration and change of use, and
- mode 4 : change of ownership and change of use.

Spectrum trading variants also include spectrum leasing and spectrum sharing arrangements. The new UK regulator has recently confirmed that companies will be able to begin buying and selling radio spectrum from the end of 2004.

Source: *Implementing Spectrum Trading, A Consultation Document*, July 2002, Radiocommunications Agency, United Kingdom available at www.ofcom.org.uk/static/archive/ra/topics/spectrum-strat/consult/implementingspectrumtrading.pdf

Changes in spectrum ownership through secondary trading have been permitted in some bands by Australia, Guatemala and New Zealand and to a more limited extent in Canada and the United States. In addition to allowing changes in spectrum ownership, however, Australia, Guatemala and New Zealand have also permitted changes in spectrum use within those bands open for secondary trading. Given the unpredictable nature of spectrum demand and technological progress, this approach is aimed at devolving the decision on how to best use spectrum to market players who have the agility to respond faster to changes in technology and consumer wants. For example in New Zealand, where such changes in use are permitted, spectrum sold originally for multipoint distribution service is being used flexibly as multipoint broadband wireless local loop.

Nevertheless, there are a number of important constraints that act on the scope of a government to introduce flexibility in spectrum use. Depending on the geographic isolation of the country, the freedom to change spectrum use is likely to be constrained by international obligations. For example, the ITU Radio Regulations and bilateral agreements on spectrum use seek to minimise cross-border interference by allocating specific bands for specific services. Such international agreements may also seek to harmonise the usage of certain frequencies in order to facilitate the provision of cross-border services such as global roaming among GSM networks. In addition to international obligations, governments may also seek to restrict changes in use in order to maintain diversity in the provision of radio services. For example, mobile communication services could be offered through a range of alternatives from self-provided trunked mobile systems to cellular telephony.

Given these constraints, the countries that have implemented spectrum trading have tended to adopt a progressive approach to its introduction. A step-by-step approach to trading gives regulators the time to facilitate spectrum reorganization and allows markets the opportunity to gain familiarity with the new regime. Limiting spectrum trading to only new assignments of licences or the use of overlay licences, have been found to be convenient approaches in making the transition to spectrum trading while accommodating the interests of incumbents. New Zealand's three tiered system of rights illustrate a unique approach to the introduction of transferable and flexible spectrum rights while accommodating incumbent interests (see Box 4.6).

Although secondary trading has been introduced in Australia, New Zealand and Guatemala, the government nevertheless reserves certain bands for specific services and not subject to secondary trading regimes. For example, Australia does allow satellite bands to be subject to secondary trading while the New Zealand government retains the rights over spectrum used for public service broadcasting.

Box 4.6: More Secondary trading
The case of New Zealand

New Zealand has shown that it is feasible to create tradable spectrum rights and to auction these rights despite the presence of incumbents in the bands. This was largely accomplished through a three-tier system of rights:

Management rights bestow the exclusive right to the management of a nationwide band of frequencies for a period of up to 20 years. Within this band, the manager can issue licences. They are not constrained as to the uses for which licences are issued.

Licence rights are derived from spectrum licences that are issued by the management rights holder which allow licensees the right to use frequencies within their bands. Licences are use specific and defined in terms of transmitter sites. The management rights holder can issue licences to itself.

In blocks of spectrum where management rights have not been created, the legacy regime of non-tradable **apparatus licences** continues.

The Government favoured a progressive conversion of licences to a spectrum rights regime. As the initial owner of all management rights, the Government has used auctions to make primary assignments of tradable management rights. There were 91 management rights as at February 2004 - with the New Zealand Government retaining ownership of 15 of these rights, predominantly over spectrum used to provide public services.

It is left to the ensuing management rights holders whether or not to trade their rights. There are no restrictions on the activities of the operators, the number of entrants into the markets or specialised licensing requirements.

Source: Ministry of Economic Development at www.med.govt.nz/rsm/ and http://spectrumonline.med.govt.nz/

In addition to incumbent considerations in the initial implementation of secondary trading, the way spectrum is divided and packaged in terms of geography or bandwidth for assignment also has a considerable influence on the ease of implementation and the eventual development of the secondary trading market. While assigning licences encompassing variable amounts of spectrum on a case-by-case basis is practised by most spectrum trading countries, Australia, for example, has adopted a more structured basis as a point of departure by first dividing spectrum into standard units of geographical coverage and bandwidth (see Box 4.7). Such an approach provides some advantages in terms of flexibility of use and ease of reconfiguration, which in turn facilitates the easier introduction of spectrum trading, but is notoriously difficult to implement given the amount of variables that have to be rationalized in creating uniform spectrum blocks.

In addition to spectrum packaging, competition safeguards also play a central role in implementing secondary trading as the possibility of spectrum consolidation may potentially lead to a decrease in the number of competitors. Spectrum hoarding, in particular, is a key concern. In Australia and New Zealand competition concerns regarding spectrum trading are largely resolved by *ex post* enforcement of competition law.[13] In other countries, regulators have resorted to more *ex ante* competition policy measures, usually in the form of requirements for regulatory approval of spectrum trades. Other *ex ante* safeguards include spectrum ownership caps that limit the maximum amount of spectrum a single entity is allowed to own.

Spectrum leasing and spectrum sharing

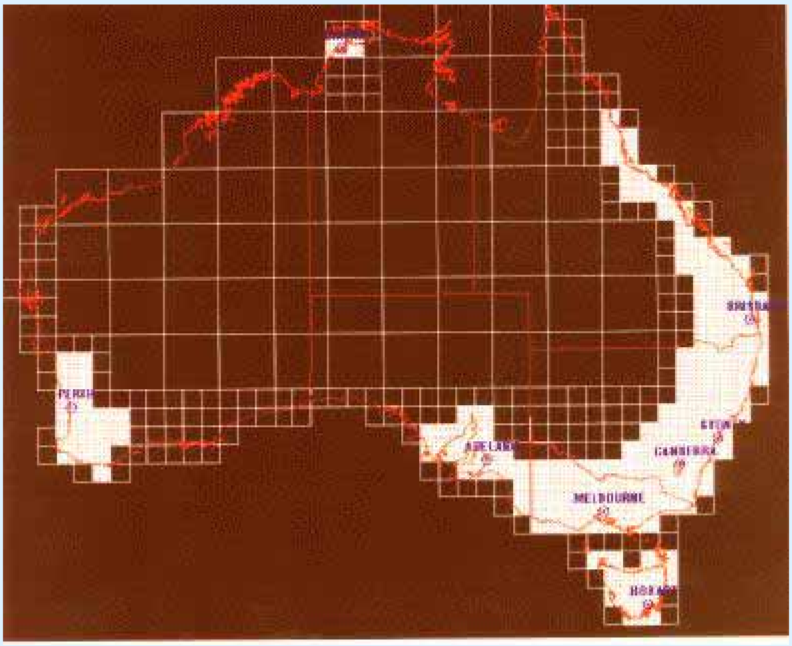
While similar to spectrum trading, spectrum leasing or sharing typically involves a partial transfer of a licensee's rights to spectrum either for a limited period of time and/or for a portion of the spectrum encompassed in the licence. This includes, for example, the transfer of the right to transmit from one site under a multi-site licence for a temporary period. The flexibility afforded by such an arrangement is particularly ideal for situations where a lessee's requirements are minor or temporary. It also allows licensees to benefit by allowing them to receive returns on portions of their assignment for which they have no present need. This allows unused spectrum to be released into the market and creates a financial incentive for licensees to adopt more efficient ways of utilizing their existing spectrum. In leasing and sharing arrangements, however, it would be important for licensees and lessees to be clear on how rights and obligations are apportioned, especially in cases where enforcement action may have to be taken by the regulator (see Box 4.8).

Box 4.7: Spectrum as commodity

Australia and the standard trading unit (STU)

In Australia spectrum blocks owned by licensees are represented in units called standard trading units (STUs). An STU covers a predetermined geographic area and frequency band. STUs can be combined vertically to provide increased bandwidth or horizontally to cover a larger area. An STU is the smallest spectrum unit recognized by the Australian Communications Authority (ACA) and its bandwidth and geographic dimensions cannot be further divided.

The minimum frequency band for any spectrum licence would have a width of one STU bandwidth. In some bands this bandwidth is as small as 0.0125 MHz. The minimum geographic area for an STU is a single cell of a Spectrum Map Grid. The Spectrum Map Grid covering Australia is shown below, and consists of cells of various sizes depending on their location.



Different cell sizes are used depending on the levels of population. Larger cells are defined in rural areas. Small cells are defined in areas with high population density, such as cities, towns and their suburban areas.

Auction lots of spectrum space are then defined for sale. An auction-lot area is defined by reference to the spectrum map grid. The auction-lot areas are defined to cover the total area available from each band release and with no overlap of areas. Auction-lot areas are created by a process that aggregates map grid cells. The process takes account of the value of populated areas, the incumbent services and the requirements of the technical framework itself, for example, the size of the emission buffer zone.

Source: Australian Communications Authority

Licence-exempt spectrum

In contrast with spectrum management regimes based on exclusive rights, a licence-exempt regulatory model does not assign users exclusive use privileges over spectrum. Instead, access to spectrum is open to all users under certain conditions. The first involves licence-exempt low power transmissions, where interference is limited by strict power limits and regulatory equipment approval. This allows low-power users to co-exist in bands simultaneously used for higher power emissions. The second involves spectrum use in bands allocated for licence-exempt use. Bands like the 2.4 GHz "industrial, scientific and medical" (ISM) band, where 802.11b standard operates, as well as the 5 GHz band, where the 802.11a standard and the emerging 802.16a standard operate, have generated considerable attention in recent times. Most regulators require users of these bands to be subject to certain restrictions, such as output power limits or communication protocols, and other "etiquette rules" aimed at minimizing interference. While users of these bands are permitted higher power outputs due to the protection offered by the dedicated bandwidth given to licence-exempt use, the use of the spectrum itself is typically granted on a non-interference, non-protected basis. Users in these bands are liable for interfering emissions they cause but are not protected from interference from others. Significant incentives are therefore created for users to deploy innovative systems that offer dynamic traffic-channel monitoring and selection and fast frequency hopping spread spectrum waveforms.

Box 4.8: Spectrum leasing in the United States
FCC's 2003 landmark order

In May 2003, the Federal Communications Commission (FCC) adopted a "landmark" order on spectrum leasing that authorised most wireless radio licensees with exclusive rights to their assigned spectrum to enter into spectrum leasing arrangements.

Under the leasing rules adopted, licensees in certain services are allowed to lease some or all of their spectrum usage rights to third parties for any amount of spectrum and in any geographic area encompassed by the licence, and for any time within the term of the licence.

The order also creates two different mechanisms for spectrum leasing depending on the scope and responsibilities to be assumed by the lessee:

The first leasing option – "spectrum manager" leasing – enables parties to enter into spectrum leasing arrangements without obtaining prior FCC approval so long as the licensee retains both *de jure* control of the licence and de facto control over the leased spectrum. The licensee must maintain an oversight role to ensure lessee compliance with the Communications Act and all spectrum related FCC rules. In enforcing the rules, the FCC will look primarily at the licensee on compliance issues but lessees are potentially accountable as well.

The second option – *de facto* transfer leasing – permits parties to enter into leasing arrangements, with prior approval of the FCC, whereby the licensee retains *de jure* control of the licence while *de facto* control is transferred to the lessee for the term of the lease. Lessees are directly and primarily responsible for ensuring compliance with all FCC rules. For enforcement purposes the FCC will look primarily to the lessee for compliance, and lessees will be subject to enforcement action as appropriate. Licensees will be responsible for lessee compliance in so far as they have constructive knowledge of the lessee's failure to comply or violation.

Source: Report and Order and Further Notice of Proposed Rulemaking (FCC 03-113), Federal Communications Commission

In addition to the technological and service innovation brought about by licence-exempt spectrum use, eliminating the requirement for administrative licensing has also lowered barriers to market entry and spurred competition. The increasing popularity of services, such as Wi-Fi, delivered over licence-exempt bands in many parts of the world serves as a strong testimony to benefits that can be reaped from an open spectrum approach.

Despite the rapid success enjoyed by some services provided over licence-exempt spectrum, significant concerns remain regarding the long-term viability of an open access regime. Over time, the increasingly diverse and intense use of such bands will gradually increase the potential for congestion and interference causing an eventual degradation in service quality. The experience of the citizen band (CB) radio in the United States is often highlighted as an example of a tragedy of the spectrum commons, even though it is uncertain as to how large a role service degradation played in its drastic fall in popularity in the mid-1970s.[14]

Administrative incentive pricing

The levying of a market-based licence fee is another alternative through which regulators have introduced market-forces in spectrum management. Beyond the basic fees that are traditionally based on management costs such as those for processing licence applications, the monitoring of spectrum use and other administrative costs, there are other forms of licence fees that are designed to reflect the workings of market forces in the absence of other mechanisms such as spectrum trading. These typically take the form of incentive fees (commonly referred to as administrative incentive pricing).

Opportunity costs of the current use of spectrum would reflect the economic value of the spectrum in the best alternative use. In theory, current users would therefore be willing to hand back rights to use the spectrum

An incentive fee attempts to use price as a means to provide incentive for spectrum to be used efficiently. In theory, licensees would be encouraged to use as little spectrum as they can to achieve their aims and to return or transfer any unused portions of their spectrum assignment if the opportunity costs of using spectrum, reflected through administrative incentive pricing, are higher than the economic value to that user.

In calculating incentive fees, a number of different elements of spectrum usage have been taken into account by the administrations that have implemented them. These include the coverage area, the extent to which the frequencies can be shared, the population density, power levels allowed, the bandwidth, etc. In a number of countries, simulated auctions and financial studies and extrapolations based on prior secondary market transactions may be used. (see Box 4.9).[15]

Box 4.9: Pricing spectrum
Australia's system

The Australian spectrum pricing system is conceived on the assumption that charges to the users of spectrum should serve two objectives:

- act as a rationing device and set in a manner that encourages efficient use of spectrum, and
- deliver a fair return to the community for the private use of a community resource.

The radiocommunication licence taxes (for transmitters and receivers) are based on a formula that takes into account:

- the spectrum location authorised by a licence (some spectrum bands are in higher demand and are therefore more congested than other bands);
- the amount of spectrum (bandwidth) used by a licensee;
- the geographic coverage authorised by the licence; and
- the power of the transmitter (transmitters operating at a low power will attract a discount).

The Australian communications Authority (ACA) acknowledges that, in the interests of simplicity and accessibility to spectrum users, the fee formula incorporates some compromises and a degree of crudeness in the manner in which different factors are measured and charged. Since introducing the fee formula in 1995, the ACA has continued to monitor and adjust the fees. The ACA has a programme to review fee levels, in particular in bands which are experiencing congestion and in which there is arguably a case for increasing fees. Ideally, in spectrum bands and geographic locations where there is scarcity and congestion, fees should be set at "market" levels. However, the task of establishing those market levels is very difficult. Methods by which values might be established by the ACA include:

- shadow pricing against auction outcomes;
- shadow pricing against alternative (non-wireless) service delivery mechanisms;
- gathering evidence of market values from observing trading in the secondary market, and
- where there is evidence of congestion (excess demand) in a band or location, gradually increasing annual spectrum charges to the level which causes an easing of that congestion.

In addition to commercial services, the ACA levies spectrum pricing on a number of public users of spectrum. For example, the Department of Defence pays around AUD 8.4 million (USD 6.01 million) each year for spectrum reserved in the defence bands. It pays a further AUD 979'000 (USD 700'423) for spectrum it uses outside the defence bands and AUD 245'000 (USD 175'284) for classified assignments. Although it may be difficult to make judgements about opportunity costs in the defence environment (for example, security reasons may prevent full disclosure of the actual spectrum used), the ACA nevertheless believes that charges for defence spectrum should continue to be made on the same basis as other uses. This provides the best assurance that there will be continued incentives for the Department of Defence to make efficient use of spectrum, including surrendering spectrum that it no longer requires. It should be noted that there have been several examples where the Department of Defence has been willing to give up or share spectrum.

Source: ITU Country Case Study, *Radiospectrum Management for a Converging World: Australia*

Administrative incentive pricing, however, is an imperfect substitution for market-forces. Information deficiencies as well as methodological problems in determining fees equivalent to the opportunity costs of current spectrum use, renders it an imperfect tool. Nevertheless, in the absence of other alternatives, there still remains considerable scope for the use of administrative incentive pricing in the case of public services and other specific services, such as satellite and public broadcasting, which are deemed unsuitable for the application of most other market-based approaches, such as secondary trading.

4.2.2 Advanced wireless technologies

While the introduction of market-based approaches to spectrum management can be expected to yield greater economic efficiency, the introduction of technology-focused policies is equally important in order to promote greater technical efficiency in spectrum use. As described in Chapter 2, a host of advanced wireless technologies have been developed to increase capacity and efficiency. However, many of the benefits that these advanced wireless technologies offer can only be harnessed only if new approaches to spectrum management are similarly explored.

Introducing the use of spectrum underlays

Certain technologies have been designed to take advantage of a traditional radio's built-in resistance to noise by keeping all communications at such low power levels that the transmissions blend in with other interference beneath the noise floor (this area beneath the noise floor is referred to as the underlay). Underlay technologies such as ultra-wide band offer the potential to drastically increase spectrum efficiency by opening up this previously unused portion of spectrum.

Incumbent licence owners, however, have generally resisted the introduction of new users in the same frequencies to which they have legal, exclusive right. Despite strong objections from such users, the FCC is studying ultra-wide band and approved a low-powered version of the technology in February 2002. While the US Department of Defense had concerns that UWB signals would interfere with the GPS navigation system, extensive testing by the FCC found that UWB would not cause significant disruption at low power levels. The FCC took a cautious approach to UWB, limiting the range of the technology to roughly 30 feet, close enough for home networking indoors. If systems in development work as planned, the FCC had stated that it would be willing to increase the power limits in the initial ruling.

Developing noise temperature measures

One of the key prerequisites for an underlay system is a regulatory definition of the noise floor, or how much interference is too much for legacy radios. Once the acceptable noise floor is established, underlay technologies can be allowed to broadcast below it. Several regulators are looking into a more dynamic version of a fixed noise floor for all equipment. By developing a "noise temperature" (sometimes called "interference temperature") devices can monitor the amount of interference in an area and adjust their emitting power accordingly. Higher noise temperatures correspond to higher levels of interference. Several regulators, including the FCC's Spectrum Policy Task Force, have been looking into ways to improve spectrum efficiency by using interference temperature measures.

Currently, however, there is no standard system for measuring noise temperature. Nevertheless, the FCC has requested comment on how such a system would work. There are two main ways a potential service could operate. In the first, each RF device would continually take its own measurements of the noise temperature and make its transmission decisions based on the results. Licensed and unlicensed devices would require different parameters to ensure that licensed devices received the highest priority. Such a system would likely be the most efficient because devices would be able to monitor their immediate surroundings before making the transmission decision. However, this precision comes at a cost; the complexity of the transmitting equipment will need to increase, consequently increasing the cost of individual devices. Another option is to have stand-alone reporting stations measure the noise temperature in their vicinity and then broadcast the corresponding permissions/non-permissions to transmitters in its area. These transmissions would offer different information for licensed and unlicensed radios. The transmitted permissions may be as simple as a "yes or no" signal or more complex signals specifying maximum power levels for each type of radio. This would allow a much more effective use of spectrum in a given location. Local, unlicensed devices could make use of licensed frequencies as long as there were either no transmissions at a given time or if the noise temperature was low enough for both signals to coexist without significant erosion of the licensed signal.

Developing coexistence models

While frequency hopping technologies, such as those used by agile radio systems, have the potential to make more efficient use of the radio spectrum by using vacant frequencies across a wide bandwidth, the amount of available spectrum depends on the bandwidth across which they are allowed to operate. If agile radio systems are only allowed to operate in small, open bands, efficiency gains will be relatively small.

The establishment of "coexistence models" that dictate protocols for frequency-hopping radios to transmit on frequencies licensed to other users, which are vacant at the time of transmission, will enable the use of larger amounts of fallow spectrum. As transmissions cannot effectively exist in the same exact time and space as another, the technology of frequency hopping radios must be robust enough to immediately detect a licensed transmission and vacate the frequency before causing interference. For these reasons, a number of regulators, such as those in the US and the UK, are initially limiting the licensing of frequency hopping technologies to certain frequency bands with low existing usage and minimal risk of interference (see Box 4.10).

Box 4.10: "Politely" avoiding interference
The concept of frequency agility

Avoiding interference on a dynamic basis can be undertaken at a macro and micro level. At a macro level, an interference free channel is used for an extended period of time while at the micro level, frequency agility involves t rapid hopping between frequency channels in a sequence. The use of "polite technologies", such as dynamic frequency selection (DFS) and transmitter power control (TPC), is a good example of the macro approach. In DFS, a transmitter listens for other users before selecting a channel to use while TPC ensures that the transmitter uses the lowest power level commensurate with the quality desired, thus keeping the level of interference down. In the United Kingdom, the use of DFS and TPC was a mandatory condition for the deployment of high-performance radio local area networks (HIPERLANs) in the 5GHz band which was occupied by satellite services. At a micro level, spread spectrum technology using frequency hopping also has interference mitigation characteristics. Rapid variation of the signal reduces the chance for same signal interference in hostile environments such as licence-exempt bands. Radio local area network (RLAN) devices operating in the licence-exempt 2.4 GHz band typically use this technique.

Source: AEGIS Spectrum Engineering, *Implications of international regulation and technical considerations on market mechanisms in spectrum management*, 2001, available at http://www.aegis-systems.co.uk/download/spreview.pdf

Permitting multi-purpose or software-defined radios

One of the most promising elements of software defined radio technologies will be the ability for one generic radio device to function as an all-in-one communication tool. Such a device could conceivably work as a mobile phone, cordless phone, GPS, and Internet data connection. Traditionally, each type of device would fall under different regulatory requirements and equipment must confirm to different regulations. However, if a generic device were to be able to "transform" into new types of devices based on the internal software, regulatory bodies must decide how to categorise such a device and how the approval process would function. In certain cases, the technological flexibility of a device may be overly constrained by restrictive regulations that limit the use of certain spectrum bands to specific services (Box 4.11).

Box 4.11: Garmin's recent moves
Confining RINO (Radio Integrated Navigation Outdoors)

Garmin is best known for its global positioning system (GPS) products but has recently entered the family radio service (FRS) market and the general mobile radio service (GMRS) market in the United States with a product called the RINO (Radio Integrated Navigation Outdoors). The RINO 130 functions as both a GPS and a two-way radio.

One of the most appealing features of the RINO is the ability for users to "beam" their location to other RINO users. The GPS in the unit determines a user's latitude and longitude, which can then be sent over an FRS radio channel to other RINO users, appearing as a waypoint in their GPS. This allows them to see the location of the people on the GPS screen with whom they are communicating. The feature is an excellent way for people to locate each other in crowds or outdoor settings.

In order to include the beaming functionality into the RINO, Garmin had to overcome a regulatory obstacle which prevented the sending of data on a voice-only channel. Garmin petitioned the FCC and initially received a waver allowing the transmission of location data on FRS channels. Eventually the FCC made a formal rule change allowing for radios to send location data on FRS channels.

FRS Radio

The range of the location beaming service is currently limited to the 2-mile range of FRS, even though the radios are capable of reaching 5 miles on GMRS channels. Garmin has also petitioned for the FCC to allow beaming on GMRS channels but there has been no decision as of yet. This leads to an awkward situation for current radio users.

Users who purchase the radios are likely to choose the GMRS channels because of the increased range of the radios, but by doing so, cannot use the location beaming technology. This leads to a situation where GMRS users coordinate a quick channel switch to FRS frequencies with everyone participating in the conversation. Once they are all on the same FRS channel, they quickly beam their locations to one another. Then, once everyone has received the beam, they switch back to the longer-range GMRS channels to resume communications.

While current FCC regulations may not allow the "beaming" of locations over GMRS, the software defined radio technology in the RINO allows for it to be quickly upgraded to allow GMRS beaming if the FCC decides to allow it on the channels.

The same scenario also raises difficult questions linked to equipment approval since rather than focusing on the hardware elements of electronic devices the key approval will now lie with the software that controls the radio.

Source: Garmin

4.3 Competition policy, access and interconnection

Structurally, the market for portable Internet services does not share many of the impediments that have characterised the market for services delivered over fixed line networks. Its relatively recent introduction and the ease of deployment and affordability of short and medium range portable Internet networks have allowed the portable Internet market to circumvent the barriers to competition that have resulted from incumbent dominance of last mile copper and cable access networks. Regarded widely as an emerging market, the market for high-speed portable Internet services has largely avoided the high level of *ex-ante* regulatory intervention that has been characteristic of fixed-line services (see Box 4.12). It is important to note, however, that the market for portable Internet services delivered over mobile networks has attracted increasing regulatory scrutiny, particularly in the context of mobile voice and data services.

Box 4.12: *Ex ante* regulation and emerging markets in Europe

Positions of the European Commission and the European Regulators Group

As part of the its new regulatory framework, the European Commission, in its Recommendation on relevant markets[16] issued in February 2003, put forward a number of criteria for the application of *ex ante* regulation. These criteria must be met cumulatively, and include: (a) the existence of high barriers to entry in to the market concerned, (b) the absence of dynamic competition in spite of these barriers and (c) the fact that competition rules are not sufficient to address the perceived market

In discussing these criteria, the European Commission in its Explanatory Memorandum to the Recommendation clarifies that "entry barriers may also become less relevant with regard to innovation-driven markets characterised by ongoing technological progress. In such markets, competitive constraints often come from innovative threats from potential competitors that are not currently in the market. In such innovation-driven markets, dynamic or longer term competition can take place among firms that are not necessarily competitors in an existing "static" market."

In response, the European Regulators Group of National Regulatory Authorities (ERG) noted in its common position that the distinguishing feature of an emerging market is its immaturity. And this was held to imply that it would not be possible to make a definitive finding on whether such a market is susceptible to *ex ante* regulation based on the criteria highlighted in the Commission's Recommendation. In this context, the ERG highlighted the provision of next generation mobile broadband data services as an example of an emerging market. It noted that in such a market, operators would provide end-users with access to the Internet through a fast connection and with the added feature of mobility.

It is to be noted, however, that the Commission's Explanatory Memorandum highlighted that most of the important issues in these markets "can currently be dealt with only with a high degree of uncertainty". On this basis, no retail or wholesale markets in this area were identified in the Recommendation.

Source: ERG Common Position on the approach to appropriate remedies in the new regulatory framework. See www.icp.pt

It is also recognised that the provision and use of the range of portable Internet services depends heavily on access to critical upstream services and interconnection with networks that are provided in adjacent markets that have attracted regulatory intervention. These include access to intra-national Internet connectivity through fixed-line broadband and leased lines services, interconnection with the international Internet backbone, and interconnection with the Public Switched Telephone Network (PSTN).

4.3.1 Access to intra-national Internet connectivity

While it is possible for users and providers of portable Internet services to own and operate a network that connects directly to the Internet backbone, a significant majority of portable Internet service providers as well as users rely on a range of intra-country high-speed Internet services such as retail broadband or wholesale leased lines. For example, a significant proportion of Wi-Fi users are consumers of retail fixed-line broadband services to which their personal Wi-Fi network is connected. Similarly, wireless Internet access providers that use a range of portable Internet technologies such as LMDS (Local Multipoint Distribution System) or Wi-Fi require backhaul connectivity to the Internet backbone, which usually involves the use of leased lines.

With respect to the market for broadband services, regulatory intervention to ensure effective competition and affordable access has involved a range of regulatory measures. These include mandating local loop unbundling and open access to cable networks, ensuring access to rights of way and allowing collocation as well as preventing cross-ownership of telecommunications and cable TV providers (see Box 4.13).

Box 4.13: Broadband policy and regulation
Key areas of concern

Although broadband penetration has been increasing significantly since its commercial introduction in 1996, the removal of obstacles to entry into the broadband market and fair competition remain a regulatory concern. In the context of broadband services, regulators have focused on a number of key areas. These include:

- Adopting simple and quick licensing requirements for providers seeking to enter the broadband market;
- Facilitating access to rights of way, particularly over government controlled land, for the deployment of fixed-line broadband infrastructure;
- Lifting foreign ownership restrictions to encourage investment in broadband service providers;
- Adopting market-oriented spectrum management approaches such as auctions and administrative pricing to encourage the efficient assignment and use of scarce spectrum resources that are vital for wireless broadband use;
- Implementing open access policies aimed at unbundling the local loop and the opening up of cable networks at prices that are cost-based to promote service-based competition in the broadband market;
- Facilitating the conclusion and implementation of collocation and infrastructure sharing arrangements;
- Prohibiting the cross-ownership of telecommunications companies and cable TV companies in order to ensure the presence of an incentive for broadband development to occur over both networks; and
- Arresting anti-competitive behaviour such as predatory pricing, excessive pricing, cross-subsidisation and discrimination both in the broadband market and its adjacent markets.

Source: ITU Internet Report 2003: The Birth of Broadband

Regulatory intervention in the leased line market has been a common feature in many countries. As a result of existing market concentration and high barriers to entry, leased line prices have been exceptionally high. In its Recommendation, the European Commission found markets for wholesale leased-line terminating segments and wholesale leased line trunk segments to be characterized by high structural barriers to entry and have identified them as markets susceptible to ex ante regulation.[17] As a result, most regulators such those in the United States, Singapore, Australia and member countries of the EU, have adopted *ex ante* regulations aimed at preventing discriminatory pricing and bringing prices down to cost-oriented levels. For example, following its review of the retail leased lines, symmetric broadband origination and wholesale trunk segments markets, Ofcom, the UK regulator, imposed a range of remedies on dominant operators in these markets. These included a general obligation to provide access on reasonable request, a requirement not to unduly discriminate, an obligation to establish cost-oriented charges, a requirement to publish a reference offer, and a requirement to provide technical information.[18]

It is nevertheless reassuring to note that the expansion of broadband networks, particularly high-speed xDSL offerings, have acted as a mitigating factor by presenting a cost-effective alternative to leased lines.

4.3.2 Access to international Internet connectivity

The issue of access to the international Internet backbone has focused on the high price of international Internet connectivity in developing countries as well as a concentration of market power in a number of international Internet backbone service providers. International concern over this issue has been raised in a number of forums including that of the International Telecommunication Union (ITU), which is currently studying the issue under Study Group 3 of the Standardization Sector (ITU-T).[19]

To a large extent, however, the debate over cost arrangements for international Internet connectivity has been somewhat mitigated by a rapid reduction in costs for international bandwidth[20]. However, these changes have predominantly benefited regions where connectivity to the international Internet backbone itself is plentiful and competition forces are at play. In many developing countries, the high cost of international Internet access is often directly related to the state of competition for connectivity to the international Internet backbone, which is usually a monopoly of the national public operator[21]. While a number of developing countries have liberalized this market by allowing local ISPs to connect directly with the international Internet Backbone, the costs that local ISPs incur in doing so still remain high[22]. High prices for connectivity to the points of presence of international Internet backbone providers have been attributed to a number of factors including the necessity of use of expensive transmission mediums such as satellite links and the lack of competition in the market for such connectivity.

A number of solutions have been advanced to overcome these problems. While encouraging local ISPs to own their own connectivity to international Internet backbones is a feasible solution for countries with high domestic demand for Internet services, the use of Internet exchange points (IXPs) to aggregate and keep traffic local has been put forward as one of the more promising remedies for developing countries. For example, a number of African countries are now establishing national IXPs to keep Internet traffic local and reduce dependencies on expensive international links. An expansion of this approach is underway to interconnect national IXPs into regional African IXPs to further reduce costs.[23]

4.3.3 Interconnection with the PSTN

The term Voice over IP (VoIP) has been used widely as a generic name for the transport of voice traffic using Internet Protocol (IP) technology. It can be carried on a private managed network, the public Internet or a combination of both. The provision of VoIP services over the portable Internet is recognized as one of the technologies' key applications. In particular, portable Internet technologies allow consumer VoIP services to acquire a level of mobility that was previously impossible.

Regardless of whether VoIP is provided through the medium of the portable Internet, its popular functionality rests largely on its ability to interconnect with the PSTN. Neverthless, for the better part of its regulatory history, VoIP has been either largely left unregulated, such as in the EU and the US, or banned completely, particularly in countries where a telecommunications monopoly of the international gateway existed. In countries where VoIP services were unregulated, it essentially implied that VoIP services were essentially provided in an environment where VoIP operators were not given the same rights and obligations as traditional PSTN operators. While that approach was functional at a time where VoIP services were provided to a niche market, its gradual entry into the mainstream has made it increasingly difficult to maintain a regulatory distinction between public voice services provided over IP networks and voice services provided over the PSTN - particularly in a regulatory environment that has embraced technological neutrality, which the EU recognized in its New Electronic Communications Regulatory Framework (see Box 4.14). While many have highlighted that the absence of regulation in the past fostered the deployment of VoIP, there is also the possibility that public VoIP services would now stand to benefit from regulation relating to, *inter alia,* interconnection , access to numbering resources and essential facilities access.

Box 4.14: VoIP in the United Kingdom
Impact of the new Electronic Communications Regulatory Framework

In its examination of VoIP services, the UK telecommunications regulator Oftel (now Ofcom) concluded that VoIP services are encompassed by the term "electronic communications services" for the purposes of the British Communications Act 2003 which regulates inter alia the provision of "electronics communications networks", "electronic communications services" and "associated facilities". In its findings, the regulator also highlighted that interconnection regulations, in particular, are likely to be relevant to the provision of electronic communications networks and services irrespective of the underlying technology.

Nevertheless, Oftel noted that the regulatory distinction between a publicly available telephone service and one not available to the public would also apply in the case of VoIP. Conditions that would be set out in the general authorisations would only apply to the former.

Oftel stated that a VoIP service should be regulated as a publicly available telephone service if any of the following conditions apply:

-the service is marketed as a substitute for the traditional public telephone service, or;
-the service appears to the customer to be a substitute for the traditional public telephone service over which they would expect to access emergency numbers, directory enquiries, etc or;
-the service provides the customer's sole means of access to the PSTN.

Source: Oftel/Ofcom

4.3.4 Mobile networks and regulation

While technically mobile technologies transport both voice and data traffic in the core network as digital packets, regulators still consider the distinction between voice and data services as an important one from a consumer perspective. Thus despite the blurring of the distinction between the transport of voice and the transport of data, regulators have continued to apply this distinction in the regulation of these services.

Voice call termination on mobile networks

The termination of voice calls on mobile networks has been a continued focus of regulatory concern for a number of years. This, for example, has led to the designation of mobile operators as having significant market power in the market for voice call termination on their individual networks. This in turn has entailed the imposition of a number of *ex ante* regulatory measures, such as price controls, in these markets.[24] Over the past year, however, countries such as Australia, Sweden and the United Kingdom have started to examine the market characteristics of next generation mobile services, particularly 3G services, in the context of a wider review of their regulation of voice call termination on mobile networks. While the high-speed data transmission capability of 3G networks has been the focus of their promotion, the carriage of voice traffic continues to serve as a key service offering over the network.

Following a broad ranging review of the regulation of mobile services, including 3G mobile services, the Australian Competition and Consumer Commission (ACCC) released a draft report relating to the mobile terminating access service market in March 2004.[25] In its report, the ACCC considered whether the termination of voice calls on 2.5G and 3G networks should be subject to the same regulations that govern voice termination access services on 2G (GSM and CDMA) networks. In the opinion of the Commission, many of the market power concerns raised in relation to the termination of voice services on 2G networks were likely to exist with regard to the provision of voice termination services on more advanced 2.5G and 3G networks. The Commission believes that the termination of voice services on mobile networks is a sufficiently mature service and should therefore be subject to the same regulation regardless of the network type (2G, 2.5G, 3G or beyond) used. Taking a similar approach, in its decision of 10 May 2004, the Swedish independent regulator, the National Post and Telecom Agency (PTS) also proposed to designate the 3G mobile network operator, Hi3G, as having Significant Market Power (SMP) in the market for voice termination on individual public mobile telephone networks along with other 2G mobile network operators. As an SMP operator in this market, Hi3G is expected to set fair and reasonable prices for voice termination on its network, like its 2G counterparts.[26]

While there has been little disagreement in considering 3G operators as dominant or as possessing significant market power in the market for voice termination services, the regulatory obligations imposed on 3G mobile network operators as a consequence have sometimes differed from those imposed on 2G mobile network operators. For example, on 1 June 2004, the United Kingdom Office of Communications (Ofcom) issued its final statement on Wholesale Mobile Voice Call Termination.[27] While Ofcom considered that each of the UK mobile operators is dominant in the provision of wholesale voice call termination on its own individual network, it has maintained the position that 3G termination services should not be regulated at present. Charge controls for 3G voice call termination services, in particular, were considered disproportionate given the fact that 3G retail services were new and innovative and as such were only adopted by a relatively small number of subscribers at the time. As such, the regulation of such services would be likely to have an adverse impact on continued investment in to new 3G services, which could limit consumer choice in the longer term. Nevertheless, Ofcom has stated that it intends to keep this position under review.[28]

Mobile data and content services

Mobile data services over lower-speed 2G networks such as i-mode in Japan, and SMS (short message service) in the GSM world, have been extremely well-received. With the progressive launch of 2.5G and 3G networks today, services such as multimedia messaging services (MMS) is also gaining in popularity. Still, in most economies, mobile data applications are generally considered by regulators as relatively nascent, particularly when compared to voice. Although, generally, no significant regulatory steps have been taken in this area, regulators recognize that there are a number of areas of concern, which may require periodic review.

For example, the practice of excessive international mobile voice roaming charges appears to have continued in the provision of international mobile data roaming services. For example, in the case of Europe GPRS roaming, the use of data roaming (including related services such as SMS and MMS services) in adjoining countries can cost up to several times more than the price charged in the home country. As a result, the European Commission is conducting an ongoing enquiry into charging practices for international roaming services in a number of markets.[29] With the likely adoption of the same network architecture for current international GPRS roaming services, international 3G roaming services run the risk of being similarly overpriced in the future.[30]

Another area of particular concern involves a potential bottleneck in the provision of content services supplied on mobile data networks. A scenario where one operator gains exclusive control of premium or high value content would be particularly worrying if such content proves to be a key driver for future mobile data services, especially with regard to IMT-2000 (3G) networks. Such a scenario can be seen in the pay-TV market of some countries where the exclusive distribution of premium channels by some networks has rendered subscription packages of competing networks relatively unattractive. It is generally acknowledged that this is a concern for the future as there is still some uncertainty as to the direction that 3G content will take. Furthermore, the use of the exclusive content, "walled garden" approach to retain consumers has been largely unsuccessful in the Internet Service Provider (ISP) market. This can be attributed to the difficulty in developing content that is sufficiently unique and popular to make other content available to subscribers of competing ISPs unmarketable. Also, the sheer range of applications and information on the Internet with which the "walled garden" must compete makes maintaining this exclusive pool of content difficult. Still, regulators remain concerned. For instance, Australia's ACCC is examining such concerns and the European Commission is conducting a sector enquiry into the availability of high value content on 3G networks in order to ensure that access to premium audiovisual rights is open and fair.[31]

4.4 Universal service and emergency services

4.4.1 Universal service obligations and universality funds

While portable Internet technologies hold great promise for making universal broadband access a reality in both developed and developing countries, the inclusion of broadband services as part of a national universal service obligation (USO) has not yet been implemented.[32] To a significant extent, broadband itself is regarded to be in an early stage of market development. With technology in a constant state of flux, policy makers will be confronted with difficulties in defining what qualifies as broadband and hence subject to USO. The government sanction of a minimum broadband delivery standard or a single technology could also discourage the development of alternative technologies or standards.

Although broadband services have not been included as part of national USOs, an increasing number of countries have nevertheless made broadband service providers subject to compulsory contributions to funds that promote universal access and services (known generally as universality funds). Such funds are typically used to support universality objectives that are often independent from the activities of the incumbent operator.

With telecommunications revenues coming increasingly from services such as broadband Internet access, regulators have found it necessary to expand revenue collection for universality funding from these sources. While levying contributions for universality funds from telecommunications licensees has become relatively common, a recent consultation paper of the Brazilian telecommunications regulator, Anatel, may expand the category of contributors in that country to users of licence exempt spectrum bands with its proposal to license any company wishing to use Wi-Fi devices with a power output above 400mW, requiring them to contribute to the Fistel state telecommunications fund.[33]

4.4.2 Emergency services

In the context of the portable Internet, the issue of emergency services revolves mainly around the determination of originating location. Whereas the originating location of emergency calls from fixed-line telephones can be easily determined by relating the calling number with the subscriber address, the location of callers using mobile telephones or VoIP services over a portable Internet device are not as easily discerned.

In an effort to extend the same level of emergency services to emergencies alerted through mobile calls, the development of location-based services has been strongly promoted by public safety initiatives. At the forefront, the United States' government-led public safety initiative known as Wireless 'Enhanced 9-1-1" has pushed the policy and technology boundaries of location based emergency services. This initiative has been led by an FCC mandate to deliver widespread capability for location-based services in the United States by 2005 (see Box 4.15). Location based services are also being developed in conjunction with public safety initiatives in other countries such as the private sector driven CGALIES in the EU and MoLI in Australia. While benefiting the provision of emergency services, location based services have nonetheless raised a number of privacy concerns which are discussed below in chapter 7.

Box 4.15: Regulatory action for access to location information for emergency services
Mobile phones and Wireless 9-1-1

The FCC has mandated the implementation of wireless 9-1-1 in several phases.

Wireless Phase I requires wireless carriers to provide the public safety answering point (PSAP) with the telephone number of the originator of a wireless 911 call and the location of the cell site or base station transmitting the call.

Wireless Phase II requires wireless carriers to provide more precise location information to PSAPs, specifically, the latitude and longitude of the caller. This information must also meet FCC accuracy standards. Generally, it must be accurate to within 50-300 meters (depending on the type of technology used).

The implementation of wireless 911 has been delayed by a number of issues, not the least of which is the expense of upgrading equipment to handle Phase II features. As a result, the FCC established a four-year rollout schedule for Phase II, beginning October 1, 2001 and to be completed by December 31, 2005

Source: FCC at http://www.fcc.gov/911/enhanced/

While VoIP services are able to provide caller line identification (CLI), there is however a potential problem for VoIP services that can be used from a portable device, away from any fixed network connection. This raises the possibility that the installation address provided to the emergency operator will be different from the actual address of the caller. Similar to the different approaches taken to wireless emergency calls, countries have also relied on different degrees of regulatory intervention. For example, while a more regulatory approach has been taken in the United States, the UK regulator Ofcom intends to rely more on industry and emergency organizations to work together to develop a technical solution to this problem. In the interim, Ofcom recommends providers of portable VoIP services to ensure that users are aware of the possibility that some of their emergency calls may not have location information or may even have incorrect location information. The UK regulator has stated its intention to examine the issue more fully in future consultations.[34]

4.5 Names and addressing

Although regulatory and policy issues related to Internet naming and addressing have an effect on all Internet services regardless of portability, a number of issues related to top-level domains (TLDs), ENUM and Internet Protocol Version 6 (IPv6) may have a direct bearing on the use, development and expansion of portable Internet services.

4.5.1 Top Level Domain Names (TLDs)

The creation of a top level domain (TLD) specifically targeted at the mobile user community, which would include IMT-2000 users, has only recently emerged as a focus of some policy debate following the Internet Corporation for Assigned Names and Numbers (ICANN) request for a proposals process for new TLDs in December 2003. This request attracted a group of prominent mobile industry players to submit an application for the creation of a ".mobi" TLD with the expressed aim of simplifying a mobile user's Internet experience and streamlining the deployment of new sites optimized for mobile usage.[35]

While the creation of a .mobi TLD could lead to easier user navigation to Internet services designed specifically for users of mobile handsets, critics have also highlighted a few concerns over its effect on the unified nature of the World Wide Web. Concerns have also been raised over the effect it might have on the development of competition in the mobile Internet content sector. For example, the partitioning of the HTTP information space into parts designed for access from mobile handsets and parts that have not been so designed would divide the World Wide Web into two separate spheres.[36]

4.5.2 ENUM

ENUM (Electronic Numbering) is a protocol that is the result of work of the Internet Engineering Task Force's (IETF's) Telephone Number Mapping working group. The charter of this working group was to define a Domain Name System (DNS)-based architecture and protocols for mapping a telephone number to a Uniform Resource Identifier (URI) which can be used to contact a resource associated with that number. The protocol is now defined in the document "The E.164 to Uniform Resource Identifiers (URI) Dynamic Delegation Discovery System (DDDS) Application (ENUM)"[37]. The protocol provides the ability to resolve numbers from the ITU-T E.164 international public telecommunication numbering plan into resources or services on the Internet.

ENUM had promised to deliver a greater level of convergence between IP and PSTN networks both in the sense of a routing service (e.g. to assist the routing of telephone calls and other messaging services using PSTN numbers over IP based networks) and as a directory service, enabling users easier access to resources on both networks. The creation of a seamless translation between PSTN networks and IP networks in both senses would allow users to communicate regardless of the technology or services involved: mobile wireless, Internet (including email and instant messages), or fixed-line PSTN. With the added elements of ease of deployment and mobility, ENUM would allow portable Internet devices a greater level of functionality particularly in situations where only portable Internet solutions are deployed.

Yet, while ENUM solutions have been deployed on a trial basis in many countries, a number of issues have required complex policy attention. These include the politically charged question of the administration of the ENUM root zone (e164.arpa) which is intimately intertwined with a number of issues related to Internet governance, including sovereignty over national numbering plan administration, privacy and protection of personal data, and concerns that ENUM could result in the creation of directories of user information which could be abused by spammers. Authentication and security measures will also be needed to prevent identity theft, number hijacking, and simple mistakes in updating databases.[38]

4.5.3 IPv6

Internet Protocol Version 4 (IPv4), the prevalent version of IP now used on the Internet, was developed more than 20 years ago with addresses defined with a length of 32 bits. The rapid expansion of the Internet and the increased consumption of IP addresses have led to fears of shortages in IP addresses.

This limitation, in particular, has attracted the concern of portable Internet service providers, and in particular IMT-2000 (3G) network operators. The impending mass deployment of next generation mobile network technologies (such as IMT-2000) is expected to lead to a proliferation of Internet access capable mobile terminals. The possibility of assigning a permanent IP address to every on-line mobile terminal is key to introducing the concept of an "always-on" connection to the IP network, even when the user is inactive.

IPv6, developed by the IETF in the mid-Nineties, is the next version of IP, improving particularly on the addressing capacities of IPv4 by allocating 128 bits to IP addresses thereby opening up to a very large pool of addresses. In addition, mobility management using IPv6 with its straightforward solutions such as auto configuration and automatic renumbering simplify the mobility management of terminals on a network.

Yes, some claim that a significant number of the many benefits claimed for IPv6 have now become disputable as a result in changes in technology and evolution in the Internet market since it was developed. A number of government policy-makers and regulators around the world are holding public consultations and considering initiatives to encourage migration from IPv4 to IPv6. It may also be important to note that on a wider policy level, the question of IPv6 deployment takes place in the context of a wider debate on the relative roles of Internet bodies such as ICANN, the Internet Assigned Numbers Authority (IANA), and Regional Internet Registries (RIR) vis-à-vis the roles of national governments in fostering Internet deployment.[39]

4.6 Content regulation and data protection

While the promotion of competition and access to the portable Internet is a major regulatory preoccupation, content and consumer protection issues have also come to the forefront as a result of the range of services portable Internet technologies can deliver to a personal, mobile terminal. Applications such as voice telephony, e-mail, instant messaging, web browsing, file sharing as well as accessibility to traditional broadcast content bring with them a host of regulatory issues that take on a different dimension in the context of the portable Internet.

4.6.1 Protection of minors

To a large extent, the same concerns over the use of the fixed Internet by children are reflected in the case of the portable Internet. Undesirable material for children such as pornography, gambling and hate material are perhaps even more accessible over portable Internet devices. For example, current 2.5G mobile technologies already offer the ability to order adult graphic content and to engage in gambling. These have been remarkably popular services with recent studies estimating that gambling and adult content delivered via mobile phones could generate combined global revenues of up to $6.5 billion by 2006.[40] In contrast with the viewing of adult content on a desktop PC or the television, portable Internet devices, in particular 3G mobile handsets, provide more privacy for the viewer and may also prevent effective supervision. The availability of affordable 3G mobile handsets would also make such personal devices more accessible to children and add the rewards of privacy, image and fashion, constant communication, lower price, and new interactive services and games.

The widespread availability of interactive services such as chat and premium-rate call services accessible to children has also raised some concern among policy makers. Among children and teenagers, instant messaging and chat rooms are already a popular means of keeping in touch with peers. When used by minors, these services are of concern because they provide a means for predatory individuals to deceive children about their identity and lure them into meetings without the knowledge of parents. Protective mechanisms such as direct parental supervision or the positioning of PCs connected to the Internet in public places may not be effective in the case of portable Internet technologies. Mobile handsets and portable devices offer a greater level of privacy to minors than the family PC. Still, the advent of new location-based services could potentially reveal the location of minors to third parties, thereby raising further security and privacy concerns.

While law enforcement in many jurisdictions has developed means of dealing with such dangers by monitoring online chat services and identifying likely offenders, the expansion of interactive services to portable devices such as 3G handsets may further tax these limited measures that exist in the fixed Internet realm.

In the face of such concern, ISPs and content providers, as well as mobile operators have been working quickly to find their own method of handling undesirable content and interactive services before public opinion calls for governmental intervention. A number of different approaches have been taken, including the establishment of self-regulatory bodies, without the direct involvement of governments, and co-regulatory approaches involving industry self-regulation under a legal framework established by government (see Box 4.16). In addition, there have also been self-regulatory initiatives by individual network operators such as Vodafone, aimed at anticipating consumer concerns and addressing them through a combination of technical measures (filtering and blocking) and age verification mechanisms.[41]

Box 4.16: Fighting inappropriate content
Self-regulation in the United Kingdom and co-regulation in Germany

In January 2004, the UK's major mobile network operators agreed on a Mobile Content Code of self-regulation to address concerns over access to inappropriate content through their networks. The code sets out eight areas where the operators will work together to guard against problems such as underage access to adult content, unsolicited communications and illegal content. This content includes internet access from phones, visual content, gambling and chat rooms.

The basis of the code is that the operators will appoint an independent body to develop a framework for classifying commercial content and will then rely on content providers to self-classify their content according to this framework. In this way, the operators hope to restrict access to content inappropriate for minors by providing parental controls and age verification. However, all content which is unclassified will be available to all users. In an attempt to address the question of existing internet content accessed from advanced mobile handsets, operators will introduce filtering technology which allows parents to block access to inappropriate internet sites. Chat rooms will also be placed behind access controls unless they are moderated.

It is important to note that while the Code calls for all operators to put barring and filtering in place to stop children accessing adult content, it sets no standard method. Rather, it allows each operator to choose its own approach. The code also does not currently involve mobile and Internet content developers and providers.

Differing in its approach, the German government has implemented a co-regulatory mechanism as part of its Interstate Treaty on the Protection of Minors and Human Dignity in the Media, which entered into force on 1 April 2003. The new regulation applies to all electronic communication and information services and to 3G mobile networks and content providers as well.

The new regulation establishes consistent standards for the evaluation of identical content across media sectors irrespective of the mode of transmission. In contrast to other self-regulatory models one supervisory body, the Commission for the protection of minors in the media (Kommission für Jugendmedienschutz or KJM), has been created to supervise the following sectors with regard to the protection of minors and human dignity: broadcasting, the Internet and other forms of digital media (including mobile networks). The Commission is comprised of twelve experts nominated by the relevant federal and state regulatory and juvenile welfare authorities. Among its many roles, the KJM licences self-regulatory bodies, sets norms defining the protection of minors, ensures compliance to these norms and approves technical measures such as content filtering and rating systems. Industry self-regulatory bodies can be sanctioned by the KJM if they act outside the scope of their discretionary powers.

Instead of relying merely on the threat of possible future government regulation, the use of a supervisory body in a co-regulatory model introduces greater certainty in the enforcement of protection norms. However, observers have also highlighted that such an approach could also increase the cost of self-regulation for industry and remove industry's necessary flexibility to adequately assess and address the impact of new services on minors in a fast changing market.

Source: Self Regulation Review May 2003, Programme in Comparative Media Law and Policy available at http://selfregulation.info/iapcoda/0305xx-selfregulation-review.htm and Mobile Data Association at http://www.mda-mobiledata.org/

4.6.2 Spam

Spam is a term generally used to describe unsolicited commercial email. As a result of the growing magnitude of the problem over the past few years, policy and regulatory efforts to combat spam have increased, adopting a wide range of approaches that range from legislation and direct regulation to government support of self-regulation efforts by the private sector.[42] While representing a significant problem in terms of unwanted traffic generation over the Internet, the problem of spam in the context of the portable Internet touches upon a range of issues felt more acutely by users of personal portable Internet terminals. These include concerns regarding privacy, increased consumer and provider costs and a lowering in consumer confidence in portable Internet technologies.

Recognized as a world leader in the use of mobile Internet technologies, Japan was one of the first countries to have been faced by spam directed at users of portable devices. Wireless advertisements, in the form of emails delivered to cellular phones, offering consumers time and location relevant information, were used extensively following the popular adoption of mobile Internet services such as iMode. The random nature and sheer amount of these advertisements delivered to consumers triggered a backlash against such services, from both consumers and operators. As consumers were charged a fee based on the amount of data downloaded, it also resulted in increased costs for consumers while operators were confronted by problems of lost bandwidth, and the need to provide more customer service and system administration to deal with the problems. In Japan, this problem triggered a legislative response with the enactment of the Law on Regulation of Transmission of Specified Electronic Mail (Law No. 26 of 2002) which provides for the flagging of e-mail advertising as such, the prohibiting of the sending of unsolicited e-mails to randomly generated addresses and enforcement action against offenders.[43]

Different approaches have been taken in other countries. Among the EU member states, for example, self-regulation solutions have been adopted in addition to legislative remedies.[44] For example, in the UK, as part of the Mobile Content Code (see Box 4.16), content providers offering new or existing premium text services must implement the "opt-out" key word "STOP" by August 2004.[45]

4.6.3 Protecting intellectual property

Advances in portable Internet technologies will enable the provision of an increasing array of digital content, e.g. music, short and feature-length films, educational information and databases. As a result, the need to protect the creators of this content will be correspondingly heightened (see Section 4.6.5).

One of the key aims of intellectual property legislation is to produce incentives for authors, artists, and producers to create, while at the same time satisfying the need for society as a whole to benefit from their creations. The development of a rich public domain is fundamental for fostering creativity and education in any society. With enhanced information portability and mobility on a global scale, the potential for individuals in a society to learn from and enjoy diverse content is widened, as are the risks and disincentives for content creators. In the age of the portable Internet, even more thought must be given to achieving this delicate balance between content creation and distribution in the public interest.

4.6.4 Data protection and privacy

The widespread development and distribution of portable Internet and mobile telecommunications technologies in recent years have further complicated the already uncertain structures for the monitoring and regulation of personal data gathering activities. While data protection and privacy concerns have been significant with regard to Internet usage and fixed-line telecommunications in general, the data generated via portable Internet and mobile devices and their infrastructures also add information regarding 'location'. Within this context, concerns surrounding data protection in the context of the portable Internet have revolved around two main issues, the access to and use of such data by the private sector and the access and use of such data by government agencies.

In preventing the commercial exploitation of personal data, information related to electronic communications is typically divided into different categories: traffic data, which is the anonymous transmission information necessary for electronic communications to take place, and billing data, which constitutes information such as the subscriber's home address and the timing, length, duration, volume and, in the case of mobile communications, the location of their calls. Policy makers in most countries have focused on providing a greater level of personal data protection to the latter category of information due to its close association with the identity of the subscriber.[46] In the case of the latter, consent by the subscriber is required for the disclosure or the commercial exploitation of this information ("opt-in"), with exceptions only in the case of emergency situations.

In the current global environment, governments, on the other hand, have reserved far-reaching powers to access both anonymous and identifiable traffic and billing data generated by electronic communications. In the case of mobile traffic data information, for example, the United Kingdom's Regulation of Investigatory Powers (RIP) Act 2000, and the Anti-Terrorism, Crime and Security Act 2001, reinforced by EU Directive 2002/58/EC, is to make traffic and billing data generated by mobile telecommunications available on request to UK law enforcement bodies. Under the RIP Act, a senior officer is permitted to ask a telecommunications operator for such data. By the end of 2002, the BBC reported that law enforcement bodies had made over 400,000 requests for traffic data from mobile network operators.[47]

4.6.5 Peer-to-peer (P2P) networks and file sharing

The ability to control how content gets to consumers has been key for the providers of content. Business models have historically been based on the ability to control the distribution of content through physical channels. Digitization of media content and the emergence of P2P file sharing networks such as KaZaA have threatened traditional ways of protecting content and traditional business models.

The copyright concerns of the media content industry with regard to P2P networks remain largely the same in the context of the portable Internet although the portable and mobile nature of portable Internet devices are likely to promote demand for media content that can be accessed on the move.

In this regard, portable Internet service providers are presented with the attractiveness of file-sharing services, which have contributed to broadband adoption rates, and which could also act as an incentive for consumers to migrate to portable Internet services. However, by taking such a permissive approach, these providers would also face the same set of legal risks as traditional fixed-line broadband ISPs.

To a large extent, the prevalence of P2P file sharing on portable Internet networks will depend on availability of bandwidth. If the bandwidth is too narrow, P2P file sharing will become too cumbersome. Billing models will also significantly affect the size of any P2P network to emerge. Billing per byte as opposed to having a flat rate will create a strong disincentive for P2P file sharing.

On a policy level, some jurisdictions, such as the United States, have taken a strong reactive approach to P2P file sharing by enacting legislation to prohibit the circumvention of Digital Rights Managements systems and by imposing stringent requirements on intermediaries such as ISPs to ensure copyright compliance by their users before they can qualify for exemption from liability for copyright infringing materials that may be accessed from or through their network.[48] However, observers have warned that such a strategy may alienate and threaten consumers and Internet service providers, thereby hindering the take-up of portable Internet services. It appears that meeting consumer demand for such copyrighted material through legal online commercial offerings, such as Apple's iTunes, presents itself as a more viable alternative.

4.7 Conclusion

From this broad overview of policy and regulatory issues, it is clear that portable Internet technologies and services require policy and regulatory attention on a wide number of interrelated aspects that range from traditional telecommunications services such as voice telephony over the PSTN to Internet-related services such as naming and addressing. While the task appears to be a daunting one for national regulators and policy-makers, an increasing reliance on the private sector through self-regulation relating to content matters, and on market forces through secondary trading in spectrum rights, promise to alleviate some of this burden. Increasing public-private sector partnerships both in the context of policy and regulatory matters is poised to become a hallmark of the age of the portable Internet.

[1] Trends in Telecommunication Reform: 2004 Chapter 1

[2] See for example, licensing practices in Malaysia pursuant to the Malaysian Communications and Multimedia Act available at http://www.mcmc.gov.my/mcmc/what_we_do/licensing/cma/framework.asp

[3] See, for example, recent amendments to Japan's Telecommunication Business Law regarding the elimination of Type-1 and Type-2 carrier distinctions. For more information, see Lara Srivastava, *Japan's Ubiquitous Mobile Information Society,* INFO, Vol.6 No.4, September 2004 (forthcoming).

[4] For more resources on Spectrum Management in the Era of Convergence, see http://www.itu.int/spectrum

[5] See for example Melody WH, Radio spectrum allocation: role of the market. (1980) American Economic Review, 70:393-397.

[6] See, for instance "Radio spectrum policy: The coming glut", in *The Economist*, August 12 2004, at http://www.economist.com/science/displayStory.cfm?story_id=3084475

[7] Beyond the inherent weaknesses of a centralized spectrum management approach, it is also increasingly acknowledged that market players such as operators and equipment manufacturers posses more knowledge about the spectrum they require as well as more information regarding the appropriate technologies to deploy and consumer preferences, than an administrative body would. As such, there exists considerable merit in allowing more spectrum management decisions to be made by those who would eventually use the spectrum.

[8] See UMTS Forum at http://www.umtsforum.org/

[9] For more information on spectrum licence auctions, particularly in the context of 3G licensing, see ITU New Initiatives Programme "Licensing for 3rd Generation Mobile" at http://www.itu.int/osg/spu/ni/3G/

[10] For more information on auctions and auction design see Melody WH, Spectrum auctions and efficient resource allocation: learning from the 3G experience in Europe. (2001) Info, 3:5-10.

[11] See for example Martin Cave, review of Radio Spectrum Management, An independent review for Department of Trade and Industry and HM Treasury (2002) available at http://www.see.asso.fr/ICTSR1Newsletter/No004/RS%20Management%20-%202_title-42.pdf

[12] In addition to the four principal modes, two other modes have also been identified by the RA as appropriate in particular circumstances, for example, during the refarming of a frequency band from one use to another. Mode 5 refers to custom designed trading as part of a strategic approach; for example, as part of steps taken to assist the replanning of a band, and mode 6 refers to the trading of "overlay licenses".

[13] For a complete review of competition safeguards in the New Zealand market see Final Report: Allocation and Acquisition of Spectrum, Report Prepared for the New Zealand Ministry of Economic Development on Competition Safeguards in Relation to Initial Allocation of and Secondary Markets for Radiofrequency Spectrum in New Zealand at http://www.med.govt.nz/pbt/rad_spec/competition-safeguards/report/

[14] For a discussion of the CB Radio phenomenon from a regulatory perspective, see Carol Ting, Johannes M. Bauer, Steven S. Wildman, "The U.S. experience with non-traditional approaches to spectrum management" available at http://quello.msu.edu/wp/wp-05-03.pdf

[15] See Report ITU-R 2012 – "Economic aspects of spectrum management" for a wide range of examples of incentive fee pricing submitted by ITU member states available at http://www.itu.int/itudoc/itu-r/publica/rep/sm/2012-1.html

[16] European Commission Recommendation of 11/02/2003 "On Relevant Product and Service Markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communication networks and services" available at http://europa.eu.int/information_society/topics/telecoms/regulatory/maindocs/documents/recomen.pdf

[17] Ibid.

[18] See Ofcom, "Review of the retail leased lines, symmetric broadband origination and wholesale trunk segments markets - Final Statement and Notification" available at http://www.ofcom.org.uk/consultations/past/llmr/statement/

[19] See activities relating to Recommendation D.50 at http://www.itu.int/ITU-T/studygroups/com03/index.asp

[20]Communications Week International (6 May 2002), *Carriers Fail While Bandwidth Prices Fall*, available at http://www.telegeography.com/press/coverage/2002/05-06c-2002.html

[21] For detailed discussion of international Internet connectivity in developing countries, see Claudia Sarrocco, Background Paper on Improving IP Connectivity in Least Developed Countries, ITU Workshop on Improving IP Connectivity in Least Developed Countries, April 2002 available at http://www.itu.int/osg/spu/ni/ipdc/index.html

[22] For example, see ibid, p.30. In Mozambique, ISPs are allowed to connect directly to international Internet backbones through VSATs, but the cost of international connectivity still accounts for 88 per cent of network costs.

[23] See the National and Pan-African IXP Workshop conducted during Africa Telecom Forum 2004 at http://www.itu.int/cgi-bin/htsh/TELECOM/scripts/forum/forum.programme?event=aft2004&_sessionid=776&_languageid=1 for a discussion on the development of national and pan-African IXPs

[24] For a general background on fixed-to-mobile interconnection issues see http://www.itu.int/osg/spu/ni/fmi/

[25] See the report at http://www.accc.gov.au/content/index.phtml/itemId/333898

[26] Post and Telestyrelsen, Summary of PTS' Decisions concerning Voice Call Termination on Individual Mobile Telephone Networks, 10 May 2004 at http://www.pts.se/Archive/Documents/EN/summary_market_16_termination_mobile.pdf

[27] Available at http://www.ofcom.org.uk/consultations/past/wmvct/

[28] For a critique/discussion on the statement issued by ofcom focusing on the 3G issues involved, see http://www.intug.net/submissions/UK_3g.html

[29]See http://europa.eu.int/rapid/pressReleasesAction.do?reference=MEMO/04/198&format=HTML&aged=0&language=EN&guiLanguage=en

[30] For an overview of the network architecture used in GPRS roaming please refer to the Summary of the study by BIPE for Autorité de régulation des telecommunications available at http://www.art-telecom.fr/publications/etudes/gprs/ang-syn-gprsjuil03.htm

[31] See http://www.accc.gov.au/content/index.phtml/itemId/333898 and http://europa.eu.int/rapid/pressReleasesAction.do?reference=SPEECH/04/353&format=HTML&aged=0&language=EN&guiLanguage=en

[32] For a discussion of broadband as USO, see Patrick Xavier, "Should broadband be part of universal service obligations?", Info [2003] Volume 5 No. 1 2003 at http://www.emeraldinsight.com and Birth of Broadband …

[33] See http://www.telecomweb.com.br/noticias/artigo.asp?id=50269

[34] See http://www.ofcom.org.uk/ind_groups/ind_groups/telecommunications/vob/vobqa/section18/?a=87101

[35] For more information on the application see http://www.mtldinfo.com

[36] See the comments made by Tim Berners Lee at http://www.w3.org/DesignIssues/TLD

[37] See http://www.ietf.org/rfc/rfc2916.txt

[38] For more resources related to ENUM policy and technical issues please see http://www.itu.int/osg/spu/enum/

[39] For a general resource on Internet Governance issues please see http://www.itu.int/osg/spu/newslog/categories/internetGovernance/

[40] Reported by UK-based consultancy Juniper Research. See http://www.juniperresearch.com/index2.htm

[41] Vodafone D2 authenticates the age of a customer at the point of sale and accordingly block adult content, dating services, gambling and violent games. For more information see http://www.vodafone.com/article_with_thumbnail/0,3038,CATEGORY_ID%253D20701%2526LANGUAGE_ID%253D0%2526CONTENT_ID%253D208061,00.html

[42] For more resources of spam in general, refer to http://www.itu.int/spam

[43] See Evan Cramer, The Future of Wireless Spam, at http://www.law.duke.edu/journals/dltr/articles/2002dltr0021.html

[44] See the Directive for the Protection of Personal Data and Privacy in the E-communications Sector, Council Directive 2002/58, 2002 O.J. (L 201) 37.

[45] For more information see the Mobile Data Association website at http://www.mda-mobiledata.org/

[46] See http://europa.eu.int/eur-lex/pri/en/oj/dat/2002/l_201/l_20120020731en00370047.pdf contrast this with the US Wireless Communications and Public Safety Act 1999

[47] See Nicola Green and Sean Smith 'A Spy in your Pocket'? The Regulation of Mobile Data in the UK at http://www.surveillance-and-society.org/articles1(4)/pocketspy.pdf

[48] See, for example, the Digital Millennium Copyright Act at http://www.copyright.gov/legislation/dmca.pdf

5 CHAPTER FIVE: THE PORTABLE INTERNET AS A TOOL FOR BRIDGING THE DIGITAL DIVIDE

5.1 The digital divide problem

In recent years, as information and communication technologies (ICT) have become the backbone of the global information economy, increasing attention has focused on the gap in access to ICTs between developed and developing countries. This gap has come to be known as the "digital divide". But this so-called divide is not a simple concept: it is multifaceted, with the gap in access to technologies affecting rural and remote populations, females, children, the elderly, those with health problems and disabilities, ethnic minorities, the illiterate and poorly educated and others—both within and between nations. It is therefore more accurate to understand the "digital divide" as encompassing a plurality of divides (see Table 5.1).

When it comes to bridging the digital divide, the underlying problem is a simple lack of infrastructure. But with the explosive growth of mobile technologies worldwide, the gap between the information haves and have-nots is already being narrowed.

Notwithstanding the growth in mobile penetration, portable wireless devices that are Internet-enabled—in other words the portable Internet, as defined in this publication—are a long way from being fully deployed in developed, let alone developing areas of the world. The portable Internet concept is far removed from the reality of those for whom a mobile phone, or access to a community Internet access point, are still unavailable, inaccessible or unaffordable.

But a more visionary view is that portable Internet-enabled devices could bring access to information and communication to huge numbers of the world's population who are currently without it. If the mobile revolution is one day extended to include portable Internet-enabled devices at low cost to users, then a bright future can be imagined. Widening access to basic infrastructure should help to reduce the other forms of divide (see Box 5.1).

In this context, the portable Internet should be seen for the future promise it holds especially in developing countries and in rural and remote areas of the developed world. This chapter explores some of the ways in which wireless technologies in general are contributing to this goal. Following an overview of the digital divide issue and its multifaceted nature, the relevance of wireless technologies and infrastructure for development are described. The chapter goes on to look at how national policy, community issues, education, innovation and affordability all play important parts in the overall picture. Finally, the likely new ICT landscape in developing countries is explored. Illustrations of initiatives taken at the community, national and global levels are also provided throughout the chapter.

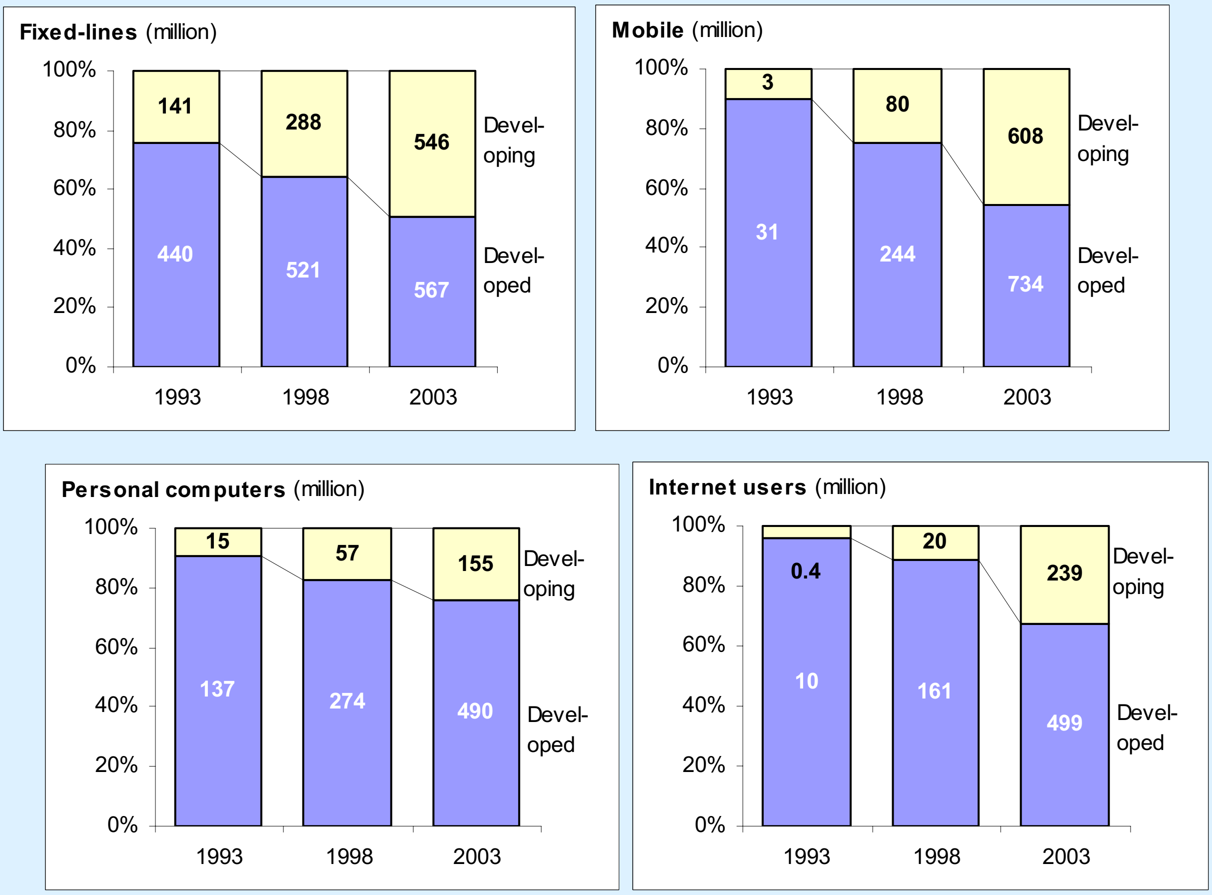
Table 5.1: Where the divides lie
Overview of the main forms of the digital divide affecting individuals and countries

For individuals	For countries
Socio-economic status	Development stage
Gender	Infrastructure
Age, life stage	Public policy
Language/ethnic status	Skills mix
Rural/urban location	Size of domestic market
Skills balance	Location relative to trading partners

Source: Adapted from *"How real is the Internet market in developing nations?"* by Madanmohan Rao, at http://www.isoc.org/oti.articles/0401/rao.html

Figure 5.1: The shrinking digital divide

Percentage shares among developed and developing economies of fixed lines, mobile phones, personal computers and Internet users in 1993, 1998 and 2003



Source: ITU World Telecommunication Indicators Database

5.1.1 Developed versus developing divides

The differences between developed and developing economies can be seen in the level of penetration of different ICT services (telephone, mobile phone, Internet) and of personal computers. As shown in Figure 5.1, the gap between developed and developing economies has narrowed markedly, with particularly rapid progress in the case of mobile phones and Internet users.

With respect to mobile phones, the number of users in the developing world has grown from just 3 million in 1993 to some 608 million a decade later, representing a compound annual growth rate (CAGR) of 67 per cent. In the case of the Internet, the respective numbers are 0.4 and 239 million, a CAGR of 89 per cent. Nevertheless, given that the developing world accounts for more than 80 per cent of global population, there is still along way to go to reduce the divide. Even if national populations were growing at similar rates, and current ICT growth rates were sustained, it would take at least ten years for this gap to be reduced. But in reality, developing country populations are growing faster than developed ones, and they have a much higher percentage of their population under the age of 15. In reality, therefore, it will take much longer to bridge the digital divide. Furthermore, given that more than a billion of the world's developing country population lives on less than USD 2 per day, well below the generally accepted minimum level of income needed for ownership and use of ICTs, it is likely that the fundamental nature of the divide will persist unless there is profound change in basic socio-economic conditions.

Can the portable Internet help speed up this process, by making ICT access more affordable and easier to deploy? The signs are good. Similar shifts in the past, like the shift from analogue to digital networks, or the shift from post-paid to prepaid as the dominant billing method, have had a profound effect on the speeding up the narrowing of the digital divide. The current shift from circuit-switched to IP-based networks, and from fixed-lines to wireless, associated with the development of the portable Internet, is likely to have a similar effect, especially given that mobile is overtaking fixed even more decisively in developing countries than in developed ones.

But some observers have pointed out that, as mobile penetration rises in the developing world, Internet development may be slowing down. This is because the vast majority of the world's Internet users still use copper-based fixed-line technologies (e.g. dial-up, ISDN, DSL, cable modems) to access the Internet. Internet access from today's 2G cellular wireless devices is certainly possible, but it is still expensive. Only with the advent of portable Internet technologies described in this report will Internet access from wireless devices provide a viable option for the developing world. Given the prohibitive cost and time delays involved in rolling out fixed-line infrastructure, the portable Internet may represent the means to leapfrog into improved connectivity for developing world users and communities. In the sections below, the promise of wireless technologies to help bring the Internet to portable devices in developing countries is explored, both for voice and data.

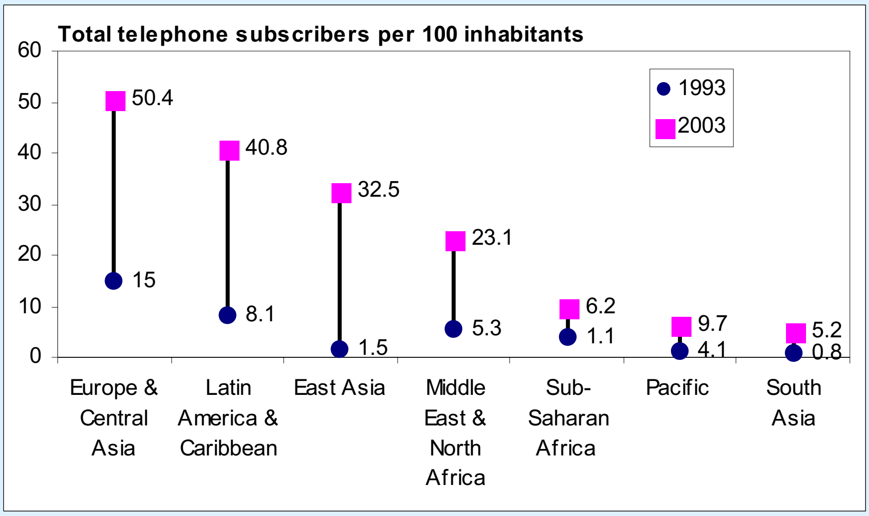
Box 5.1: The real challenges for bridging the digital divide
The future of data-based communications in the developing world may take on new forms

"It is too narrow to think only about the Internet. Rather, it is the ubiquitous information environment. It is important to look beyond the current information and communication systems to the developments that are rapidly transforming them. Current ICT features are digitization, exponential increases in information processing and concomitant increases in storage capacity, enormous growth in network bandwidth, and the common, decentralized architecture of the Internet, TCP/IP.

For the bulk of the population of the planet, billions of people, their first exposure to the ubiquitous information environment will not be like the developed country experience of the late twentieth century. It will not be through a personal computer, sitting on a desk that an individual interacts with on a discrete basis for several hours a day at work or school. […] Instead of the box on the desk, most people in developing countries will reach for a cheap hand-held device. [...] At command, torrents of information will surge from the device. The question will not be whether people can get the box or the information. The challenge, far more difficult than device or data, will be how, for billions of people, to inculcate the skills to enable people to find the information that is useful to them, to absorb it, and to adapt it to their own lives and needs."

Source: Deborah Hurley in Pole Star, September 2003, available at:
http://www.ichrdd.ca/english/commdoc/publications/globalization/wsis/PoleStar-Eng.html

Figure 5.2: Catching up, but not fast enough
A decade of growth in total teledensity (fixed and mobile combined) among different developing regions, 1993-2003



*Note:*All developed economies are excluded from the regions analysed in the chart (see Data Notes)
Source: ITU World Telecommunication Indicators Database

5.1.2 Problems specific to developing countries

The digital divide concept, or differences in the level of penetration of ICT devices and services, has existed for some time now. With the growth in new ICTs however, such as broadband or IMT-2000 or 3G mobile, many developing countries are falling even further behind.

The problems of the digital divide are particularly evident in Africa, but also in South Asia, especially among the Small Island Developing States (SIDS) of the Pacific, which have so far failed to benefit from the information age (see Figure 5.2). The major problems relate to lack of infrastructure and investment, adverse geographical conditions, regulatory and policy provisions that are not conducive to promoting investment, skills shortages and lack of relevant content and applications. Another problem is also that, with small domestic markets, the introduction of competing mobile and fixed-line operators has not always been perceived to be viable (for contrary evidence, see the case of St Lucia illustrated in Box 3.1). Many developing countries, especially SIDS, have also suffered from the decrease in settlement payments from international voice traffic that had historically helped them overcome the problems of isolation and lack of economies of scale.

In the ICT era, the digital divide is shifting, and the focus of development efforts is having to change with it. Along with numerous national, regional and international initiatives, the World Summit on the Information Society (WSIS), the first phase of which was held in Geneva from 10 to 12 December 2003, provides a fresh impetus for international efforts to address the digital divide.[1] The challenges to be overcome are recognized as substantial, but the WSIS (notably in the WSIS Plan of Action) set out objectives to improve infrastructure, training and skills, and other pre-requisites to help increase connectivity in the developing world and other less-connected areas. The commitments made by governments, the private sector, civil society, multilateral organisations and other WSIS stakeholders during the first phase of WSIS, for making process in ICT development, are summarised in Figure 5.3.

Figure 5.3: The WSIS commitments
Progress in ICTs to be achieved no later than 2015

world summit on the information society
Geneva 2003 - Tunis 2005

Summit Objectives by 2015

a) to connect all villages with ICTs
b) to connect all educational institutions
c) to connect all scientific and research centres;
d) to connect all public libraries, museums and archives
e) to connect all health centres and hospitals;
f) to connect local and central government departments
g) to adapt all primary and secondary school curricula to meet the challenges of the Information Society;
h) to ensure that all have access to television and radio services;
i) to encourage the development of content on the Internet;
j) to ensure that more than half the world's inhabitants have access to ICTs within their reach.

Source: WSIS Plan of Action, Para 6

5.1.3 A plurality of digital divides

Typically, the digital divide is perceived as a north/south, developed/developing, rich/poor country dichotomy. This notion tends to hide the fact that digital divides exist within nations: there is a strong tendency for ICT development to be concentrated in urban areas for example, as well as in high-income regions. In rural and deprived areas, even in countries that are generally well developed, there is often a digital divide that leaves those already at a disadvantage with even fewer means to catch up (see Box 5.2).

Broadly speaking, the multiple divides within nations can be broken down into socio-economic status, gender, age, ethnicity, geographic location and education (see Table 5.1). In the United States for instance, one study found that, in 2002, fewer than 50 per cent of rural inhabitants were using the Internet as compared to 63 per cent of city-dwellers.[2]

In terms of education too, there are strong national divides. While ICTs are increasingly contributing to educational goals, ICT illiteracy is a factor, especially among older people. According to a survey carried out in Japan for instance, 80 per cent of Japanese in their twenties used the Internet (of which an astounding 53 per cent via mobile phones) while only 15 per cent of those in their sixties did so (2001 figures).[3] Where there are strong wealth divides within a nation, this problem is exacerbated. The gender gap is also, to a greater or lesser extent, a reality in many nations. In all but a handful of countries, men have better access than women to ICTs, and in particular to the Internet, although in many places women are catching up. There is also a strong age-related divide across the regions.

Box 5.2: Bridging developed country gaps: The example of Canada
Wireless connectivity among Canada's native Aboriginal people

Burns Lake, home to some 2'500 people, is an isolated First Nations-inhabited region located in British Columbia, Canada. Like most other native peoples, the Aboriginal First Nations people of Canada have long been socially, economically and politically marginalized. In addition, Aboriginal communities tend to be located in rural, isolated, far-flung communities with extreme weather conditions, calling for strong and reliable communication systems.

Within Canadian Aboriginal communities, 46 per cent of First Nations inhabitants have access to dial-up Internet access, while 19 per cent have access to broadband. With five per cent of Aboriginal people connecting by other means, 30 per cent are left without access to the Internet.[4]

With the support of a Federal Government programme, a wireless computer centre has been successfully established at the Lake. The Many Eyes Friendship Centre (MEFC), which is managed by locals, took the first step in recognizing a need for training in computer and Internet skills. In setting up this initiative, the project organizers acquired the help of a local company, LakeWeb, and Canada's Community Access Program. The centre is equipped with 10 computers connected to the Internet via radio waves rather than via wired means, providing wireless Internet service to residents in a 242 km radius around the lake.

The system has transformed communications, allowing the community to be linked to the global marketplace—reducing the intra-country digital divide. For such communities, even a single computer in an isolated village linked wirelessly to the Internet can expose residents to a flood of knowledge—ranging from crop prices, to medical information and distance learning courses.

Source: http://www.aboriginalcanada.gc.ca/abdt/interface/interface2.nsf/vSSGBasic/ao28082e.htm and http://cap.ic.gc.ca/english/4000newbcsuburnslake.asp. See also ITU Country Case Study on broadband in Canada, at http://www.itu.int/casestudies.

5.2 Deploying infrastructure

5.2.1 Technologies for narrowing the gap

Prior to any marketing or policy-led initiatives aimed at broadening wireless Internet access, it is first necessary to identify and target appropriate technologies. This section looks at the most important technologies for narrowing the digital gap and identifies some of the criteria for their successful deployment.

The wireless revolution

In many developing economies, mobile phone growth catapulted the market directly to wireless telecommunications. While the main market is for voice communications, data services, especially in the form of SMS, are also widespread in some economies. As an early sign of the potential for data over mobile devices, SMS—that can be considered an early form of the portable Internet—has taken some countries by storm (see Box 5.3 on the Philippines).

Nevertheless, in most low-income countries, mobile phones are mainly used for voice communications.[5] Furthermore, the limited budget users are willing or able to spend on communication services, and the low rate of mobile subscriptions (prepaid dominates the market), greatly limit the development and diffusion of more advanced technologies and applications. Other than SMS, the most successful service for mobile users in many of these economies has typically been the download of logos and ring tones.

Existing 2G and 2.5G cellular networks provide a platform for slow-speed and medium-speed Internet access, as well as for voice. But for higher speeds, advanced wireless technologies and techniques provide a platform for high-speed data access using Internet Protocol (IP). For developing economies, one of the most promising technologies may be WiMAX (IEEE 802.16), which offers high-speed connectivity over a range of up to 50 kilometres. In addition to the wide geographical range, WiMAX also promises to be relatively quick, easy and cheap to install. A particular advantage with WiMAX is that the main investment burden falls on users rather than network or service providers, or the government. Start-up costs are thus much lower and investment burden is more widely shared. WiMAX networks are characterised by relatively low sunk costs and networks can grow "organically", as more users join the network. The spectrum costs for WiMAX are also likely to be much lower than for IMT-2000.

Box 5.3: First place for SMS
Texting in the Philippines

Despite not being a developed economy, as recently as 2002, the Philippines held first place in the world for SMS messages sent and received by each mobile user. At the height of the SMS boom, statistics showed that Filipino users sent an average of 20 text messages per day. The success of SMS in the Philippines can partly be derived from the pricing policies applied. A number of free SMS messages were included in each prepaid subscription sold. When the users ran out of minutes on their prepaid card they would send SMS messages to family and friends to call them back. Of the 22 million cellphone users, between 92 and 95 per cent (2002) were on prepaid subscriptions, and the SMS habit stuck with the users even when the number of free SMS messages was reduced. Filipino operators have also pioneered the use of SMS on fixed-line telephones.

If peer-to-peer SMS messaging growth were to slow down in the near future, it would be interesting to observe the potential for other wireless services (via SMS or mobile) to sustain the market. Using the mobile phone as a means to pay for services, or for gaming and advertising could be examples of this in developed as well as developing countries.

Source: Adapted from ITU Internet Reports: *Internet for a Mobile Generation*, 2002. See also the ITU country case study on the Philippines at http://www.itu.int/casestudies

"Fixed-wireless" as a formula for low-cost Internet access

One option that can ensure greater user affordability is fixed wireless, particularly by virtue of low-cost installation and roll-out, and the use of licence-exempt frequencies. Fixed wireless systems use a small, inexpensive microwave antenna that is attached to a local radio network at the customer premises and their provision costs are far less than digging up the earth to install copper-based cables. They are also cheaper to install in countries with rugged terrain—as long as line of sight is available. Along with low-cost equipment and installation, the relative lack of regulation over the supply of fixed wireless also presents a considerable cost advantage. However, for developing countries in particular, the potential loss of revenues received by the incumbent operator and resulting loss of taxes, is an issue that needs to be taken into consideration.

Fixed wireless systems have been deployed in a number of countries, each addressing particular needs and requirements. In February 2002 for example, Telkom South Africa selected a technology for providing fixed wireless access telecommunication services throughout South Africa that operates in the 1.9 GHz frequency band. It takes advantage of frequency-hopping CDMA technology and supports toll quality voice, low-speed voice band data (V.90) and ISDN-Basic Rate Interface (BRI).

In Ethiopia, in March 2004, the Ethiopia Telecommunications Corporation (ETC), the State-owned public telecommunication operator (PTO), awarded a CDMA2000 1X contract to Chinese vendor Huawei Technologies. The network infrastructure will be comprised of a wireless local loop (WLL) implementation in both the 800 MHz and 450 MHz frequency bands. An 800 MHz CDMA2000 1X WLL network will be deployed in the capital, Addis Ababa, as well as 450 Mhz networks in three other industrial cities. The network is among the first implementations of the broadband wireless system in the region after Angola, Egypt, and Nigeria. In the latter, a limited fixed-line infrastructure, and the huge demand for mobile, together with market liberalization have helped create the right conditions for fixed wireless growth. The country's private telecommunication operators have focused largely on fixed wireless for rapidly rolling out infrastructure, and have captured almost 25 per cent of the fixed line market in 2004.[6]

Wi-Fi: Cheap, unregulated and unlicensed broadband?

The advantages of Wi-Fi for increasing wireless access include the fact that it can be built from the bottom up, by small and local entrepreneurs. Each telecommunication operator can provide services within the local community simply by purchasing the basic radio equipment and transmitting on these unlicensed frequencies. The model is relatively inexpensive, responsive to local needs and realities, able to grow organically and fully scalable. It can also create employment, especially where the provision of Wi-Fi service is combined with sale of other services (e.g. mobile prepaid recharges, photocopying, etc.). As the number of local providers increases, so does the overall capacity of the network. Each new operator increases the number of pathways between any two points.

The proliferation of unlicensed wireless network technologies may not be revolutionary, but what certainly is groundbreaking is the new paradigm that wireless LANs represent, and especially how this can be used for creating an affordable infrastructure in developing countries. A particular advantage is that multiple unlicensed users can operate overlapping (even competing) wireless networks, all transmitting within the same frequency bands. This type of small-scale and entrepreneurial approach may become a central element in bridging the digital divide and help make universal access pay for itself.

However, there are a number of constraints with WLANs, most notably the small cell size, which may not be appropriate in rural areas. Furthermore, while WLANs may be cheap to roll-out, installing and operating conditional access and billing systems may be more expensive. For these reasons, it is more likely that WLANs would be used in developing countries not as a standalone service, but in conjunction with another technology, like WiMAX, DSL or Very Small Aperture Terminals (VSATs).

Satellite technologies

As described in Chapter two of this report, satellite technologies afford the widest range for wireless services. The major benefit of satellite for wireless transmission in developing and rural parts of the globe, is that satellite data services can cover vast areas and provide access in remote or underserved areas. In particular, two-way VSATs provide a potential backbone around which rural ICT services could be provided.[7]

However, satellite communications are prohibitively costly for low-income economies, although they have been deployed in some developing contexts, for example in Sub-Saharan Africa, where few alternatives exist. However, while affording good wireless connectivity, the high cost of satellite solutions filters down through the providers to the users, making widespread usage of wireless technologies based on satellite a difficult goal to achieve in economic terms.

High- and low-altitude platform stations

One lower-cost alternative to satellite is offered by high- and low-altitude platform stations (HAPS/LAPS) while still keeping some of the advantages, such as wide geographical range. It is indeed envisaged that a key market for HAPS and LAPS will likely be rural and developing areas that are underserved by traditional infrastructure. However, these solutions are still in the early stages of development and their potential has yet to be fully explored.

5.2.2 Success stories

With considerable innovation and creativity—often resulting from sheer need due to a dearth of other types of communication technologies—many initiatives and applications have been established for wireless technologies that are helping deprived communities start to cross the digital divide. Whether Wi-Fi, WiMAX, satellite or cellular technologies, the different types of wireless infrastructure have spawned applications that have increased quality of life for many. Through projects that have set the infrastructure in place and offered services at reasonable rates, various services now exist that have increased access. For instance, Box 5.4 describes a Wi-Fi bus that has improved connectivity in rural India.

Wireless solutions can also be used to increase access to the democratic process. For instance, the Chinese Government has made it possible for citizens to send SMS to the 2'987 deputies of the National People's Congress.[8] In a similar initiative, in South Africa, an SMS-based service was launched in 2003 to engender dialogue with voters. The South African public can now send messages or queries on topical national matters, as well as voting on issues.[9] Encouraging the public to go online for national matters can also help spread familiarity with electronic media.

Box 5.4: Riding the Internet
Wi-Fi bus brings connectivity to rural India

In the Dadobalapur district of Karnataka in India, a quiet wireless revolution is unfolding. In the not-so-distant past, tele-service applications could only be accessed from a *taluka* (an administrative and geographical block providing tele-services such as e-mail and Internet access), involving a round trip of up to 100 km. Now, residents can save time and money by accessing the services offered by the *taluka* from their village computer.

Stemming from the need to create an online database of land records, the project was set up by the Karnataka Government in collaboration with the US-based technology consulting company, First Mile Solutions. The project involves a bus equipped with a computer and Wi-Fi, which drives around stopping in different communities to transfer data from and to the community's local computer.

The project uses Wi-Fi equipment and runs at 2.4 Ghz, with a DakNet Mobile Access Point that is mounted on and powered by a vehicle. In a normal day's work, the DakNet-enabled vehicle drives past a village kiosk where it receives and delivers land record queries and responses. This information is synchronised with a central database on a daily basis. Data is transferred through the access point, which automatically and wirelessly picks up and drops off data from each kiosk on the network. The transportation of data can occur up to a radius of 1.25 km of the kiosk and after the bus arrives. This type of store-and-forward connectivity is particularly appropriate for email and for electronic transmittal of remittances.

The Karnataka undertaking is a further example of how Wi-Fi technologies can actually deliver connectivity to underserved populations at a fraction of the cost of alternative wired or wireless technologies.

Source: http://infotech.indiatimes.com/articleshow/266500.cms

5.2.3 Challenges and opportunities for deployment

When one considers that more than 2.5 billion people (or about 40 per cent of the world's population) live in the rural and remote areas of developing countries, where infrastructure and technology are in short supply, the challenges for deployment are apparent.[10] Providing connectivity to these areas raises huge challenges, but it also presents exciting opportunities for innovation. In particular, wireless technologies can serve to leapfrog fixed-line infrastructure, and, in the future, Internet-enabled portable devices may provide even more hope for the deployment of services and applications to the world's information have-nots.

For any successful deployment of technology, whether wired or wireless, awareness of the challenges is essential. Accessibility, weather conditions, absence of non-telecom infrastructure (e.g. electricity supply), sparse and scattered populations, lack of technical know-how, availability of currency, and even the risk of vandalism and theft, along with the cost of laying the necessary equipment are some of the potential obstacles. Even today, for example, approximately 80 per cent of the labour force in Bhutan is made up of farmers who have never used a telephone, much less seen a computer. In these conditions, the Bhutanese are forced to recruit foreign consultants at a very high cost. Weather conditions can also cause havoc with the supply of communications: with the harsh snowstorms in the north of Canada, for example, structures such as terrestrial satellite dishes and radio masts are at severe risk of damage.

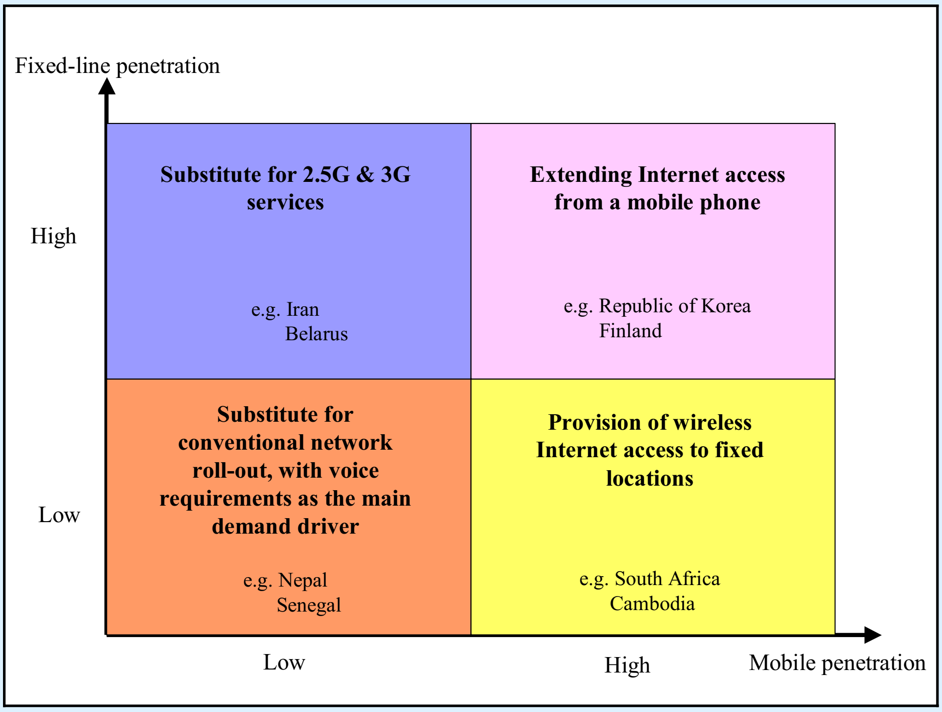
Beyond many of the challenges though, lie opportunities that often outweigh the difficulties involved. In the interest of achieving universal access for example, network deployment can be seen as a tool for development, and not solely as a source of revenue, which is why licence-exempt frequencies are advantageous. Although one downside of unlicensed wireless use is that radios operating on the same frequencies may cause interference among competing networks, the advantages of rapid and effective deployment may far outweigh any concerns about interference—a problem which in any case affects metropolitan areas to a greater extent than underdeveloped, rural ones.

Where lack of affordability and accessibility hinders access, efforts to include the community (for example through town hall meetings, employment creation, etc.) can help. Where feasible, community efforts, combined with government and/or private-sector support, are a proven way to establish relevant, viable and sustainable wireless initiatives. As the success stories described in this chapter show, wireless communication systems can offer the most cost effective and flexible alternative wherever wired systems cannot be easily deployed. The community approach also has the advantage of drawing in women, children and other segments of the population who are at risk of remaining out of reach of ICTs.

Where there is only a limited fixed-line network, fixed wireless telephony can be employed as an efficient and cost-effective method for bypassing the last-mile of the existing telecommunication network. A fixed wireless link can bypass the traditional copper landline—which is expensive to lay, thereby quickly and cost effectively completing the last-mile of a telephone network. As a fixed wireless connection uses towers, it can also avoid the digging of difficult terrain, although line of sight is required. Radio masts are also less vulnerable to theft than copper lines.

The "stakes" for the portable Internet are illustrated in Figure 5.4 (see also the underlying data in Figure 3.3) for different levels of mobile and fixed-line penetration. Where both fixed-line and mobile penetration are low for example, the portable Internet represents a potential substitute for conventional network roll-out, with voice requirements as the main driver. A combination of wireless LANs and Voice over IP (VoIP) has the potential to meet basic communication needs as well as offering data usage. Where fixed-line penetration is low, but mobile penetration high, the portable Internet will offer the means to extend IP-based services and applications to places where this may otherwise be impossible.

Figure 5.4: The portable Internet: The stakes
The portable Internet in relation to differing levels of fixed and mobile penetration



Source: ITU

As pointed out earlier in this chapter, infrastructure and technologies alone are not sufficient to entice people to use them. There remain enormous linguistic, cultural, commercial and educational barriers as well as simple issues of access and affordability. The following section therefore takes a look at some of the factors that lie "beyond infrastructure" for bridging the digital divide.

5.3 Beyond infrastructure

5.3.1 Effective national policy

In the new ICT landscape worldwide, the majority of countries that have forged ahead in terms of ICT deployment have done so against a backdrop of enabling changes at government level. The traditional national telecommunication market, led by a monopoly State-owned incumbent with no separate, independent regulatory agency, has been relinquished by many countries in favour of the creation of competition through the sale of licences to new operators, and the establishment of independent regulatory agencies. While the level of competition allowed varies among countries, in general those which have already introduced competition have seen an upsurge in communications growth and a marked increase in telephone penetration—particularly in the case of mobile communications. Effective licensing policy is a key role of government in fostering the development of new technologies. De-licensing of spectrum is one approach to boosting wireless connectivity, as illustrated by the example of the creation of a Wi-Fi lake in India (see Box 5.5).

It is often considered that there is no one-size-fits-all policy prescription for national ICT development. Policy formulation is contingent on national cultural, social and economic provisions. It is also path-dependent, with different policies being suitable at different stages of development. There are nevertheless some overarching best practices and principles. These are invariably based upon the principles of market competition, private sector participation and independent regulation.

Box 5.5: A Wi-Fi lake for the developing world
Houseboats provide floating Internet access in India

With the recent de-licensing of radio spectrum for spread-spectrum packet-based communications in India, wideband connectivity has been extended—using Wi-Fi technology—to reach sparsely populated communities, through a partnership between the Department of Tourism and private companies.

Local boats, called shikaras, that are used to travel on the five kilometre-wide lake, are connected to stationary houseboats—boats that have served as living accommodation for tourists and residents for centuries. These houseboats have been equipped to provide the lake's Wi-Fi network connectivity since 2003.

A *shikara* against the sunset on Dal Lake.

The Dal Lake Wi-Fi project was envisioned by Dax Networks and was implemented in partnership with the Indian Department of Tourism, the state of Jammu and Kashmir (J&K) and an ISP, Ipeaks. A similar Wi-Fi marine service was also set up off the shore of Lake Michigan in the United States in 2004, covering over 32 km.

Now that the project has been successfully implemented, Dax has plans to duplicate the model at other lakes in India—Nainital, Hussain Sagar, Kodaikanal and Kumarakom. During the pre-launch of the project, a representative of Dax Networks stated that this Wi-Fi lake is "not just a bold statement, but also a move that can have cascading effects in the state (of J&K) and a positive rub-off on the overall image of the country".

The project was not without challenges, however. Obstacles had to be overcome to obtain approval from the J&K government, the Tourism Department and local ISPs. Difficulties were also faced in finding the necessary manpower, resources and even electricity. But it is now operational.

Source: W2i at: http://www.w2i.org/pages/in_the_news/news_internet1.html; picture credit: courtesy IndiaMART.com - http://www.indiamart.com/ and: http://www.ottawawireless.net/about-us/press-releases/2004-02-11.pdf

As regards top-down regulation, some governments have contributed to creating opportunities for discussion, including events such as roundtables and forums. Given the borderless nature of today's communication networks though, cooperation must also take place at regional and international levels—particularly with respect to international standardization, interconnection and spectrum issues. ITU is just one of the organizations which holds events to bring national players together at the international level.[11] It publishes both free and paid-for statistics and carries out published research for the benefit of countries worldwide. ITU has also helped to bring national governments together with organizations and the private sector to broker key partnerships. At the first phase of the World Summit on the Information Society (WSIS) held in 2003, for example, ITU partnerships included a project with the Turkish Ministry of Health to boost e-healthcare, and a partnership between the Canadian International Institute of Telecommunications, supported by the Canadian Government, to provide technical assistance and training to the ITU Centres of Excellence Network worldwide.[12]

In the same vein, some countries have organized national seminars for leaders, volunteers and trainers to discuss particular topics with regard to programme development and to strengthen the organizing community. Online discussion forums, such as an online discussion of regional development strategies in Albania and Kyrgyzstan's Public Access Points, are particularly important in order to raise awareness about programmes and to facilitate communication between stakeholders.[13]

Public-private partnerships

Public-private partnerships aimed towards supporting the growth of developing countries are essential to "ensure that the benefits of ICTs are made available to all and not just a privileged few".[14] Public-private cooperative initiatives afford many benefits, such as the recruitment of local people and the provision of a skills base for the local community as certain skills will be needed for the new created labour force of the local partner. Furthermore, the shared mutual stakes between local, national and external players that are engendered in a public-private partnership can help ensure the longevity of the initiative, as well as paving the way for further cooperation. In one example of such a collaboration, within the framework of WSIS, ITU brokered a partnership with Cisco Systems Incorporated (a private technological solutions entity) for the establishment of 20 further Internet training centres in developing countries.[15]

5.3.2 Community and culture

Community-based initiatives

Community-based initiatives are a crucial part of the extension of wireless access to those who do not have Internet-based communications within easy reach. This is partly because of the difficulty and time delays for the deployment of fixed infrastructures, licensing procedures, and so on, particularly when the only decision-makers and executors involved are acting at the national level. By contrast, at the local level, residents and partners can join forces to erect masts for wireless access, create community-level centres and kiosks, and use locally-adapted solutions with a minimum of resources. At grassroots level, the "power in numbers" of a community can make all the difference in turning a pipe-dream into reality, as the example of Brazil in Box 5.6 shows. Not only do community-based initiatives stimulate local activity and strengthen solidarity, but they ensure that local culture is respected and that technology is integrated in a meaningful way.

However, local communities obviously need to enlist the assistance and support of others. For projects in rural areas, the participation of local authorities and municipal mayors is crucial. Local representatives of project stakeholders can be engaged to work towards ensuring better participation, contribution of local resources (such as locations to house the projects) and so on. Communication with the global ICT community is also needed to share technological know-how, benchmarking and technology transfer.

Box 5.6 : Internet in the trees
Satellites link Xixuaú-Xiparinà Ecological Reserve in Brazil

The Reserva Ecologica do Xixuaú stretches over 1'720 km^2 and is the only private nature reserve of its kind in the Brazilian Amazon. The Reserve was founded in 1992 by the Amazon Association, a Non-Governmental Organisation (NGO) focused on conservation and sustainable development issues. The reserve covers a large area of primary forest and is home to many species of animals that are threatened with extinction elsewhere in the Amazon, as well as to many rare rainforest birds.

One of the major challenges facing the reserve is that Xixuaú-Xiparinà is quite isolated, with access possible only via a 40-hour boat trip from the city of Manaus. The reserve's isolation and lack of electricity has left the native Caboclo Indians with virtually no access to modern health care, education and economic opportunities. Consequently, the viability of the reserve acutely depends on ensuring that the local people are able to lead healthy, prosperous lives in ways that preserve the environment.

To combat the problem of lack of electricity, the president of the Amazon Association contacted the Solar Electric Light Fund (SELF), a non-profit organization located in Washington, DC, for help with the financing and establishment of solar electric systems on the reserve. SELF subsequently installed the systems, which were used, *inter alia*, to power a satellite Internet link. High-speed Internet access (a maximum capacity of 4 Mbit/s downlink and a 192 kbit/s uplink) was set up by means of a two-way VSAT system. To complement the VSAT system, a wireless LAN was installed at the reserve. Before operation of the satellite dish began, it was necessary to acquire a licence from Anatel, Brazil's national telecommunications authority. No commercial return is expected from this initiative.

In addition to a link to the outside world for the first time, there are other applications now available to the Xixuaú as a result of the establishment of solar power and wireless connectivity on the reserve. One such application is a telemedicine project in which a "Vital-Link" device will be used to measure the blood pulse, blood pressure, blood oxygen level, body temperature, and electrocardiogram of everyone in the community. The information will then be transferred via satellite to the United States for remote diagnosis. On the educational front, with a wireless Internet connection, the children can take part in the national education authority online schooling system and pursue studies beyond the four years of primary teaching now currently available on the reserve. The reserve school also has intentions to twin with some primary schools in Italy via the use of their wireless Internet connectivity. Similarly, the adults can conduct specific research with relevant applications such as improvements in agricultural techniques. E-commerce is another application with potential. The women of the local villages intend to sell their craftwork products directly through the Amazon Association's website.

Source: Wireless Internet Institute case studies at: http://www.w2i.org

Portable Internet technologies over mobile devices hold an additional attraction for users in these areas in the future: the services and applications with which they may become familiar at the community level can be brought to the individual and household level through more personal devices.

Local, culturally-relevant content

In many developing countries, the digital divide problem is often exacerbated by the absence of useful or relevant content. For example, language barriers often prevent user interest from growing among large swathes of the population. In Morocco for instance, the development of content in Arabic exists, but is still at a very early stage for both mobile and Internet services.[16] In Lao PDR, a project is underway to include Lao language tools to facilitate access for remote village users (see Box 5.7).

In terms of services offered, there are numerous examples of adaptation of existing service content to local cultures. To cite once again the example of Morocco, information services are being developed by the two largest operators, Méditel and Maroc Telecom, with various SMS info-services allowing access to up-to-date information relating to cinema, train time tables, or daily prayer timings. In early 2004, SMS revenues amounted to some four per cent of the total revenues of these operators. The cost of the service is DAM 0.80 (USD 0.09), the same as a normal SMS. In India, an SMS-based matrimonial service has proved very popular (see Box 5.8). Elsewhere, a handset manufacturer has recently launched a mobile phone targeted at the practising Muslim user (see Box 5.9).

Box 5.7: Wireless project in Lao PDR to meet remote village needs
High-bandwidth wireless network for the supply of VoIP and other services

With an area of 236'800 km^2, the Lao People's Democratic Republic is Indochina's only landlocked country. Lao has a population of 5.5 million with an annual population growth of around 2.4 per cent (2002). The majority of the population, around 85 per cent, lives in rural areas and at 22 people per square kilometre, Lao has the lowest population density in Asia. Close to 94 per cent of the population is below 29 years of age.

A remote IT Village project is responding to villagers' needs through a high-bandwidth wireless network, the development of a low-wattage computer that can be powered by a foot-crank and support for small village businesses. Without telephone lines or electricity, and with torrential rains followed by high temperatures and thick red dust, standard technologies often fail to function. The low literacy rate and lack of knowledge of English mean that using the Internet and e-mail is fraught with problems. In an attempt to overcome this obstacle, a Lao-language version of Linux-based graphical desktop and Lao language office tools have been provided to the villagers.

A wireless LAN (based on the 802.11b protocol) has been developed, enabling signal transmission between the villages and a server located at the Phon Hong Hospital for switching to the Internet or the Lao telephone system. Now, villagers in five villages and their surroundings can use the communications centre to make telephone calls within Lao PDR and internationally (using VoIP), as well as for other activities, such as accounting, letter writing and e-mails, helping to support local business activities. The communications centre and wireless network are owned by the villages, with low user fees charged to support costs for personnel, paper, and telephone charges, thus making the project sustainable.

Sources: *ITU case study on Lao PDR* (2002), available at: http://www.itu.int/asean2001/reports/material/LAO%20CS.pdf, and Jhai Foundation Village Project, available at http://www.jhai.org/technology.htm

Box 5.8: A Short Marriage Service helps couples find their mate
BharatMatrimony.com's SMS matrimonial service in India

Matchmaking via SMS has joined Internet matchmaking to give neighbourhood matchmakers and matchmaking organizations a run for their money. New York-based matrimony web portal BharatMatrimony.com has ventured into the area through its "Matrimony on Mobile" service in India. The portal claims that anyone looking to get married can find a match for herself or himself in just five minutes via SMS.

Source: ITU research taken from Yahoo News India, Bharat Matrimony.com. See: http://www.itu.int/osg/spu/ni/futuremobile/content/messaging.html and ITU paper on "*Social and human considerations for a more mobile world*", 2004, at http://www.itu.int/futuremobile

Mobile applications and services are also particularly useful for *business-to-business* interaction. In countries with low Internet diffusion and PC penetration, mobile phones offer a potential substitute to transfer information and data. Using mobile phones loaded with wireless application protocol (WAP), a company can, for example, set up a system through which their salespeople travelling around a country are able to consult their timetable and also to update company databases directly via their mobile phones.

The examples given here only represent a small proportion of initiatives to date, all of which have the potential to serve as replicable models in other areas. What they show above all perhaps, is that the "local" aspect is immensely important to ensure that communities actively participate in, and benefit from, projects that are adequate to meet their specific needs. Each success story is an incentive for the development of other small scale projects, thereby providing hope for future growth.

Box 5.9: Portable religion?
LG Electronics new Mecca phone

While mobile phones seem much alike the world over, unique features aimed at specific markets are becoming a new selling point. A GPRS mobile phone with inbuilt compass and ability to indicate direction (created by LG Electronics - LGE) is now available in Muslim countries. The unique feature offered by this particular phone is that it can indicate the direction of Mecca (Quiblah). Muslims conduct Salat (prayers) to Allah five times a day—at sunrise, noon, afternoon, sunset and midnight—and to do so must face towards the direction of Kaaba (the house of Allah) in Mecca.

By setting the 5300 compass to the north and inserting their location information into the phone (see the picture below) the direction of Quiblah can be found. The phone clearly sets itself apart as a specialized functional phone in the Middle Eastern market. An added benefit that is expected to increase the attractiveness of this phone is the fact that the compass may be used as a stand-alone feature, even where GPS services are not available. In addition to the Arab States, LGE is intending to widen the compass phone market to target the 1.1 billion Muslims all over the world, including those in Asian nations such as Malaysia and Indonesia.

This kind of feature, that is adapted to meeting the needs of a specific market, is a good example of how mobile technologies can serve a useful social purpose, while at the same time opening up new—and perhaps unexpected—markets.

Source: Future Now article, at http://blogger.iftf.org/Fitire/000187.html; AME Info (a Middle East business resource), at http://www.ameinfo.com/news/Detailed/27828.html

5.3.3 Educating users

In order to avoid technology simply being "dumped" on uninitiated users, an adequate and sustainable skills base needs to be created in developing countries. By teaching users about ICT usage and maintenance, and encouraging the sharing of know-how, the populations of deprived and rural areas can be empowered and projects made more self-sustaining. The example of e-post and other services in Bhutan, described in Box 5.10 below, illustrates how initiatives can be enhanced by adequate training and education.

5.3.4 Fostering innovation and entrepreneurship

Increasingly, wireless data applications are being used to foster innovation and entrepreneurship. To remain competitive in today's global environment, transforming an everyday application like SMS from a simple short messaging service into an innovative tool, can deliver an extra competitive edge. In the United Arab Emirates for example, as of November 2003, subscribers to the Pay TV network Showtime could order their personal selection of pay-per-view movies via SMS ordering.[17] In Scotland, United Kingdom, in January 2003 the Fife Council launched a programme that delivers text messages to tenants who fall behind with their rent. Some 50 per cent of those who received text messages got in touch with the necessary authorities as requested, compared to 25 per cent of those contacted via postal mail.[18]

Box 5.10: From snail mail to e-mail

Establishment of e-post and other developmental services in rural Bhutan

In a collaboration between ITU and the Universal Postal Union (UPU), with the assistance of the Government of India, WorldSpace and Encore Software, thirty-eight "telekiosk" post office centres are being set up across Bhutan, five of them in northern and north-eastern areas, at altitudes ranging from 2'500 to 5'300 metres above sea level. In these regions, postal mail is currently delivered via "postal runners," for whom a one-way trip can between three and seven days on foot. The telekiosks will offer "e-post" services, making it possible for e-mail messages sent to the post office to be delivered as local post.

Other services are also being developed on the back of the telekiosk project. For instance, handheld multimedia technologies and software have been integrated, creating a favourable technological framework for other applications. In the future, it is planned that the telekiosk post offices will serve as resources for schools (providing access to computers and Simputers), as well as health, agricultural and veterinary workers.

This Telekiosk project was designed to be scaleable and expandable in order to allow ongoing learning and evaluation and to allow room for changes in its construct. Since the inception of the project, the organizers have conducted training, awareness initiatives and an outreach programme. They have also expanded and enhanced the e-post services, with the introduction of specialized software. Early on in the project, with the logistical support of Bhutan Post, a survey was conducted in post offices on the needs of telekiosk users, and the results used to create the appropriate range of services.

Students using computers at a post office

Furthermore, throughout the project, telekiosk users were surveyed to test how the offered services were meeting their needs and to check whether their aptitude at using the ICT equipment was improving with time. For the future, there are plans to connect six remote locations (currently served by postal runners) via a VSAT system for both voice and data channels.

This initiative is a shining example of a project that goes beyond simply providing infrastructure by aiming to ensure that users are educated about the benefits and usage of the equipment. Just as importantly, efforts have been made to ensure that services are tailored to the needs of the community, and of the existing infrastructure of post offices.

Source: ITU Development Sector success stories at http://www.itu.int/ITU-D/success_story/story_bhutan.html and ITU News magazine at http://www.itu.int/itunews/issue/2002/05/himalaya.html. See also the case study on Bhutan at http://www.itu.int/osg/spu/casestudies/index.html#asia

There has also been no shortage of innovative applications of SMS. In Spring 2003, approximately 100 trade association members in India decided to register their disapproval with Value Added Tax (VAT) by commencing an SMS campaign. Each trader had been asked to send at least 10 messages via SMS to other numbers informing consumers of the negative effects VAT has on both traders and consumers, pioneering the use of SMS as a means of protest. By March 2003, 800 messages had already been sent for this cause. In the first phase of this SMS protest initiative, the original working group shared the message with other traders, then subsequently the media, politicians and leading citizens were contacted.[19] Texting is also being used by farmers in Kenya to market their produce (see Box 5.11), and in Morocco to convey banking information (see Box 5.12).

Investment or funding strategies

Despite doubt by investors in the past, potential ICT market opportunities certainly exist, even in the least developed economies. With the number of telephone subscribers, PCs used and mobile subscribers drastically increasing in low-income countries, investing in these countries is economically justified.

Box 5.11: Farmers use SMS for marketing their produce

Farmers can now monitor price changes in the market using the short messaging service

Farmers in Kenya can avoid travelling to central markets in order find out commodity prices—providing they have access to a mobile phone and SMS. Farmers can currently inquire about prices of maize, beans, potatoes, tomatoes, cabbages and onions in the towns of Eldoret, Nairobi, Kitale, Bungoma and Karatina. Kenya Agricultural Commodity Exchange (KACE), an agricultural non-governmental organization, plans to provide information on prices of approximately 100 commodities and eventually to extend the service to include alerts about disease outbreaks. This development could also help minimize the exploitation of farmers by middlemen and commodity speculators.

The SMS service will be provided to subscribers of KenCell Communications, and was developed jointly by KACE and Safaricom.

Source: Daily Nation on the Web, Peter Ng'Etich, 28 July 2003

In rural settings, services are sometimes offered as a community resource through, for instance, a telecentre or telekiosk, often sponsored by governments, multilateral institutions, and non-profit organizations, or part of a service provider's universal service obligation. Since the foremost aim is often to expand access to the basic service, in many cases less focus has been placed on creating sustainable business models and including entrepreneurship in the solution provided. However, investors—particularly foreign investors—are more inclined to support profitable and economically sustainable business models while at the same time extending universal access to rural and remote areas.

Box 5.12: Bank balance by SMS

Online banking services for mobiles in Morocco

Crédit du Maroc is one of the Moroccan banks currently providing SMS services to its clients. By subscribing to the "Bip Bip" service, bank customers are able to receive their account information by SMS almost in real time.

A more advanced service is being provided by the BMCE bank, which has launched "*Librity*" (in Moroccan Arabic dialect meaning "everything you want"), available to both Méditel and Maroc Telecom customers. "Librity" allows users to access a number of services either by SMS or by mobile Internet, subject to a monthly subscription charge. The amount of the monthly fee varies depending on the services needed, and ranges from DAM 45 per month for basic SMS service—through which one can receive information about credit accounts or book train tickets—to DAM 120 per month for WAP over GPRS services, allowing users to access also real time information about the stock exchange, and receive automatic stock exchange "alerts".

Source: Crédit du Maroc at http://www.cdm.co.ma/ and BMCE Librity webpage at http://www.librity.com. Logo and ringtones: http://sogo.meditel.ma/.

While foreign investors may err on the side of caution in a developing country setting, local or regional investors tend to have a higher tolerance for certain types of risk—for instance currency fluctuations. The former often look towards higher returns in order to balance the risk, to get buy-in for their investment case. International investors tend to look for long exclusivity periods for their investments in incumbent operators to maximize income. Regional investors may be more willing to compete with the incumbent. In general, a liberalized ICT policy and regulatory framework can help to create a competitive environment in which the private sector will participate, which in return can attract more foreign investment.

In order to get more investors to look into opportunities in developing country markets, governments, policy-makers, and project organizers need to increase awareness among potential investors with regard to the benefits and impact that portable Internet technologies, such as Wi-Fi and WiMAX, can have for the overall development of these countries, as well as the potential opening up of new markets. Spreading information about successful initiatives are a good way of raising awareness. The benefits and advantages of wireless over fixed networks can also be highlighted. Furthermore, in countries where liberalization of the market has not yet been undertaken, in order to cut prices and offer a wider range of options to the customer, this should be a government priority in order to raise overall investment. When encouraging investment, governments should also beware that encouraging only multinational corporations and foreign companies while ignoring local and regional companies could be to the detriment of the appropriateness and sustainability of the project, as well as to the potential growth of the home economy.

5.3.5 Ensuring affordability

The prepaid revolution

Along with access, affordability plays a key role in extending access. Pricing and payment methods are not only essential elements in ensuring affordability, but play an important role in attracting users to a product and service, building confidence with users and ultimately establishing long-term value. But the impact on the digital divide is double-edged. For example, while prepaid can be considered an efficient tool in shrinking the telephony gap, it can also represent a gap *grower* for access to advanced data services. However, this and similar stalemates can be overcome by locally adapted solutions.

The introduction of prepaid calling cards for mobile services, both for making phone calls and sending SMS messages, has been the key to mobile success in many developing and developed countries across the globe. Prepaid has allowed users to keep an eye on their mobile expenditure, while creating access for people with limited financial means. For example, the initial offering of prepaid cards for mobile services to Venezuelans in 1997 boosted users by 221 per cent. Further developing prepaid services, for instance by including benefits like sending MMS, will allow the market to grow even further.

For future wireless services too, payment models akin to prepaid will be useful in attracting customers and boosting user bases.[20] Prepaid Wi-Fi service plans are in fact already being developed and prepaid services for hotspots are currently available in Europe, Asia and North America. How to successfully deploy this in developing countries as well is the next challenge for providers, for which they need to take into account not only locally-gauged affordability but also local demand. Offering multiple payment options can also help launch new services successfully. The bundling of services to groups, such as family members, which would allow for remittances to be paid between relatives, can also promote service deployment, together with special off-peak rates and other enticing packages. Above all, users look for variety of offer in pricing schemes as much as in services, and providers in developed and developing countries alike should be aware of this.

Regulating prices

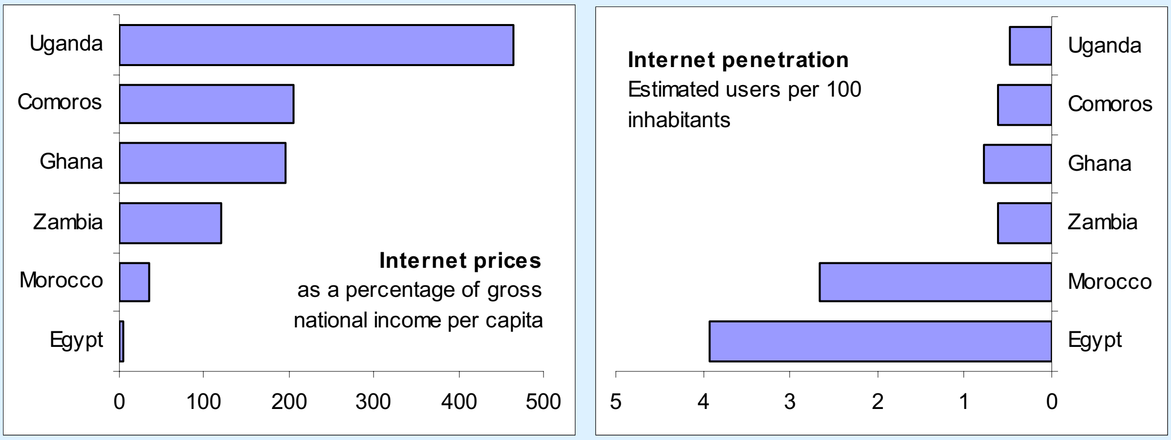
While prepaid and other pricing schemes lie in the hands of service providers, governmental regulation of pricing also plays an important part in making services affordable. Regulation may also be used to ensure that the incumbent operator does not use predatory pricing, or cross-subsidy between monopoly and competitive services, to deter market entry. Price caps, as well as the introduction and fostering of competition, are examples of regulatory measures to ensure affordability.

In many developing countries, the high cost of international Internet access is usually due to low competition levels for connectivity to the international Internet backbone, which is often monopolized by an incumbent public operator. Though a number of developing countries have liberalized this market, by allowing local ISPs to connect directly to the international Internet backbone, the costs that local ISPs incur in doing so remain high. This situation may arise due to a lack of economies of scale in the domestic market, or long-term tie-in to international circuit agreements, or a lack of infrastructure options. For instance, SIDS and land-locked economies may be obliged to use satellite links when the cheaper option of undersea cables is unavailable. The costs to ISPs are reflected retail prices for users, thereby affecting affordability and overall access levels.

Among the selected African economies shown in Figure 5.5, Egypt was offering the cheapest Internet access tariff relative to individual wealth in 2003 (4.5 per cent of average gross national income per capita), while Uganda had the most expensive (464 per cent). While 20 hours a month of Internet access costs less than one twentieth of an average Egyptian monthly income, it costs almost five times the monthly income of a Ugandan. There is an inverse relationship between Internet price and penetration, as shown in the left chart. Egypt has the highest level of penetration among the selected economies, at 3.93 Internet users per 100 inhabitants against 0.49 in Uganda[21]. This reinforces the well-known notion that the cheaper the service, the more people will use it. But economies of scale may also be a factor here, with Egypt having more than twice Uganda's population, as well as access to undersea cables.

Figure 5.5: Cause and effect

Total Internet price (monthly fee and telephone usage charge) for 20 hours of use per month calculated as a percentage of GNI per capita, August 2003, and Internet penetration per 100 inhabitants, 2003



Source: ITU World Telecommunication Indicators Database

A number of policy solutions have been advanced, such as the use of Internet exchanges to aggregate regional demand, as well as encouraging local ISPs to own their international connectivity to international Internet backbones. Also, *ex ante* competition policy principles like mandatory access, cost-orientation of prices, non-discrimination, transparency and accounting separation to international connection services should ideally be promoted as safeguards against anti-competitive and non-transparent pricing strategies.

A strong case can be made for how an independent regulatory agency can impact on tariffs through pro-competitive policies. In the case of mobile cellular services, competition in India, especially from limited mobility wireless services, managed to keep pressure on tariffs, and intervention by the Telecommunication Regulatory Agency of India (TRAI) though minimal, has been key in terms of lowering costs of access. Through the 1999 Telecommunication Tariff Order for basic and long-distance services, TRAI has demonstrated its willingness "to achieve a good balance between cost and affordability"[22] by implementing a 45 per cent reduction in domestic long-distance charges and a 50 per cent reduction in international long distance charges. Along with a standard tariff package, operators could, for example, offer an alternative and more competitive package.

Strong pricing policies, including geographic averaging of prices, are also key in terms of bridging the rural-urban divide. Two examples developed countries with remote and mountainous areas, which have successfully encouraged higher take-up rates in rural areas, are New Zealand and Iceland. New Zealand has followed a strategy based on consistency of pricing of satellite relative to DSL (see Box 5.13) while Iceland has mandated data services as part of the incumbent carrier's universal service obligation (see Box 5.14).

Box 5.13: Pricing satellite broadband access
Pricing parity strategy in New Zealand

The parity of satellite and DSL pricing in New Zealand has meant that satellite services have a relatively high take-up rate compared to other broadband platforms, although New Zealand's overall rate of broadband penetration is low compared to that of other developed nations.

In 2003, the incumbent operator in New Zealand, Telecom, attained 84.8 per cent digital subscriber line (DSL) coverage, with 46 per cent of Telecom's customers able to access DSL from rural areas. According to Telecom estimates, some 80 per cent of rural households were able to access some form of broadband service via DSL or fixed wireless by June 2004.

Satellite broadband access has been available to many parts of New Zealand since December 2000. Since that date, "iHug" has offered a one-way satellite service at sub-broadband and broadband speeds. The service uses a satellite for the downstream link and the PSTN for the upstream link. While local calls are free for residential users in New Zealand, users of iHug's "Ultra" satellite service need to subscribe to a dial-up ISP. In August 2003, iHug's sub-broadband offer of 128 kbit/s downstream and iHug dial-up, for the upstream connection, was priced at a total of USD 38 per month. This offer included 250 hours of online time and 500 Megabytes of international traffic (national and international bytes are priced differently by some providers in New Zealand). iHug also had a number of higher-speed downstream offers. For example, a 1 Mbit/s downstream connection was priced at USD 44 for 60 hours and 1'000 Megabytes of international traffic. By October 2002, iHug had gained 5'000 satellite subscribers.

iHug's one-way satellite has obvious disadvantages compared to Telecom New Zealand's DSL service. One difference is the need to use the PSTN line for the upstream link, whereas a DSL user would still have the first line available for concurrent telephony use. In addition, all satellite broadband services have an inherent latency that may be important for some applications such as online games. Notwithstanding these differences, depending on usage levels, iHug's pricing is comparable to or less expensive than DSL in New Zealand.

To place New Zealand's satellite use in perspective, New Zealand has a higher availability of DSL than Australia and around a quarter of the population, satellite services in Australia had gained just 11'200 subscribers by October 2002. Accordingly, New Zealand's satellite broadband penetration was double that for Australia. The obvious difference between the two countries is that satellite costs significantly more than DSL in Australia (and most other countries) whereas the price of the two services is similar in New Zealand.

This developed country example serves as a useful model for pricing strategies that can be tailored to meet a given country's specific needs: for example, where large rural areas need to be covered by satellite technologies at an affordable price.

Source: OECD (2004), "The development of broadband access in rural and remote areas", available online at http://www.oecd.org/document/43/0,2340,en_2649_34225_31718315_1_1_1_1,00.html

5.4 Conclusion

It will certainly be some time before Internet-enabled hand-held devices become sufficiently widespread and affordable to make the portable Internet the technology to span the gulf between the information haves and have-nots in the world. However, this chapter has shown how the explosion of mobile and the development of wireless technologies are promising steps to enable technology leapfrogging to take place.

The advantages of the availability of portable Internet-type technologies are manifold. Among the areas that stand to reap benefits are: education (e.g. distance learning, training); business (e.g. e-trading, e-banking); environment (e.g. databases of crop patterns); governance (e.g. information for citizens, democratic processes), and rural and urban development in general. Healthcare stands out as an area where considerable benefits can be drawn, with e-health providing great potential for becoming a key factor for widespread healthcare provision. Technologies like networked electronic health records, broadband communication and secure networks enable the delivery of " ubiquitously available" and enhanced services to patients. The massive deployment of information technologies changes the access to and the nature of healthcare at a rapid pace. Box 5.15 gives an example of wireless technologies applied to healthcare services in rural areas.

While the obstacles to network roll-out include policy, technical, infrastructure, investment, environmental and educational aspects, these can all equally be seen as opportunities. The keys to successful deployment of wireless in rural and developing settings include locally-led initiatives, encouraging international and private-sector participation, and a competition-friendly environment, all of which have beneficial spin-offs for society and the economy as a whole.

Box 5.14: Bridging the rural/urban divide in the industrialized world
An example from Iceland

The definition of universal service has been quick to evolve in Iceland. In 1999, a policy decision was made to extend the concept of universal service to data transmission lines. On 10 August 2000, Regulation 641/2000 was passed by the Icelandic parliament, making it obligatory for data transmission at a minimum speed of 128 kbit/s to be guaranteed to all households in the country. As of February 2003, 98 per cent of Icelandic households had access to ISDN.

In 2000, Iceland's Minister of Communications created a Data Transmission Working Group to study the cost of data transmission in Iceland and the methods for strengthening telecommunication infrastructure and services. The Group submitted its report and proposals to the Minister in April 2002. The main conclusion of the report was that broadband should be made available to all Icelanders at the same price. In this context, the Group proposed the establishment of a fund to be managed by the Icelandic regulator, the Post and Telecommunications Authority (PTA), which would subsidize the difference in cost, for a 2 Mbit/s broadband connection, between rural areas and urban areas. This would allow small and medium-sized enterprises outside large urban centres to access broadband networks at the same price as their urban counterparts. The proposal is under consideration by the Minister.

Source: ITU case study on Iceland at http://www.itu.int/osg/spu/ni/promotebroadband/casestudies/iceland.doc

Box 5.15: Information technologies for bridging the health divide
Wireless telemedicine initiative in India

A promising wireless telemedicine initiative is currently in operation in rural villages across India. The system is based on corDECT, a Wireless Local Loop technology, based on the Digital Enhanced Cordless Telecommunications (DECT) standard specified by the European Telecommunications Standards Institute (ETSI). CorDect provides simultaneous high-quality voice and data connectivity in both urban and rural areas. It has the potential to connect 85 per cent of the villages of India with coverage radius of 25 km. Radio exchange and base stations are deployed in towns (where fibre is present) and a subscriber unit is deployed in the village, providing a telephone connection and an Internet connection at 35/70 kbit/s.

The aim of this system is to provide healthcare services to people living in rural areas, where it is difficult to reach a doctor. In the example of sixty-year old Palaniammal, a web camera set in a special kiosk was used to photograph her eyes, and the photo sent electronically for diagnosis. The process was facilitated through the use of a real-time video conferencing system and the exchange of on-screen instant messages. Despite the low quality resolution, a doctor based at a distant healthcare centre was able to diagnose that she was suffering from a cataract. The photos were also e-mailed to the Aravind Eye Care Hospital in Madurai for a second opinion. The doctor then sent back instructions and Palaniammal's vision was restored in few days. This example shows how wireless technologies can help reduce the social disadvantages suffered by rural communities at a relatively low cost.

The service also caters for other medical conditions: a medical kit is provided at the telekiosk, with a multi-channel electrocardiogram, electronic stethoscope, automatic blood pressure, and temperature measurement and pulse rate calculation. It is completely battery operated, and communicates with the computer through a wireless infrared serial link. Software provided facilitates patient record capture and storage, real-time video conferencing and the exchange of medical data (both real-time and store-and-forward).

Source: (Graphic) Prof. Ashok Jhunjhunwala, IITM, Chennai, India. See www.itu.int/digitalbridges

[1] See the World Summit on the Information Society (WSIS) website at http://www.itu.int/wsis

[2] "Charting and Bridging Digital Divides: Comparing Socio-economic, Gender, Life Stage and Rural-Urban Intenret Access and Use in Eight Countries", 27 October 2003, AMD Global Consumer Advisory Board, at http://www.amdgcab.org

[3] Ibid.

[4] Based on the results of a connectivity survey of 737 Aboriginal communities conducted by Aboriginal Canada, a major portal to Canadian Aboriginal online resources at http://www.aboriginalcanada.gc.ca/

[5] While this is generally the case, the Philippines present a striking exception. Filipinos took to SMS data messaging to such an extent that SMS use was initially even more widespread than mobile voice communications. This was principally spurred by the fact that SMS was initially offered as a free service. See also Box 5.3.

[6] ITU African Telecommunication Indicators 2004 at http://www.itu.int/ITU-D/ict/publications/africa/2004/

[7] See discussion in "Improving connectivity in the Least Developed Countries" (Feb. 2002), available on the ITU website at http://www.itu.int/osg/spu/ni/ipdc/index.html

[8] See http://www.itu.int/osg/spu/ni/futuremobile/content/messaging.html

[9] See http://www.mg.co.za/Content/l3.asp?ao=23493

[10] See Kawasumi, Yasuhiko (2004) "Rural communications on the global agenda", ITU News magazine issue No. 5/2004, available at http://www.itu.int/itunews

[11] Information on ITU events can be found on its main website at http://www.itu.int

[12] Held in Geneva. See http://www.itu.int/wsis

[13] United Nations Development Programme (UNDP), 2004, *How to build open information societies – a collection of best practices and know-how*, Europe and the Commonwealth of Independent States.

[14] As stated by ITU's Secretary-General, Mr. Yoshio Utsumi, on the occasion of the first phase of WSIS.

[15] See http://www.itu.int/wsis/geneva/newsroom/highlights/10.html

[16] See ITU Case Study on Morocco at http://www.itu.int/osg/spu/ni/futuremobile/general/casestudies/index.html

[17] http://www.ameinfo.com/news/Detailed/31484.html

[18] http://www.ananova.com/news/story/sm_743972.html

[19] http://cities.expressindia.com/fullstory.php?newsid=46606

[20] Portal Software, Brian McCann, http://www.portal.com

[21] ITU African Telecommunication Indicators 2004 at http://www.itu.int/ITU-D/ict/publications/africa/2004/

[22] ITU Case Study on Competition Policy in Telecommunications: The case of India, at http://www.itu.int/osg/spu/ni/competition/

6 CHAPTER SIX: THE FUTURE OF PORTABLE INTERNET TECHNOLOGIES

Nothing has had as dramatic and rapid impact on our generation as the Internet and the mobile phone. They have dramatically influenced the telecommunications landscape and in some cases, completely changed lifestyles and social habits. They have also created new revenue-generating streams and transformed business models. Today, with the marriage of the two giants, the so-called "portable Internet" revolution is underway. Ten years ago, no one could have imagined the ubiquity of the mobile phone around the world. Similarly, gadgets that seem like science fiction to us today will be commonplace in the world of tomorrow.

This chapter describes important new advances in portable technology. The first section describes current applications and the second takes a peek at future developments.

6.1 Innovative mobility for today

6.1.1 Portable messaging

From Generation X to Generation TXT

The phenomenon of messaging seems to be a very, if not the most popular, use of the portable Internet in today's mobile information society. China, which is a world leader in text messaging, sent a total of 220 billion text messages in 2003.[1] In the UK, some 2.1 billion text messages were sent during the month of March 2004[2]. Text messaging is an unprecedented success that has taken the whole industry by surprise. It is interesting to note that at the origin text messaging was not meant for consumer use but was created to allow operators inform their customers about things such as problems with their network. It was afterwards adopted mainly for person-to-person communication, but with the portable messaging device becoming more versatile and multi-modal, messaging has advanced from being a fun idea to becoming an essential communication and business tool. Today, it has been turned from a fad into a cash cow. It is now being used to inform, sell, organize, entertain, and facilitate our increasingly busy lives. Businesses, governments, institutions and many others are cashing in on the high penetration of portable handheld devices and the ubiquity of access to promote their goods and greatly influence the course of today's society.

Messaging has become an integral part of our lifestyle. It is very easy to consult train or bus timetables in real time by sending a text message or to receive instant notification via email or SMS on the latest flight status to portable handheld devices. Airlines like Virgin Blue have introduced SMS check-in services where a barcode containing reservation details is sent to the mobile phone which is scanned at check-in. Mobile marketing campaigns are becoming commonplace with different techniques such as competitions, SMS-based promotions, m-coupons, alerts etc. being used to connect to targeted audiences. Conferences and exhibitions are replacing badges with mobile barcodes. Registrants receive a barcode when they register for the exhibition and this code is scanned from their phone at the door. SMS is taking the place of the traditional pink slip where in countries like South Korea and the UK, companies are informing their employees of their redundancy via SMS. It is also becoming a common form of court room evidence, playing a major part in many criminal investigations. It is no doubt that portable messaging is greatly influencing our daily lives in a full-fledged manner.

This section is dedicated to highlighting some of tomorrow's more interesting messaging applications, several of which are in a nascent stage today. The focus is on innovation in the areas of health, entertainment and smarter homes as well as service growth in developing countries.

Saving lives through portable messaging

Portable messaging is proving to be a vital tool in dealing with emergency situations such as accidents especially immediately after they occur. It is a known fact that the manner in which the very first minutes of any accident are handled will have a significant effect on the fate of the victim. Multimedia Messaging Service (MMS) is today being used by accident services in the UK to warn hospitals of the state of accident victims before they arrive at the Emergency Units. The service, which is run by Orange UK and Fife Fire and Rescue Service, allows rescue workers at the scene of an accident to take photographs of casualties and immediately send the images to Dunfermline's Queen Margaret Hospital via MMS which also has mobile phones and can receive the pictures in real time. The doctors on call are able to assess the extent of the injuries through the images and mobilize the appropriate medical teams. The images also help them decide if they are to travel to the scene or to wait for the patient's arrival before beginning treatment. It is hoped that the introduction of this new service will help improve the management of the critical early stages of treatment following an accident.

Motorists have always been at risk of having an accident in a remote place or in a foreign country where help can be very difficult to come by. Researchers are planning on equipping today's cars with sensors which automatically send a text message to emergency services after a car crashes. The system E-merge by ERTICO[3], fits the car with a device the size of a mobile phone, a GPS positioning unit, a microphone and a loudspeaker. A South African company, Beget Holdings has recently launched a location-based SOS system, SMSOS, which turns most mobile phones into a mobile panic button, alerting family and friends to a distress situation and pinpointing the sender's location within five seconds[4]. One can SMS their SOS by pressing the SMSOS speed dial or "panic button" on a mobile, a priority SMS is relayed to each of the preset respondents. The SMS includes personal and contact information, as well as the location of the person in distress using GSM coordinates. Multimedia messaging enabled phones can also receive a location map of the appellant.

Box 6.1: Father and daughter's SMS lifeline

An Essex man has taught himself to use text-messaging at the age of 81 so that he can communicate with his daughter who is deaf and unable to speak

Arthur Dee from Romford decided to buy two mobile handsets which were on offer at his local Tesco supermarket so that his daughter, Pamela, could contact him to let him know when she wants to be picked up. Mr Dee said that 57 year-old Pamela still lives with him but likes to travel around independently by bus.

“In the past we've had real problems when the bus hasn't turned up," he told BBC News Online. "She had to ask somebody to ring me but often I would already have left to pick her up, so there was no way she could let me know that she wasn't going to be at the bus stop."

Mr Dee said he had taken to texting so quickly that he now wishes that he had bought a mobile years ago.

"Texting has given my dad and me a much greater sense of security," Pamela Dee told BBC News Online by SMS. "The world seems so much smaller now."

Text messaging has become extremely popular among people with hearing impairments as a means of staying in touch..

Source: http://news.bbc.co.uk/2/hi/technology/3650555.stm

Managing your micro-moments of boredom

Entertainment on the go is rapidly gaining importance as it moves from single-player gaming to online multiplayer gaming. According to estimates from Informa Media Research, the global mobile phone gaming market more than doubled in 2003 to $587 million from a year earlier and is expected to grow six-fold to $3.8 billion in 2007. Location-based technology with portable messaging is a developing trend in the mobile gaming world with popular games such as BotFighters, Mogi, or Gunslingers on the market . BotFighters lets users play via SMS using any standard GSM phone, or via a downloadable J2ME client. Players locate each other with their mobile phones, move physically to get within range and then duel by firing lethal SMS at each other. Mobile positioning is used to determine whether the users are close enough to get a good hit. SingTel's Gunslinger which is Asia's first location-based mass multiplayer mobile, is also a game about conquest and battles. SingTel's postpaid mobile customers can download the game by dialing *480. They can then play either an SMS or Java version of the game using selected Java-enabled mobile phones. Players can locate nearby opponents for a challenge. The game uses the whole of Singapore as a playing field. Mogi, a game which is differentiated by its non-fighting nature uses GPS to determine where players are in relation to the items they are seeking. Players at PCs figure out where players in the city are and direct them to the closest treasure. Through portable messaging, this fosters teamwork and communication between the players and forms a community. Dodgeball[5] is a new service which can inform a user which of their friends are within a ten block radius of their location. Once the subscriber signs up and registers their mobile phone number with the Dodgeball network, they can "check-in" by sending a text message to Dodgeball with their location. Then, if anyone on their list of friends has also checked-in and is within range, they both get a text message with this information.

Towards the smarter home

Home technologies are taking advantage of the messaging phenomenon as we move towards smarter homes. Baking that cake via your cell phone is no more science fiction. In tomorrow's homes, the washing machine will inform you when the laundry is ready and portable messaging will become an integral part of home technology. The kitchen of the future as envisaged by the Internet Home Alliance[6], a consortium of home technology companies, will include networked devices that can connect with each other and with the Internet. With its Mealtime Pilot[7] project launched in the Boston (United States) area, consumers managed kitchen and meal preparation tasks from an oven, a web-enabled refrigerator tablet, a web-based entertainment/command center and a WAP-enabled (wireless application protocol) mobile device. They could, for example, receive a text message on their mobile phone from the oven confirming that evening's cooking instructions e.g. "Do you still want me to have this dish ready at 7?"

Box 6.2: The "connected" kitchen
A boon for the busy and the on-line

Imagine being able to leave a meal in the fridge for the day but then send a command over the Internet to cook it so that it is ready when you get home

A US company called Tonight's Menu Intelligent Ovens (TMIO) has come up with a refrigerated microwave that can be controlled over the net or by mobile phone. The product is part of a trend towards the smart kitchen hooked up to the Internet, so that you can browse the contents of the fridge or tell the oven to immediately refrigerate your chicken once it is cooked. It also means the oven can be controlled over the internet or by mobile phone, allowing you to delay the cooking time, change the cooking temperature or cancel the cooking order altogether.

Source: BBC

Portable devices such as the mobile phone or the web-enabled personal digital assistant are now being used as remote control systems for the electrical and mechanical systems in the smart home, such as lighting, air-conditioning, security etc. Several security companies are now offering new services that hook up for example cameras to the Internet which send a text message to a mobile if something moves in the home. Home owners can now watch live pictures from their mobile and alert the police if someone is attempting a break-in. Some cameras are capable of transmitting images to MMS mobile phones, enabling clients to identify at a distance, a person entering their premises.

Innovative portability in developing countries

The cost of owning a mobile phone in many developing countries is cheaper than owning a computer with an Internet connection and is simpler to use. Due to the growing penetration of mobile phones, portable messaging is gaining in importance and popularity in these countries mainly because of its low pricing. It is also fast becoming more than a simple communication tool. In the Philippines, a country which toppled its president through portable messaging and sends an average of 252 messages per user per month[8], e-government is giving way to m-government or mobile government. Government agencies are taking advantage of the widespread use of SMS to improve their services. The Philippines Bureau of Internal Revenue is one such agency that is using portable messaging to solve the major problem of tax collection which has always plagued the Philippines (See Box 6.3). The Philippines National Police – the country's unified police force – introduced a text messaging system in 2002 enabling the public to report wrongdoings by police officers (as well as by criminals). The text messaging system can also be used to report corruption in other public agencies, which the police themselves could then investigate.[9] Recent elections in the Philippines have shown the extreme popularity of mobile text messaging the country. The National Citizens Movement for Free Elections (NAMFREL)[10] decided to relay precinct results by portable messages. The Movement later admitted that it was overwhelmed by the volume of votes sent via portable messaging, acknowledging that this caused a delay in their tabulations.

Box 6.3: SMS – the mobile "tax man"
Improving tax collection through text messaging in the Philippines

Tax collection has always been a problem in the Philippines. Leakage is high: by one estimate close to a third of tax due is not collected by government. Of particular concern to tax collectors are the self-employed professionals who do not have fixed incomes. The Bureau of Internal Revenue (BIR) has a difficult time determining if the declared incomes of these professionals are correct. While it is generally assumed that people regularly under-declare their income for tax purposes, sending tax examiners to go over the income tax returns of these high net worth individuals might simply create opportunities for corruption.

The BIR believes that if more citizens demand receipts for goods and services rendered, they would have a more solid basis for determining taxes due from professionals. The traditional solution is to undertake a "demand a receipt" campaign, which has been done. The BIR also decided that winning a million pesos (approx US$20,000) in a raffle might give citizens incentives to ask for receipts. So they launched a raffle where citizens send the receipts they've collected for a chance to win the million pesos. To a certain extent the raffle was a success. People were sending in receipts by the thousands but the BIR did not have enough people to go through the receipts for data mining purposes. This led them to *Bayan I-Txt ang Resibo*: an SMS-based raffle to replace the traditional raffle.

Application Operation

To join the BIR's SMS-based raffle, citizens send their name and address, the Tax Information Number (TIN) of the professional/business/commercial establishment from which they have purchased goods or services, the receipt number, and the cost of purchase (one raffle entry is given for every 100 pesos-worth of purchase) to their cellular service provider. Each text message to the BIR costs the sender P2.50 (US$0.05).

In its first five-month run (June-Oct 2003) Bayan I-Txt ang Resibo paid out P5m (US$100,000) in total to five winners of five national draws. In November 2003, the BIR decided to change the format of raffle. Henceforth there would be weekly draws in the country's 16 administrative regions where the winner will get P25,000 (US$500), then a grand (national) draw where the winner gets P1m.

Application Impact

The BIR reports that 168,694 individuals registered for the SMS-based raffle from June to October 2003. But as a single registrant can send multiple entries there were a total of 2,775,902 entries for the said five-month period. The total amount of goods and services accounted for by receipts sent is P15.577bn (more than US$300m).

But what if the service provider did not issue a receipt? Bayan I-Txt ang Resibo also provides taxpayers an opportunity to report stores/service providers who do not issue official receipts. In the same five-month period, the public reported to the BIR a total of 16,533 establishments/businesses/professionals who were not issuing official receipts.

Source: mGovLab.org

In India, text messaging is going "green" by helping reduce energy waste and bring down electricity bills in the municipality of Kalamassery . The local government is planning to install `smart street-lights' which will allow the municipality to operate street lights through SMS messages from a mobile handset (See Box 6.4).

Africa is not being left behind in the portable messaging revolution and innovation is rife in this area. According to the ITU African Telecommunication Indicators 2004[11], Africa is currently the fastest growing mobile market. A South African company, BlackHatMedia[12] has created South Africa's first SMS directory[13] which offers a quick and easy way of finding business names and phone numbers in South Africa by using SMS. An SMS is sent to a hotlink with the keyword and location (e.g. " plumber in Soweto") and an immediate reply is sent back with a list of matching businesses together with phone numbers. The phone numbers can then be dialed directly from the reply SMS or saved in your phone for future use.

Box 6.4: Text for Power
India saves energy by SMS

Saving energy is just an SMS away. In a bid to reduce energy wastage and bring down mounting electricity bills, the Kalamassery municipality is planning to install `smart street-lights' which will allow the municipality to operate street lights through SMS messages from a mobile handset

ELPRO Energy Divisions, a Bangalore-based private consultant firm specialising in energy saving by reducing wastage has approached the municipality for installing this facility. The project, christened `Prakash Jyothi' is expected to be taken up shortly, Kalamassery municipal chairman Jamal Manakkadan told this website's newspaper.

An SMS sent to the special equipment installed in the street lights will be received by sensors, which will confirm and send back a message as to whether the lights have been turned on or switched off. Another feature of the facility is that it will be possible to dim street lights after 11 p.m. when the streets are deserted and do not require normal voltage. This will bring down the cost and wastage of energy.

Source: New India Press, http://www.newindpress.com/Newsitems.asp?ID=IER20030518130157

6.1.2 Towards the smarter consumer device

Portable devices are rapidly evolving from the mundane devices of yesterday into very sophisticated gadgets with more computer functions such as e-mail, calendars, multimedia messaging, cameras, games, walkie-talkies, video, and music players and more. The computational power of some mobile phones today is comparable if not more than that of some PCs a few years back. "Smart phones" as they are called use a standardized operating system developed by a third party and work seamlessly among various devices. ABI Research[14] estimates that Smartphones and connected PDAs will represent nearly a quarter of all handsets shipped by 2009.

Monitoring health parameters

Innovation is spreading like wildfire and consumers are today being offered a wide array of functionalities with their devices. These devices are empowering people to take issues like their health and well being into their own hands. They are also being personalized in terms of "self-care".The Korean manufacturer LG Electronics is rolling out sophisticated diabetes care phones which monitor the owners' diabetes or obesity any time and anywhere. The phone that is equipped with a microchip, can measure the human body's glucose levels. The company is also planning to commercialize diet phones containing devices which can measure human-body fat and beauty phones which will be incorporated with a massaging function as well as equipment to gauge skin humidity level.

One of the 21st century plagues of our world is obesity, and Japan has reported troubling increases in recent years, Japan's NTT DoCoMo has recently launched the world's first handset to be equipped with a pedometer function. The pedometer is activated wherever the phone is being carried. By setting the user's weight and length of stride, distance walked and calories consumed can be calculated and displayed on screen. The pedometer function is integrated with the handset mailing system. Email messages indicating the amount of walking, and corresponding calorie burn, can automatically be sent to a designated mail address at a preset time everyday. The Japanese mobile phone group Tu-Ka has recently put on sale the world's first mobile phone that enables users to listen to calls inside their heads -- by conducting sound through bone. This type of phone will help consumers who want to hear calls better in busy streets and other noisy places (See Box 6.5).

In the case where consumers may not have a bone phone to help them hear better in noisy places, IBM engineers are proposing a smart switching device which can switch a voice call to silent instant messaging without breaking the flow of the discussion. The new system, which IBM calls Mercury[15], will track the location of the consumer, at work, at home, in the street and plug him into the medium he prefers in that location, whether it be by mobile phone, email, instant messaging, pager or landline phone.

Box 6.5: I'm talking on the bone
Japan's new "bone phone" with sonic speaker

The TS41 handset, manufactured by electronics firm Sanyo, was placed on sale by the Tu-Ka mobile phone group in winter 2003, drawing healthy demand from customers who want to hear calls better in busy streets and other noisy places. The new phone is equipped with a "Sonic Speaker" which transmits sounds through vibrations that move from the skull to the cochlea in the inner ear, instead of relying on the usual method of sound hitting the outer eardrum. With the new handset, the key to better hearing in a noisy situation is to plug your ears to prevent outside noise from drowning out bone-conducted sounds. If the user holds the handset to the top of the head, the back of the head, cheekbone or jaw and plugs his or her left ear, the call will be heard internally on the left side. It is the first time that the bone conduction has been used in mobile phones although the technology has been available for fixed-line phones in Japan, mostly for elderly people, for the past two years.

Source: TU-KA Group

Information while you move

Speaking on a mobile phone whilst driving has become commonplace in most countries. This has engendered a great debate on the risks of talking whilst driving. A study by the British Transport Research Laboratory showed that driving behaviour is impaired more by using a mobile phone than by being over the legal alcohol limit. This has resulted in many countries and states passing laws against the use of mobile phones whilst driving. These laws are encouraging car manufacturers to equip their cars with telematic or hands-free features. Telematics are in-vehicular solutions which enable an automobile to have two-way wireless services used for voice, Internet access or emergency purposes. Telematics range from GPS navigation systems to satellite radio and integrated cell phones. According to a report by the Telematics Research Group, the number of North American car models with wireless devices in the dashboard has doubled since 2001.[16] Today it is possible to access the Internet from your car and download music wherever you are. BMW and Hewlett Packard have every intention to introduce the "portable office" on wheels[17]. They have recently unveiled prototype technology to put a wireless network into a car for executives who need to do business on the move. The wireless LAN hardware is stored in the boot of the BMW 7-Series, to create an 802.11 network running a virtual private network. The network connects to a printer and PC notebook in the back seats that can be folded away into the central armrest when not in use.

There are however many dangers associated with having access to all types of information whilst on the go. It is not difficult to imagine how distracted a driver might be if he has a real-time stock feed in his car and the market is plummeting, dragging down his life savings.

Wi-Fi phones

With the rapid proliferation of Wi-Fi hotspots, it comes as no surprise that Wi-Fi phones seem to be the next big thing. Mobile phone maker Motorola Inc. plans to introduce a device that would seamlessly switch calls from cellular networks to cheaper Wi-Fi networks wherever they're available. Internet-phone company Skype Technologies SA - launched by the creators of the KaZaA music-swapping program - already has introduced software that enables users to make Skype voice calls using their Wi-Fi-enabled Microsoft PocketPC based handheld computer from any Wi-Fi hotspot, though Skype members can only call each other.

Box 6.6: Is it a pen? Is it a phone?
The first ever tri-band mobile phone housed in the unusual shape of a pen.

Siemens prototype PenPhone is incorporated with a laser which tracks movement and a handwriting recognition engine. It lets users write virtual telephone numbers on anything and enter them in that form. Due to the PenPhone's integrated handwriting recognition, SMS messages can be written directly into the mobile phone. The user can talk on the phone by holding it to his head vertically, but in the future it will include Bluetooth, making it possible to use a separate headset.

Source: Siemens

What next?

The next logical step in the evolution of the "smartphone" is to increase the size of the hard drive. The increased storage will make these handsets a viable option for graphics, music and business applications. A report from analyst firm IDC says that the arrival of mobile phones incorporating hard drives will "require a number of further evolutionary steps" before such technology is good for consumers. It warns that cost, size, and power consumption may delay the technology. Today's smartphones may be rich in features and stiff competition is compelling manufacturers to roll out more attention-grabbing phones. The downside however, is that many of these features go unused because users find the devices too difficult to configure.

6.1.3 Commerce on the go

The "portable revolution" is changing the traditional way of doing business and m-commerce is beginning to represent a major revenue-generating stream for many operators. Research by the UK-based Centre for Economic and Business Research (CEBR)[18] found that the mobile industry contributed 22.9 billion pounds (41.6 billion USD) to the United Kingdom's GDP in 2003 (i.e. 2.3% of the country's total GDP). The most popular sources of revenue today are games, SMS, and simple downloads such as ringtones. With more advanced handsets on the market, MMS picture messaging is definitely on course to becoming an equally major revenue generator.

Mobile commerce seems to be used mainly for micro payments today. A micro-payment is defined as a low cost transaction (typically ranging from a few cents up to 10 Euro), for a digital or physical item bought via or downloaded/recorded onto a mobile device and/or its components and paid in a cash equivalent, i.e. a prepaid phone account, stored value account or phone bill.[19]

As payments with portable devices become easier and more secure, they are being embraced by a larger number of people and some countries of the world are rapidly moving towards becoming cashless, mobile information societies.

To today's average Korean, the daily portable device is already an electronic wallet because of the number of financial transactions that can be made with it. Mobile phones on Korean CDMA networks do not use the common GSM SIM card that could be used to store credit card information. Therefore, mobile phone manufacturers, at the request of mobile operators, have built in smart-chip slots on phones that can be used for specialized services. Information from the chips is transmitted in two ways, either via the IR port on the top of the phone or by using radio frequencies. There are more than 470,000 locations in Korea that will accept m-payments[20] (see Box 6.7)

Box 6.7: Paying for everything via mobile phone
How mobile phones may make credit cards a thing of the past in Korea

When Koreans stop in for snacks at the neighbourhood convenience store, they don't need to bring any money with them. All they need is their m-commerce enabled mobile phone. Korean operator SK Telecom's Moneta service has more than 470,000 terminals around the country that will accept payments via RFID chips embedded in mobile phones. Users simply wave their phone in front of the Moneta receiver placed next to the cash register (see image). The purchase is then assigned to the mobile user.

Users can also use their mobile phones to pay for public transit. They simply scan their mobile phone over the receiver and the money is debited from their account. Billing is handled through a joint investment between SK and Visa International. One reason that Moneta has been so successful is Moneta terminals were first installed in another branch of SK's businesses, petrol stations.

Source: *ITU Case Study on Shaping the Mobile Information Society: The Case of Korea*, www.itu.int/futuremobile

Japan is another country which is at the forefront of the m-commerce revolution. Several shopping applications for portable devices are now being offered by different companies. Sony's FeliCa contactless integrated circuit (IC) chip solution and NEC's Lightholder i-appli technology are examples of products available to facilitate portable online shopping and payments. It would seem that the future objective of these companies is to consign traditional leather wallets to the history books. Since summer of 2004 FeliCa is now mandatory on all new DoCoMo mobile phones. NTT DoCoMo has announced the development of the Voucher Trading Service Platform, a new information distribution platform that enables high-speed and secure reservation, purchase, and confirmation of tickets or other values using diverse user devices, e.g., mobile phones and IC cards. The Voucher Trading Service Platform transforms the mobile phones and IC cards that users are accustomed to into the ultimate wallet that combines various settlement and ticket examining functions. The East Japan Railway Company and NTT are developing a new ticket payment system using mobile phones with inbuilt IC Suica cards, called Mobile Suica. Suica is an IC card system for automatic ticket gates. Owners of mobile phones with in-built Suica cards will be able to use their phones for paying train travel by passing the phone near the check-in machines at the automatic ticket gates.

Several banks in both the developed and developing world are offering mobile banking services. The Ogaki Kyoritsu Bank of Japan[21] has gone a step further by allowing customers to withdraw cash and check their balances at some of its automated teller machines (ATMs) without using ATM cards but with cell phones. India's Housing Development Finance Corporation Limited (HDFC) Bank offers SMS and WAP banking[22]. Consumers can now access their bank accounts and conduct a host of other banking transactions and inquiries through their Mobile Banking service. They can check their account balance, stop a cheque payment, and even pay utility bills.

It is interesting to note that mobile banking has never been popular in Western Europe. For a region that has a very high penetration of mobile phones, one would have expected that the next logical step would be to marry financial services and portable devices. According to a report by the research and consulting firm Celent[23], there is little demand for interactive banking services via WAP or i-mode in Western Europe. Some of the problems prompting the lack of demand are technical issues and security concerns with the most significant being the high cost of mobile services. The consulting company IDC believes that the prices that mobile operators charge for data transmittal are still too high to spur mobile banking in some European countries, such as Italy.

6.1.4 The new interactive mass media

The marriage between portable devices and the mass media seems to be a done deal and it is not an exaggeration to call today's portable phones media phones instead of mobile phones. Like with everything else, portable devices are being used to shape the mass media of tomorrow.

Being able to watch television only in a fixed place and on a TV set will soon become a thing of the past. Tomorrow's world will be characterized by "mobile television". Many Asian carriers such as KDDI, NTT DoCoMo and SK Telecom are developing new phones and services which will enable users to view terrestrial and satellite television. SK Telecom, Korea's largest wireless telephony carrier has recently introduced the world's first mobile broadcasting handsets with satellite digital multimedia broadcasting (DMB) services made by LG Electronics. The satellite DMB is a next-generation feature, which enables people to enjoy broadcasting on the move via handheld terminals like mobile phones or personal digital assistants (PDAs). With KDDI's prototype mobile phone, consumers can not only watch terrestrial television, but they can also obtain various types of data linked to the programs, such as audience ratings.

The marriage is not without difficulties. The conflict between the recording industry and mobile carriers over online music is widening as carriers like LG Telecom begin to sell MP3 player-equipped handsets. This new revenue-generating avenue has no regard for copyright laws, which could be a threat not only to the music industry but to the mobile content industry as a whole.

For those who cannot afford the new handsets, and who forgot to program the VCR to record that favorite program, the portable device is transcending to remote control. Opera Software has created a novel software application, Mobile IPG (Interactive Programming Guide), enabling mobile telephones to control when a compatible video or digital recorder would start recording. Viewers can now record their TV programs from their mobile phones.

Portable messaging is opening up new channels of communication across the media and creative industries. These industries seem to have quickly grasped the important benefits of integrating portable messaging to their programs. Today, viewers can not only watch or record their favorite programs on the go, they also have the possibility to interact with these programs through portable messaging. In Finland, viewers can interact with avatars (animated characters) on live TV in a virtual nightclub. (See Box 6.8). Television networks are making it possible for viewers to have a say on how the storyline should be written through portable messaging. The plot of UK soap opera InYrShoes is not being written by scriptwriters as is traditionally the case, but by viewers using text messaging. At the end of each show which, like most soap operas, ends with a dilemma, viewers decide how characters might react to a dilemma and text or phone in to offer a solution.

Reality TV is definitely not lagging behind. Owners of Sprint PCS Vision phones can view the interactive form of the first Internet Soap, "The Spot", on their handsets. Sprint's new version of "The Spot" will be the first time original content of this sort has been made available for wireless phones in the United States. Radio stations are using MMS to track what their listeners are doing whilst listening to the radio. The UK radio station Galaxy[24] encourages listeners to snap and send in photos of themselves and their friends doing weird and wonderful things. The funniest pictures will then be published on Galaxy's website for all listeners to see. The use of interactive MMS opens great doors of opportunity for stations and advertisers to achieve richer communication with listeners. Texting is emerging as a driving force behind radio as for any given radio show, listeners can send their opinions, vote or request special songs.

Box 6.8: SMS and chat shows

Text your avatar in Finland

Finnish viewers can now interact with avatars on a live TV chat show in a virtual nightclub called "Flame". In the TV program Double Life 2, the viewer creates his avatar by sending a text message during the show. After that he can personalise his avatar online with over ten million personalisation options. The avatar receives instructions to interact and chat with other avatars through SMS. What makes Double Life 2 different from any SMS-TV product is the live camera. The director of the show can choose where the best action is and take the "camera crew" right there with zooms and close ups of the avatar participants. The amount of SMS traffic generated depends on the actions of the director during the virtual show.

Source: 160characters at http://www.160characters.org/news.php?action=view&nid=1073

Television networks are not the only ones taking advantage of the ubiquity of the personal device. Music companies and bands are doing likewise with the first band in Europe "SUPER SMART" releasing a complete album "Panda Babies" only as polyphonic mobile phone ringtones with integrated voices and instruments. Direct sales via SMS help to reduce the music to the marginal cost of 1.99 Euro. The Malaysian rock band "Search" is also selling its next album as well as VCDs and previous discs by SMS. The downside of this system is that it takes 5-7 days to receive the CD and there does not seem to be a possibility of listening to the music before the purchase.

Without a doubt, the portable revolution has deeply affected and shaped society as we know it today. With no end to innovation in this area, it is not an exaggeration to say that in a few years to come, the days of not owning a portable device will be so distant in our minds that it will be unthinkable to conduct our daily activities without it.

6.2 Science fiction or fact?

This section explores some of the newest technologies transforming the portable Internet, and those that may re-invent it in the future. Though some of what is described below may seem far-fetched, the line between science fiction and fact is rapidly blurring.

6.2.1 An Internet of things

Human beings are more often connected to a network than not, through personal computers at work or home, and through mobile phones. But what if not only *people*, but all *things* were also connected and contactable? Far from science fiction, the day is fast approaching when every consumer product (from cars to razors) will be tracked using tiny radio transmitters, or tagged with embedded hyperlinks. Such "smart labels" will ultimately transform the way that products are distributed, sold and purchased, creating what some have aptly named an "Internet of things". This section describes two important developments in this area: RFID (radio frequency identification tags) and two-dimensional codes.

Tagged and ready-to-go

RFID tags are essentially tiny microchips, some only 1/3 of a millimetre in diameter, that act as transponders (transmitters/responders), continuously waiting for radio signals to be sent by transceivers, or specially-designed RFID readers. When a transponder receives a certain radio query, it responds by transmitting a unique ID code. Most RFID tags are passive tags, that is to say that they are not powered by batteries. The most important functionality of RFID tags is the ability to track the location of the tagged item. RFID tags can cost as little as 0.50 US cents and the prices are dropping. Some analysts say that RFID will soon replace the familiar bar code in the retail world. In Tokyo, RFID tags are being used to track and price plates of sushi[25]. They have also been applied to retail shopping in the trendy Roppongi Hills area of Tokyo. The trial of NTT DoCoMo's "R-click" service began on 1 November 2003. The R-Click service delivers information specific to a user's location using RFID tags. DoCoMo has issued about 4'500 RFID tags embedded in small handheld terminals. Over 200 stores are participating in the trial. Subscribers can inform the network that they wish to be located by pushing a button, but the default setting is off. The small, handheld device then enables users to receive a wide variety of area information as they walk around the new metropolitan cultural complex of shops, restaurants, entertainment facilities, residences and hotels. The use of RFID has also spread to nightclubs and marathons (See Boxes 6.9 and 6.10).

In the United States, the Department of Transportation's Federal Highway Administration is currently exploring the use of RFID for roadways. The Administration plans to use RFID as a way to warn drivers of possible dangers, e.g. imminent intersection collisions or vehicle rollovers. More specifically, the government and technology vendors are investigating a technology called "dedicated short-range communications", which is related to RFID. A prototype system is expected to be ready for testing near the end of 2005. The Federal Communications Commission (FCC) has allocated frequencies from 5.850 to 5.925 GHz for such products.

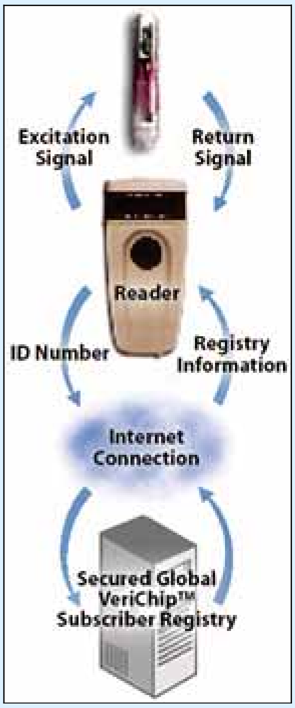
Box 6.9: Clubbers get "chipped"

RFID has its privileges

The Baja Beach Club in Barcelona recently introduced RFID chips for their VIP patrons. An RFID implant (VeriChip™), injected via syringe, allows club-goers to breeze past readers that recognize them and their VIP status. The chip contains information about access permissions, thereby opening exclusive areas of the club. The chip also stores information regarding credit balances - the "chipped" VIPs can therefore purchase drinks and food by simply waving their hand. About the size of a grain of rice, each Verichip RFID device contains a unique verification number, which can be used to access a database with personal information.

VeriChip works in the following manner. Once implanted just under the skin (typically in the upper arm), the chip can be scanned when necessary with a Verichip™ RFID scanner. A small amount of radio frequency energy passes from the scanner, energizing the dormant chip, which then emits a radio frequency signal. The signal transmits the individual's unique personal verification ID number and provides instant access to the Global Subscriber Registry. This is done via secure, password-protected Internet access. Once they are confirmed in the registry, VIP benefits are granted.

The VerichipTM



The Process

Baja Beach Club ad

Source: Baja Beach Club at http://www.baja-beachclub.com/bajaes/ and Verichip at http://www.4verichip.com

Box 6.10: Running frequency ID tags
RFID tracks participants in marathons

Marathon organizers in cities such as Boston, London, New York, Berlin, Los Angeles, and Capetown are bringing high-tech communications to participants as they run through their course.

All of the official entrants in the 2004 Boston Marathon, for instance, were issued what's known as "ChampionChip", a small token that is either tied onto the runner's shoe or attached to a wheelchair. These chips time the runners at various points throughout the race, including the starting line. As a runner crosses stationary mats located throughout the race, his/her time is recorded. The chips contain Radio Frequency Identification Tags (RFID) that transmit the runner's time at the checkpoints to databases operated by the Boston Athletic Association and its technology partners (Hewlett-Packard and Verizon Wireless).

Some 33,000 runners competed in the London marathon on 18 April. Participants could have their positions tracked and recorded by electronic tags attached their shoes. Friends and family of competitors were able to follow their progress by signing up to an SMS text message service that will send athletes' positions as they make their way around the course. Special mats were positioned every 5km along the marathon course. When an athlete ran over the mat, their time and position was sent to an Oracle database. Running over special mats with receivers would send a message to those who signed up to receive the alerts.

Ready, Tagged, Go: 2004 London Marathon

Source: "Boston Marathon gets wired", PC World, 16 April 2004 at http://www.pcworld.com/news/article/0,aid,115719,00.asp. See also the "Champion Chip" website at http://www.championchip.com/

Portable information: The evolution of the bar code

For the past many years, black and white bar codes have been used to tag a wide range of consumer items, thereby facilitating retail and distribution channels. Each of these bar codes contains a unique serial number, which provides a key to a database of detailed information, notably the product's checkout price. More recently, there has been a demand for transforming this simple bar code into a "portable information database", rather than a mere database key with limited information.

A number of terms are being used to describe this new class of keyless data entry "symbologies": two-dimensional code or 2-D code is the most generic. 2-D codes can encode information along the height as well as the length of the symbol (X and Y axes), and are therefore capable of holding a much higher volume of information[26]. There are two types of 2-D codes, stack and matrix, with the latter proving to be the most useful. The most common types are the 'data matrix' code, becoming a standard across Europe and the US, and the 'QR' code being used in Japan. DataMatrix is a two-dimensional barcode that can store up to about 2,000 characters. The symbol is square and can range from 0.001 inch per side up to 14 inches per side. Similarly, the QR code allows for the fast reading of large amounts of alphanumeric data: it can contain up to 7'366 characters of numeric data and 1'888 Japanese characters. QR codes are currently being used by NTT DoCoMo (See Box 6.11). They can be read by code scanners or digital cameras now standard on a number of mobile phones.

The Semacode system, developed in Canada, is another recent example of mobile phones linking to URLs. Semacodes are in fact standard URLs in the form of 2-D “data matrix” codes. The semacode website transforms text URLs into Semacodes. Downloadable readers for camera phones can then translate these Semacodes into URLs and load them into the phone’s browser. The big advantage is the Semacode is an open system to bridge the physical and virtual worlds. The quality of digital cameras on mobile phones (e.g. focus, resolution, illumination) needs to be improved before such a technology can take off.

The potential applications of hyperlinked 2-D codes are many. They can be included on any physical object, to provide additional information. For instance, in Amsterdam, in May 2004, the art group “Etoy” issued Semacoded uniforms to 500 children participating in a day care project. A quick scan of a child’s uniform with a camera phone would link to the child’s web page with real-time information. Other possibilities include codes on business cards that would link to constantly updated contact information, exhibits at museums tagged for information in multiple languages, and tagging inventoried goods[27].

Box 6.11 Japan's portable mobile response
“Quick Response”(QR) two-dimensional codes in Japan

Japan’s NTT DoCoMo has already released two mobile phone models with embedded 2-D (QR) code readers, namely the Fujitsu 505i series and the Sharp 505i series.

In order to read the QR code, a mobile phone requires a digital camera and the appropriate software. As of 2004, all of NTT DoCoMo’s mobile phones will be equipped to read QR codes. Codes will begin appearing on all kinds of products, such as newspapers, artwork, business cards, retail goods, food items and so on.

By reading the code with their mobile phone, users will be able to download additional information about the product. In the early days, only text will be made available, that is to say that the 2-D codes will be static and off-line. But dynamic on-line 2-D codes will be soon be available, embedding hyperlinks and multimedia content. This is likely to further transform the way in which Japanese people use their mobile phones. There are currently 500’000 terminals with the appropriate software and camera capability in circulation in Japan, and NTT DoCoMo estimates that the development of a mass market for 2-D codes is not far off.

The quick response code

Source: NTT DoCoMo. See also *Japan's Ubiquitous Mobile Information Society,* INFO, Vol.6 No.4, September 2004 (forthcoming) and http://www.itu.int/osg/spu/ni/futuremobile/general/casestudies/japan.html/.

6.2.2 Measuring the metrics

Biometrics generally refers to the study and use of measurable biological characteristics. In this context, it relates to authentication techniques that can identify individual users, such as fingerprints, hand, speech or iris recognition. In the future, devices such as computers, electronic locks, and mobile phones may include such techniques, in order to determine a user’s level of access and permissions.

Biometric systems have existed for some time, but are fairly expensive to deploy. Since the United States terrorist attacks of 11 September 2001, however, cost has been less of a deterrent, and funds have been channelled towards this technology which was previously regarded as too costly to develop. There is a move towards the “de-criminalizing” of fingerprints and using this method as a way to ensure both individual and national security. The United States government, for instance, now requires all foreigners entering on visas to have their hands and faces digitally scanned. On a global scale, the International Civil Aviation Organization (ICAO) is currently finalizing specifications and laying the groundwork for the widespread use of biometric passports. The organization has already decided that facial recognition is to be the standard biometric identifier, with the option for individual countries to add fingerprints or iris scans. They are also contemplating the use of radio frequency identification tags (RFID) as the standard method for storing and transmitting information. The hope is biometrics will help fight terrorism and fake passports. Human rights advocates are concerned that biometric passports will facilitate global surveillance and lead to a number of different biometric databases, including some run by states with dubious human rights records. In the early days, due to the availability of databases, fingerprints will be the natural biometric measure, and have already been imbedded in new models of mobile phones in Japan (See Box 6.12). Hand scanning is being used by the tourism business for entry and ticketing, such as amusement parks (Box 6.13). Parents taking their children to Legoland theme parks can benefit from this technology to keep track of their children: children entering the parks are fitted with an RFID bracelet that can be tracked anywhere within its boundaries and, if required, parents can be alerted to their child's location via SMS[28]. Current biometric techniques are fairly limited, and may not raise significant privacy concerns in the short-term. In fact, the ability to track the location of mobile phone users (without RFID) will be a much more serious concern. However, in the longer-term, biometrics will begin to threaten human privacy in a fundamental way. If not controlled, they will find their way into every aspect of our lives, and individual choice may have little to do with its use or misuse.

Box 6.12: The first "biometric" handset
Let your fingers do the talking

In July 2003, Japan's Fujitsu released world's first biometric-enabled phone for DoCoMo mobile subscribers, the F505i, which boasts a personal identification system based on a fingerprint sensor. Although it is a 2nd generation handset, running over a slower data network, it has proved to be the most popular phone that Fujitsu has made: 100'000 units were sold in the first week and 700'000 in the firs 75 days.

The fingerprint sensor on the F505i at the base of the phone (see below). Subscribers can use the sensor lock and unlock the device, protect data stored on the device, and as a password for access to email or calendar functions. By using different fingers, it can also be used as a speed dialler. It is also being used in a mobile game, which features a puppy that users can pet with their fingertip. NTT DoCoMo no doubt plans to expand the uses of the fingerprint sensor to applications such as mobile commerce, thereby turning the mobile phone into a personal portable digital wallet.

Source: Shaping the Future Mobile Information Society – The case of Japan, ITU, 2004
at http://www.itu.int/osg/spu/ni/futuremobile/general/casestudies/japan.html/

Box 6.13: Scan this

Hand recognition systems in operation in US theme parks

Hand scanning has taken the place of photo identification for season-pass holders at Busch Gardens and Water Country USA. The new system allows pass holders to enter the park more quickly and securely. It eliminates long line-ups for photo IDs and prevents fraud.

The park's "HandEScan" device measures the top of a person's hand, taking in finger height, knuckle shape and distance between the hand's joints. It takes two separate images and then combines the photos to create a 3-D image. The information is then stored in an internal database, and matched to each person's season-pass bar code upon entry to the park.

Though park officials claim that the new system does not raise any privacy issues, some sceptical about storing their "hand prints" with Busch Gardens. One season-pass holder admitted "It's hard to believe that this isn't like fingerprinting...I wouldn't want my fingerprints in a big Busch Gardens file."

Source: MSNBC, 12 April 2004

6.2.3 Wearable wonders and smart fashion

Hi-tech on the runway

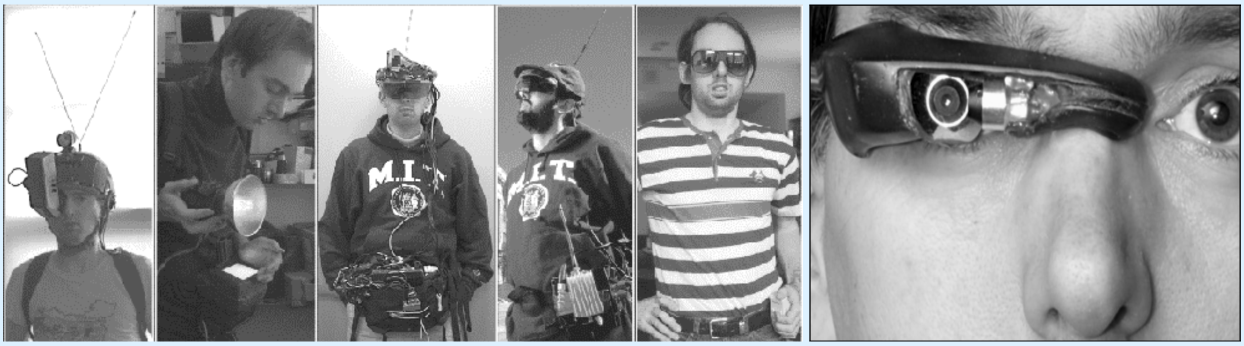
At the annual 2004 "3GSM World Congress" in Cannes (France)[29], one of the mobile industry's largest commercial events, participants were entertained not only by a trade show and conference, but were for the first time exposed to high-tech fashion-show. "Cool and Connected, the Wearable Technology Fashion show"[30] proved that technology is well on its way to becoming an integral part of everyday fashion. Although wearable technology (particularly computing) has been talked about for the last decade or so, very little of it has made it to market. But the overwhelming penetration of portable IT devices has not gone unnoticed by the fashion industry. With the advent of the portable digital assistant and more importantly, the mobile phone, it is no longer uncommon to see backpacks, vests and sweaters with specialized high-tech compartments or pockets being sold in retail stores. Even dresses and skirts are being designed to include the world in your pocket. In this respect, the present emphasis is on flexible "personal connectivity", rather than the physical merging of human bodies and technological devices. The mobile phone is already portable enough, and fashion need only adapt to its increasingly pervasive nature. For instance, bluetooth-enabled gear in the form of colourful wireless earpieces is being used by a number of trend-conscious mobile phone users. Manufacturers, such as Nokia and Motorola, are now recognizing the potential of technology as a fashion statement.

True wearable computing, nonetheless, is not far off, albeit still in the making. Many credit Steve Mann[31] of the University of Toronto (Canada) with inventing the first wearable computer ("WearComp") in the 1970s, thereby sowing the seed for the creation of the Wearable Computing Project at the Massachusetts Institute of Technology (MIT)[32]. The MIT project defines wearable computing as follows:

> "Wearable computing hopes to shatter this myth of how a computer should be used. A person's computer should be worn, much as eyeglasses or clothing are worn, and interact with the user based on the context of the situation. With heads-up displays, unobtrusive input devices, personal wireless local area networks, and a host of other context sensing and communication tools, the wearable computer can act as an intelligent assistant, whether it be through a Remembrance Agent, augmented reality, or intellectual collectives".

Box 6.14 sets out images of the wearable computer and its evolution from the 1980s to this decade. Analysts predict that personal wireless services (building on today's mobile phone) will be at the foundation of future wearable technology.

Box 6.14: Generation Cyborg?
The evolution of the wearable computer



1980s *Mid 1980s* *Early 1990s* *Mid 1990s* *Late 1990s* *Early 2000s*

Mid-2000s

The trendy sunglasses above, part of Motorola's Offspring Wearable Prototypes, contain a tiny digital camera lens (which peeks out from a pinhole opening above the right lens) as well as a miniature display inside the left lens for reading e-mail or looking up information on the Internet. An earpiece for a mobile phone is available from the side of the glasses. This wearable wireless system from Motorola includes a two-way-radio watch, a PDA and other add-ons. The glasses will be available in 2006.

Source: Professor Steve Mann (University of Toronto, previously at Massachusetts Institute of Technology), Motorola

Stuff gets smart

Over the last many decades, human beings have been learning how to develop specialized materials that can respond to changing conditions. In other words, not only are our devices, such as PDAs and mobile phones, getting "smarter", but so can the clothes we wear, the containers we use and the houses we build.

Generally, there are three different kinds of smart materials:

- 'Passive' smart materials that respond directly and uniformly to stimuli without any signal processing
- 'Active' smart materials that can, with a remote controller, sense a signal, and then determine to respond in a particular way, and;
- 'Autonomous' smart materials that carry internal, fully integrated controllers, sensors and actuators.

Smart materials are currently being used for a growing range of applications, such as noise and vibration suppression (e.g. noise-cancelling headphones), strain sensing (e.g. seismic monitoring of bridges and buildings), and sensors/actuators. Over the next ten to twenty years, however, the biggest opportunity lies in the synergies between wireless technologies and smart materials. The use of wireless technology will enable remote analysis and control of a wide range of sensors, in real-time. Many applications will be developed for the biomedical, military and space fields, but research and development will not be limited to these areas. Imagine a jacket that can determine the outdoor temperature and humidity and adjust accordingly. Or smart bricks that can gauge a school's temperature, vibration and movement (Box 6.15). Once these smart materials become seamlessly integrated into a ubiquitous wireless environment, they will start to challenge our basic assumptions about what is "living" and what is not[33].

Box 6.15: Build me a smart home

Smart bricks could monitor the health of buildings and save lives

A "smart brick" has been developed by scientists at the Center for Nanoscale Science and Technology at University of Illinois at Urbana-Champaign, funded by the National Science Foundation. The prototype brick combines sensor fusion, signal processing, wireless technology and basic construction material. As such, it can analyse and transmit building status information to a remote operator.

Smart Brick Team member, Professor Chang Liu

The brick is embedded with wireless technology and can communicate in real-time with operators. Potential applications include the monitoring of nurseries, daycares and senior homes. In the future, new "smart toys" could respond to a child's touch, and allow gamers to engage "physically" in their games with wireless body-sensors.

Source: University of Illinois (Urbana-Champaign)

6.2.4 The five human senses and beyond

Portable voice, text, and Internet browsing services typically use two of the human senses: sight and sound. But what of the others? Many will argue that we already have a very tactile relationship with our mobile phones. The overwhelming popularity of texting as a mode of communication has meant that the touch and feel of a mobile phone is just as important as its appearance. It is not surprising, therefore, that scientists are working on mechanisms to add the sense of touch to electronic communication. In the mobile world, a way to read text messages by touch has been developed by researchers at the University of Bonn in Germany. Their system would allow users to perceive text messages as " tactile melodies" [34] (See Box 6.16).

To the sense of touch, researchers are now looking to incorporate the sense of smell.. For instance, the UK Internet service provider *Telewest Broadband* is testing a "scent dome" which can generate up to sixty different smells over the Internet. About the size of a teapot, the device releases particles from one or more of twenty liquid-filled odour capsules, in accordance with codes included in an email communication or web page. In this way, the website of holiday-makers, grocery stores and cosmetic companies can be significantly enhanced. For consumers to benefit, they will have to pay about 250 pounds (452 USD) for the dome[35]. Not far behind the sense of smell is the sense of taste, and scientists have also been working together with food companies to develop a device that can mimic the taste and "feel" of food in the mouth. Dubbed "the last frontier of virtual reality", the food simulator is now being tested at the University of Tsukuba in Japan[36]. A future where restaurants can send sensual "bytes" of their food offerings to the portable devices of passers-by may not be so far off.

Box 6.16: Text and Feel
Use your fingertips to read text messages

Researchers at the University of Bonn in Germany have developed a mobile phone that can allow a user to read text messages simply by feeling them. The phone comes with tiny arrays embedded with moving pins that rise and fall under a user's fingertips The system can recognise circles, lines, squares, and letters such as V. However, the intention is not to transmit individual letters, but rather fixed expressions or sentiment. The user might be able to select and generate different tactile patterns/melodies for different situations, e.g. " I will be home in an hour" or " I love you".

The technology can also have a number of different applications. For instance, such arrays could be into steering wheels or control handles and provide drivers or pilots with information on routing or dangerous curves. Medical engineering applications might include reproducing sounds for the deaf. In the meantime, the portable electronic communications space is being transformed with the sense of touch at a distance.

Working prototype was displayed at the trade show CEBIT 2004

Source: BBC News, 22 April 2004

Sense technologies will also serve to enhance the experience of gamers, particularly those engaging in "virtual world" experiences. Virtual lives, complete with bank accounts, lovers and gifts, are becoming more and more common online. "Second life" and "FunHI", for instance, are fantasy worlds in which players can meet other players during various social or adopted professional activities, and buy each other gifts with virtual cash. Some of the more avid players have spent a large amount of real money buying items in fantasy worlds, thereby enriching the pockets of the content provider. The portable Internet means that players can adopt these virtual characters and lives anytime and anywhere. The limits of the virtual world will be tested even further as players exercise their sense of smell, touch and taste online.

But scientists and technology innovators are not stopping at the five human senses. Some are exploring the potential of brainwaves for wireless communications, and the development of brain computer interfaces (BCI), which would eliminate the need for humans to touch a keyboard or manually interact with their communications device. At the MIT Media Lab, for instance, bluetooth technology and Wi-Fi are being used to enable direct communication between a human brain and a digital character on screen (Box 6.17). Early applications of this technology will most likely be in the bio-medical sphere, namely in rehabilitation and physiotherapy. The long-term potential of these technologies is vast and limited only by human imagination.

6.3 Conclusion

This chapter has described cutting-edge services and applications on the market, and the wider potential of the "portable Internet" revolution. In the future, portable Internet technologies will continue to enhance information access and further expand the relationship we have with technology and technical devices. With machines playing an increasingly important role in our daily lives, the human aspect cannot be overlooked and must play an integral role in both public policy and product design. The next chapter discusses the human factor, and the impact of an evolving information environment on society and socialization.

Box 6.17: The wireless wave and brain computer interaction
How the MIT Media Lab uses brainwave control with bluetooth

The MindGames group at the MIT Media Lab Europe is now working on non-invasive and real-time analysis of human brainwaves. Their first trial is called "Mind Balance", a game in which a participant helps an animated creature of a virtual world known as the "Mawg" (right image), to keep his balance on a tightrope. This task must be accomplished without any joystick, mouse, or camera. Rather, it uses Cerebus (left image), an experimental brain computer interface (BCI) in the form of a cap that measures signals from the back of the participant's head (more specifically those emanating from the occipital lobes). The signals are very weak, in the order of microvolts, and are transmitted via Bluetooth to the virtual world. A Wi-Fi network is used between that virtual world computer and the signal-processing computer.

Ten years from now, devices like Cerebus will be much less cumbersome and could be built into baseball caps or fashion accessories. The constant availability of wireless communication networks (between machines and between machines and humans) could enable the remote control of a number of different appliances and devices via brainwaves. With a response time of under one second, humans will enjoy yet another degree of freedom. Society, however, will have to ensure that information relating to brainwaves is placed squarely and the securely in the hands of the users concerned.

Source: MIT Media Lab Europe. See the web site of the lead software architect, Robert Burke, at http://www.mle.ie/~rob/mindbalance/index.html for more information.

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1 See http://www.chinadaily.com.cn/english/doc/2004-04/16/content_324043.htm

2 See http://www.text.it/mediacentre/default.asp?intPageId=664

3 See http://www.ertico.com

4 See http://www.itweb.co.za/sections/telecoms/2004/0404221029.asp?S=Cellular&A=CEL&O=FRGN

5 See http://www.dodgeball.com/social/index.php

6 See http://www.internethomealliance.com

7 See http://www.internethomealliance.com/press_room/press_releases/docs/MealtimePilotPressRelease%2Edoc

8 See http://edition.cnn.com/2004/TECH/ptech/02/04/cellphone.spam.reut/

9 See http://www.mgovlab.org/modules.php?op=modload&name=News&file=article&sid=27&mode=thread&order=0&thold=0

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[11] See http://www.itu.int/ITU-D/ict/publications/africa/2004/

[12] See http://www.blackhatmedia.com

[13] See http://www.wirelessdevnet.com/news/2003/nov/14/news1.html

[14] See http://www.abiresearch.com/abiprdisplay2.jsp?pressid=261

[15] See http://www.newscientist.com/news/news.jsp?id=ns99994640

[16] See http://www.telematicsresearch.com/PDFs/TMpress042104.pdf

[17] See http://vnunet.com/News/1154973

[18] See http://www.160characters.org/documents/CEBR.pdf

[19] See http://www.gsmworld.com/technology/applications/mpay_whitepaper.shtml

[20] *Welcome to e-Korea*, Korea Agency for Digital Opportunity and Promotion, page 38.

[21] See http://www.okb.co.jp

[22] See http://www.hdfcbank.com/ri/RI-EAGE-MobileBanking-intro.htm

[23] See http://www.celent.com/PressReleases/20031023/MobileEurope.htm

[24] See http://www.galaxy105.co.uk

[25] Pintokona has introduced RFID tags to track and price their plates of sushi that are presented on a rotating belt. The system facilitates the calculation of the bill, as each tag contains information such as price, sushi type, chef, time stamp and other types of information. And as it can track the precise time when the sushi is placed on the plates, once a thirty-minute period has expired, the sushi is automatically removed from the rotating belt, in order to ensure that only the freshest pieces are made available to patrons. See http://2.pro.tok2.com/~higashi-nagasaki/anti/pintokona.html for pictures and text (Japanese only). See also http://urawa.cool.ne.jp/vfsarah/kaiten2_pinto.html

[26] For example, all human alphabets are two-dimensional codes.

[27] "Camera phones Link World to Web", Wired News, 18 May 2004, http://www.wired.com/news/technology/0,1282,63493,00.html?tw=wn_tophead_2

[28] "RFID on kids makes Legoland safer" , 24 June 2004, Silicon.com at http://www.silicon.com/research/specialreports/protectingid/0,3800002220,39121670,00.htm

[29] See http://www.3gsmworldcongress.com/congress/

[30] See http://www.3gsmworldcongress.com/fashion/

[31] See http://wearcam.org/

[32] See http://www.media.mit.edu/wearables/

[33] Institute for the Future, "Emerging Technologies Outlook Program".

[34] "Fingertips ' read' text messages", BBC News, 22 April 2004, http://news.bbc.co.uk/2/hi/technology/3649093.stm

[35] "Smelly device would liven up web browsing", New Scientist, 20 February 2004

[36] "Virtual reality conquers sense of taste", New Scientist, 31 July 2003

7 CHAPTER SEVEN: THE INFORMATION SOCIETY AND THE HUMAN FACTOR

Technology does not exist in a vacuum. Alongside its development lie important human drivers and human consequences. The ubiquity of access to information and communication has had an undeniable and profound effect on human existence. But this is only the beginning. As innovations continue to cater to an ever-increasing user appetite for information and entertainment on the go, technology will pervade every aspect of human existence.

This chapter looks at the impact of the portable Internet on the society of tomorrow, and the influence that the it is having on our daily lives.

7.1 A day in the life: Scenarios for the future

The portable Internet will revolutionize the day-to-day lives of ordinary people living in the developed world, but even more so in those developing countries that seem to be leapfrogging developments at a phenomenal pace.

This section takes a peek into the future of our "portable world". It sets out four scenarios depicting a day in the life of two citizens in the industrialized world and two citizens in the developing world in 2020.

7.1.1 2020 in the industrialized world

A day in the life of Tom

Tom is an engineer working for the marketing department of a manufacturing company. His day normally starts with his ritual morning coffee after which he hangs his company badge around his neck. This is just as important as putting on his contact lenses every morning. His badge has an RFID chip which contains important information on his tasks and daily activities. He consults the data on his badge through his contact lens which acts as a virtual screen. This comes in very handy when he is away from his office and needs to rapidly check some information.

As Tom enters the company gates, he taps his cell phone against a special pad on the gate to identify himself. The reader authenticates his phone and the door swings open. Today is a busy day for him. He has to travel to two of the company's plants situated on the south bank of the city to meet with clients. Rather than choosing the virtual conferencing system, Tom has decided to opt for a physical meeting this time. This means crossing the lake that divides the city and traffic always moves at a snail's pace on the bridge. In spite of the traffic, Tom prefers to drive since his car comes equipped with the latest information systems, which allow him to connect to the office server. As he approaches his car, he presses the key button on his mobile phone and his car door is automatically unlocked. When he takes his seat behind the wheel, the car seat, which is fitted with biometric sensors, detects important personal information such as his fingerprints, body mass etc. With this information, it checks whether he has permission to drive the car and displays a code on the virtual screen of the dashboard. Tom has to key in this code to start the car.

Once in the car, he connects to the Internet to check his e-mails and uses a text-to-speech software which reads out the messages to him so he can concentrate on driving. He notes down an important appointment with a client at 15h00. He is now in the thick of heavy traffic and he decides to maximize the time by doing some work. Because he still has to concentrate on driving, he prefers to use a brain computer interface (BCI) which enables him to control his computer remotely with brainwaves. He puts on his special baseball cap which is fitted with BCI and begins to surf the company intranet for information about the machines which need to be fixed. He notes that one of them does not have a complete service history and thinks this could be the reason for the breakdown. His hands are free to drive and he browses the different pages using his brainwaves.

He finally arrives at the first plant and he has all the information he needs to get the job done. This cuts down the amount of time he spends fixing the machine, given that he need not stop each time he comes across a difficulty. By 14h00, he has finished his work at both plants, and is ready for his 15h00 appointment. He keys in the address of his client on his mobile phone and quickly receives detailed instructions of how to arrive at his location.

At 17h00, Tom's hectic day is over and he begins the long drive home. His trip is made much easier thanks to his in-vehicular portable Internet, which provides five minute updates on the best route to take given the changing traffic patterns. It is very hot today, so he contacts the air conditioner in his home via his mobile phone, setting it to the perfect temperature. He is expecting guests tonight and sends a message to the oven in his kitchen to start baking the duck that he left marinating in the morning. He also sends a message to his entertainment "teatro" unit to select and play the latest jazz-fusion tracks. He relaxes and drives home listening to streaming music online from his favourite digital radio station.

A day in the life of Mako

Mako, a young mother of 30 years lives in a surburb of Tokyo and commutes to work every morning by high-speed train. Like everyone else, she is a "*keitai*" (Japanese term for mobile phone) user and is heavily dependent on it to organise her day and her life.

She normally drops her 3-year-old daughter Akiko at kindergarten before rushing off to catch her train. Her daughter owns a "kiddy *keitai*" and presses on a specially programmed red button anytime she wants to make a video call to her mother. Mako also sends her video messages during the class break to let her know what time she will be picking her up. The classroom is fitted with a special CCTV, which parents can connect to via any portable device to check on their children through video display. Mako decides to do that during her train ride and sees her daughter painting a cat and spilling red paint all over her new shoes.

Mako has a doctor's appointment in the afternoon and as usual, she has to send her doctor some important information to prepare her for the appointment and also to reduce the time of the visit. She is lucky to find a seat on the train this morning so she sits down and takes out her *keitai* which also serves as her portable health consultant. She is diabetic and has to check her sugar levels daily. Using the sensors on her *keitai,* she receives a full report on her pulse rate, blood pressure, temperature and glucose levels. The *keitai* automatically sends all the details to her doctor who returns a message acknowledging receipt. The transmission is effected over a secure channel, thereby maintaining Mako's privacy.

Her train finally arrives at her destination and she rushes off to work. At 15h00 she goes for her doctor's appointment, which is very short as the doctor has already received the necessary information and was able to adjust her medication without delay.

Mako rushes to pick Akiko up from kindergarten and on her way, she quickly logs in to the computer of her home robot through her *keitai.* She gives it several instructions to clean the living room, run the bath and to bake the fish in the oven. She then connects to the CCTV in her daughter's classroom and sees that it is story-telling time. She'll arrive just at the end of the story - perfect timing.

When they finally arrive home, a beeping signals that her telecommunications bill is available for viewing on her *keitai.* She almost gets a shock when she sees the monthly total. It now amounts to nearly a third of her salary. This is because she uses her *keitai* for everything: to manage her home, her finances, her health, her social life and her daughter's education. She is so heavily dependent on it that she realises that her life cannot function without it.

She reflects on her *keitai* "dependency syndrome" and concludes that it may be costing her but it is definitely worth it. She cannot imagine for a minute what life would be without her precious keitai.

7.1.2 2020 in the developing world

A day in the life of Kwaku Ananse

Kwaku Ananse, an illiterate cocoa farmer, lives in the once powerful and wealthy kingdom of Ashanti land. As he turns over in his bed at the crack of dawn, he contemplates the very busy day that lies ahead of him. His life seems to have changed radically since the introduction of new wireless technologies in his village.

His day begins with checking the latest cocoa prices via the Internet (using a text to speech conversion programme) at the local Farmers Union office. This has been made possible by the introduction of WiMAX technologies by Ashanti Telecom, which has brought connectivity to this once remote village in Ashanti. The

Farmers' Union office is now a very busy place in the mornings. Farmers receive cocoa prices in real time thus eliminating cheating middlemen who took advantage of illiterate farmers in time past. With their wireless "Simputers", they are able to sell their cocoa beans over the Internet directly to the Cocoa Buying Agency, eliminating fraud and smuggling practices that were very common before the introduction of Internet trading.

Kwaku Ananse, after checking the current prices, heads for his farm where he has been told of a strange disease attacking his cocoa pods. He is meeting his friend Ntikuma who has bought one of the new camera phones with VoIP being offered at discount prices to members of the Farmers' Union. Ntikuma takes pictures of the sick pods and transmits the images to the database of the Cocoa Processing Board in the capital. Within minutes, Ntikuma gets an answer telling him which insecticides his friend needs to fight the disease. This process, now reduced to a few minutes, would previously have taken a week, if not more, as it would have involved an inspector coming from the capital. Mr. Ananse leaves instructions to his workers to get the insecticide and rushes off for his doctor's appointment at the Community Health Centre.

He has been suffering from severe stomach cramps and was told by the village doctor that he needed to see a specialist. In the past, he would have had to travel 500km to the capital but with the new practice of tele-medicine, (thanks to cheap wireless technologies such as WiMAX) he will be examined by a specialist via the Internet, right here in his village. The village doctor sets up the connection and the specialist appears on the screen. He reads the results of Ananse's tests, which were sent to him by email. The specialist talks at length both with Ananse and the local doctor. He gives instructions to the local doctor on how to examine Ananse as he watches on the screen. After further discussions with the village doctor, he makes his diagnoses and dictates a prescription for Ananse. In no time Kweku Ananse is out of the Health Centre, medication in hand.

It is now 3 o'clock in the afternoon and he has two more tasks to accomplish before calling it a day. He is off to buy one of these new camera phones, like the one his friend Ntikuma has. Why is he so excited? It's because his son Kwame who lives in the capital is getting married. Kwame wants to send the short video of his beautiful fiancée to his father via multi-media messaging. Since the introduction of VoIP in mobile phones, communication is so cheap that keeping in touch with his son is getting easier. In times past, Kwame would have had to come to the village to introduce his fiancée but today, he only needs to send her picture over the phone and get his father to speak to her. Kwame then sends his father the amount of the dowry by SMS. His father feels it is too high and sends an SMS to his in-laws negotiating the price. Text messages are sent back and forth until both parties agree on the dowry. They set the wedding date for the last Saturday of the month.

Kwaku Ananse walks home after his busy day. During the evening meal, his grandson begins to tell him of how e-learning has been introduced in the village school. After his meal, Kwaku Ananse smokes his pipe and reflects on his day. He makes several observations as he admires the picture of his future daughter in law on his mobile phone. Since the introduction of new wireless technologies, there have been many economic and social benefits to the inhabitants of Ashanti. A lot of wealth has been created in the village as farmers are now able sell their goods faster at decent market-based prices. Health services have greatly improved in the village through the introduction of tele-medicine and villagers now have access to the qualified specialists in the capital. He communicates more with his children who have all moved to the bigger cities to seek greener pastures. He does a little calculation and concludes that all the tasks that he has accomplished in one day, such as seeing the specialist, getting the right insecticide for his plants etc., would probably have taken him a month without all the new technologies available!

A day in the life of Deepa Patel

Deepa Patel, a 25 year old software engineer, works in India's booming tech sector. Her job takes up almost all her time and she has very little time to socialise. Deepa has to leave home at 6 am every morning for work, if she is to beat the early morning traffic. A journey that would normally take 20 minutes, takes her two hours if she sets off too late, and she cannot afford to be tardy. Deepa has many things on her mind this morning and one of them is marriage. Her parents are thinking of an arranged marriage as is common in Indian tradition. She however wants to use the online matrimonial agency where her friend Gupta found true love. As she drives her Indian-made Maruti in the teeming traffic, she takes out her mobile phone and logs into their mobile portal. She notices that the traffic is barely moving and so she quickly registers her profile.

She gets an SMS telling her that her request is being processed and she will be receiving profiles of "suitable life partners" in a few minutes. The traffic is crawling and with her air conditioning having broken down, Deepa is beginning to feel the effects of the hot early morning sun. All of a sudden she hears the familiar beep of an incoming MMS. She receives three pictures of suitable partners with accompanying short video messages of their profiles. One is a software engineer, the other a medical doctor and the third has two business degrees (MBAs) and a doctorate. Deepa is very excited and suddenly forgets about the sweltering heat and terrible pollution outside. Sanjay, the one with two business degrees, is really handsome, loves cricket and is a fan of Bollywood's most loved actor, Hrithik Roshan. Could this be the one? She quickly sends an SMS back to the agency saying she is interested in meeting Sanjay. Unfortunately, she has arrived at the office and has to shelve her matchmaking activities until her lunch break.

At her desk, she suddenly remembers that she forgot to program the DVD-RW to record the cricket test match between India and Pakistan. Her father, who is away on business, specifically requested that she record all the matches. Like most Indians, he is a great fan of cricket! She whips out her mobile phone and using the Mobile Interactive Programming Guide (IPG), she looks up the television schedule and finds out that the match started a couple of minutes ago. She presses the record button to activate her DVD-RW at home. Whew, she has just avoided the wrath of her father!

During lunch, her friend Chandra tells her of the premiere of the latest Bollywood film, *Kaho Naa Pyaar Hai II*. *Kaho Naa Pyaar Hai I* was voted best film when it was released and critics say, the second part is even better. They need tickets and decide to use the mobile ticketing service. They text "Film" to 333 and receive a ticket reference number. To print out their tickets, they rush down to the cyber café in the shopping mall down the road to use the mobile printing service. As they enter the mall, Deepa turns off her Bluetooth-enabled phone. She has opted-in to receive promotional alerts on her phone from several shops in the mall. Her bluetooth-enabled phone automatically receives commercials and coupons when she is within a 15-metre radius from any of the shops. She does not feel like being bombarded with information on the latest reductions on lingerie today but as she turns her phone off, she realises that she will not be able to activate her "party-chat" where she enters into anonymous flirtatious chats with strangers. It is fun sending anonymous text messages to unknown passers-by, especially when she is on the train. One of them even proposed marriage to her whilst another discovered her identity and stalked her for weeks until a judge issued a court order. For a few rupees, Chandra connects her mobile phone to a portable printer and prints out the tickets.

Chandra is getting married in a week and tells Deepa all about the making of her wedding sari. She is using smart fabrics, or intelligent clothing. The fabric for her sari is being interlaced with electronics and special dyes. The idea is that, instead of having to change her clothing during the ceremony, the fabric, which can be controlled by any wireless device such as a mobile phone, laptop or PDA, will change colours in a programmed sequence, thus giving her a new look at different intervals.

As Deepa drives home at 20h00, she notices that the city is ablaze with light. There are huge screens on every corner projecting the most amazing colours. It is the beginning of the Diwali festival (festival of lights), one of the important and celebrated Indian festivals. Thousands of lamps are normally lit to create a world of fantasy. For this year's festival, you can select your lights on a website or on your mobile phone and send an SMS to have them projected on one of the many big screens around the city. Deepa logs on to the site through her mobile phone. As she chooses her lights, she makes a wish: to be married to Sanjay at next year's Diwali festival. All of a sudden, the familiar beep of an incoming MMS resounds. Sanjay's face pops up on the screen with a text underneath saying "When can we meet?"

7.2 Societal implications of a portable world

7.2.1 The digital persona

With the spread of "anywhere, anytime" communication infrastructures, comes increased convenience, better access to information and streamlined business processes. The capacity of current and future technologies to enter the private sphere of human lives, however, is correspondingly increased. Always-on connectivity, portability and mobility will define not only the future technological landscape, but equally the socio-political one.

It has been remarked by many that the expanded or enhanced social networks afforded by portable cellular phones has created a new sense of identity for various groups of people, especially teenagers. At the same time, the highly personalized nature of the mobile phone has meant that its form and use have become important aspects of the individuality of a user. The personalized and pervasive use of communications technologies is leading to the construction of a "digital persona" with which we humans now navigate the world.

Our sense of "belonging", for instance, is shifting with the increased use of these devices. The sense of belonging to a *place* is slowly giving way to a sense of belonging to a communication network: "those emotional elements that are lost in the relation with space are transferred to a social level, that is loyalty, the sense of identification, familiarity, stability, security, and so on".[1] Mobile phones and portable communications devices allow users to construct their own "at-home" environment regardless of where they find themselves in physical space. With the fixed-line phone, an incoming call rings at a place, no matter which person is being called. With the mobile, a person is being called regardless of place. The home or the office, therefore, is no longer the portal to the person – the person becomes the portal.[2]

Indeed, never before has a technical device become such an important aspect of human lives, and a determinant so powerful of individual identity. Users are getting closer and closer to their mobile phone and at all times of the day. A large number of people use their mobile phones as their alarm clock and sleep with their phone under their pillow or on their bedside table. The Japanese have recently released a mobile phone that enables users to listen to calls inside their heads, by conducting sound through bone[3]. The mobile phone has indeed become the most intimate aspect of a user's personal sphere of objects (e.g. keys, wallet, money etc…). It gives users the impression that they are constantly connected to the world outside, and therefore less alone. Both physical and emotional attachment to mobile handsets is on the rise. For many users, the thought of having their mobile phone privileges revoked can cause indignation and even protest[4]. Not surprisingly, the Universal Mobile Telecommunications System (UMTS) Forum concluded in its 2003 paper *Social Shaping of UMTS*, that users have a more "emotional" relationship with their mobile phones than with any other form of information and communication technology.[5] Mobile users often use "emoticons" (or diagrammatic representations of emotional states such as a smiley face) in communications with each other. The use of "smiley faces" and the like to express feelings through text is notably higher in mobile messaging than in email. In Japan, this is known as the "face letter" or "kao moji", and mobile users have a staggering array of face letters to choose from. With the advent of the portable Internet, this intimate relationship with technology will only intensify.

The mobile phone is already somewhat of a status symbol. Some mobile users engage in "stage phoning"[6] or speaking loudly on their mobiles in order to be heard and seen (regardless of whether or not they are on an actual call). Many young people show off their mobile phones to each other - their social status is even enhanced by the brand and type of phone, the ringing tones they use, as well as the number/quality of messages stored on their phones. The extent and nature of the personalization of the telephone is now essential to individual identity, to one's digital self.

The effect of mobile phones on cultural and political identity cannot be overlooked. In his book *Smart Mobs*, Howard Rheingold describes "thumb tribes" and "the power of the mobile many". In this context, he explores the power of masses engaged in the furtive exchange of SMS messages. He cites a group of mobile phone users in Stockholm, for instance, who exchange SMS messages while on the public transport system in order to avoid fines for ticket-less riding. Mobile phones have also served to flatten traditional hierarchical structures and enhance the accessibility to political institutions, allowing individuals to vote or to lodge complaints with authorities directly. Some governments, such as that of Hungary, have conducted SMS elections, following the lead of popular TV shows, e.g. "Pop Idol", the television series that originated in North America. Others are considering both e-voting and m-voting for future campaigns. Since March 2002, mobile users in the world's largest mobile market, China, can directly send SMS messages to the 2'987 deputies of the National People's Congress. The new service lets people test the bounds of a new freedom of expression in China, where politically charged jokes have begun to spread like wildfire from the Internet to mobile phones.

The use of mobile has the potential to facilitate assemblies of unrelated people at a moment's notice (see Box 7.1) In the past, these assemblies would take a significant amount of time to orchestrate, and information about them could spread to third parties, including authorities before they were to be held. This may increase the rapidity of political change and open up varying paths of political development, but at the same time raises concerns relating to social order in some countries.

Box 7.1: Flash Mobs
A new form of social assembly

The first flash mob occurred in June 2003, in the carpet section of Macy's department store in Manhattan, when 200 "flash mobsters" expressed their desire for a 15'000 USD love rug for their homes. Since then, due to the use of email and the instantaneous medium of mobile messaging, this phenomenon has spread across the globe, to Asia, South America, Europe etc…

Flashmobs UK defines a flash mob as "a large group of people who gather in a usually predetermined location, perform *some* brief action, and then quickly disperse". Over 200 odd flash mobs have occurred worldwide since June 2003.

The *principle* is simple. Anyone can organize a flash mob and anyone can participate. The first step is to find a website such as www.flashmobs.co.uk and join a flash mob group. Mobsters can broadcast messages about a flash mob they wish to organize, or simply wait to hear about the next event. Typically, events are scheduled no more than a few days in advance, the objective being maximizing surprise and fun, in minimum time. The gatherings are peaceful and usually centre on a theme. Last minute details are almost always broadcast by SMS.

Source: www.flashmobs.co.uk; The Age, Australia, September 2003, http://www.theage.com.au/articles/2003/09/01/1062403447291.html

7.2.2 Public and private

The "technological intimacy" users have with their mobile phones means that they carry and use the device wherever they go, in a wide variety of social and professional settings. Indeed, the mobile has equalized the opportunities for communication between the moving and the non-moving person: in the past, those in physical proximity of a fixed-line telephone had an added advantage. The use of mobiles has also made it easier for shy or reserved people to communicate, and SMS has been a big hit with the deaf community. The mobile phone has furthermore decentralized our networks of communication. Communication no longer occurs only from a fixed point to another fixed point: a multitude of different points can now communicate with a multitude of moving or still targets.

The overwhelming presence of mobile communications in everyday life has led to a blurring of boundaries between the public and the private spheres of life. Public places are now commonly "colonized" by the private lives of mobile users. There has been a corresponding extension of one's physical space, through the creation and juxtaposition of one's "social" mobile space. This has led to a constant "permeability" between the separate contexts of social life[7]. For instance, individuals have often been observed talking on the phone at a restaurant table, while their dining partner either looks elsewhere or is similarly engaged talking or texting on their own mobile device. The intrusion (or potential intrusion) of remote others, in any given social context, has become commonplace, and even anticipated.

Although in some countries (e.g. Japan[8]), there have been efforts to regulate mobile phone usage in public, (e.g. through restrictions on use in restaurants and public transport), the effect of the mobile phone on the public and private spheres has not yet led to the establishment of any clear social norms. Two areas of complaint stand out:

1. *Voice over mobile*: many mobile users tend to speak on their mobiles about very private issues, and more loudly at that, resulting in forced eavesdropping;
2. *Simultaneity of place*: the complexity of managing two sets of social contexts at the same time.[9]

In addition, while admitting to an overall increase in spontaneous and widespread social interaction, some argue that mobile phones may be reducing the quality of face-to-face social interaction. And the ambiguity regarding the social norms that mobile users are to follow in public or group settings seems to further dilute this quality.

Many people now choose to text rather than talk with their mobile phone, depending on the social situation they find themselves in. Students sitting in classrooms, or in their room at bedtime, prefer to text. In meetings, many prefer to text in order not to disturb the proceedings. With texting of course, users can continue to engage in conversation with those co-present, while communicating with a distant third party. In Europe and North America, loud ringing tones and mobile conversations are commonplace. On the other hand, in Japanese restaurants and trains, people send mobile e-mail and rarely engage in telephone conversations; in public, many cover their mouths while speaking on their mobile. Restaurants and public transport authorities have erected signs urging mobile users to put their handset in “manner mode”, or silent mode.

It is clear that we have not had sufficient time, as a society, to adapt to this new technology, notably its overwhelmingly pervasive nature. However, patterns of behaviour are already becoming evident. The initiatives mentioned above represent a means to manage the potential embarrassment surrounding the public audibility of private conversations[10], or in other words “forced eavesdropping”. It is an attempt to respect privacy (of oneself and others) in a public setting, or to create a private environment within a public one. An unanswered mobile phone is frowned upon, as are long intimate mobile conversations in public settings. Many who answer phone calls in meetings or quiet areas are subject to glances of admonition by others. It is no wonder that technology jamming mobile phones has begun appearing on the market, and is in use in some movie theatres and places of worship.

The case of the camera phone

Another important problem arises with camera phones. The first camera phone was launched by J-Phone in Japan in October 2000. Since then, the number of camera phones has skyrocketed. According to a report by the ARC Group, more than 55 million customers worldwide owned mobile handsets with digital cameras by the end of 2003, compared to 25 million sold in 2002.[11] Many predict that the digital camera will become a standard feature of mobile phones. The quality of digital images captured by camera phones has also been substantially enhanced, from the original 110K pixel cameras to the recent release of 4-megapixel mobile camera phones in Japan and Korea[12].

With camera phones, users can snap pictures of famous sites and celebrities but also of things or people they find beautiful or funny, strange occurrences, or everyday events. The portability and discreet nature of camera phones means that pictures can be taken quickly and unbeknownst to the photographed. For this reason, camera phones are being banned by various companies around the world, because they are seen as a threat to either corporate security or the privacy of clients. The Saudi Arabian government has outlawed camera phones throughout the country. Even Korean handset manufacturer Samsung has banned camera phones from their factory.

Similarly concerned, mobile manufacturers are taking steps to ensure that mobile users respect the privacy of others. In one of the most advance mobile markets, Japan, all camera phones must emit an audible sound when a picture is taken - a self-regulatory effort on the part of manufacturers and operators. Following suit, the Republic of Korea has ordered manufacturers to ensure that all new handsets emit a beep (of at least 65 decibels) whenever a picture is taken.[13] The Government was pushed into action after a number of incidents, including one case in which a woman used her camera phone to snap a naked woman in a popular sauna bath, and then sold the picture to a website.

It is possible that technology can provide a solution – technology such as Iceberg’s “Safe Haven”, which can control the use of camera phones in selected areas. Safe Haven works by sending a signal to a camera phone telling it that it is in a designated privacy zone, and switching off the phone’s imaging system[14]. The phone can still be used to make calls. This is a nascent technology and therefore will only work for future generations of phones, but its existence, and the existence of mobile phone jamming technologies, shows the growing concern among public and private actors alike over the use of mobile phones in public places.

As the 2003 UMTS report "Social Shaping" concluded, "the intersection of the public and the private will reach a peak, after which there will be a resistance or backlash".[15] We have already begun to witness its early signs.

7.2.3 Towards responsible communication

Not only has the use of mobiles in public settings been a common object of discussion and observation by sociologists and users alike, the possible adverse effect of mobiles on the quality of communication and on individual responsibility has also been noted.

Let us consider, for instance, the survey conducted in September 2003 by mobile phone giant Nokia. This survey found that a staggering 89 per cent of mobile users believe that people need to adopt better 'mobile etiquette', for example the use of ringing and messaging tones that do not disturb others around them, and by not shouting and pacing while on the phone. In the United States, a similar survey by Harris Interactive in July 2003 found that 50 per cent of Americans believe that people are generally discourteous in their use mobile phones.

According to the results of the Nokia survey:

- 71 per cent of users are now consistently late for social events because of the option to rearrange through a mobile voice call or text;
- Almost 70 per cent admitted that they often cancel at the last minute by sending a text message;
- 78 per cent admitted to ducking out of uncomfortable or awkward social situations by sending a text message rather than calling.

Many argue that mobile phones have served to change social etiquette. For example, people seem to be less willing to commit. The "approxi-meeting"[16] is now standard practice: mobile phone users rarely set an exact time and place for a meeting, the excuse being that details could always be worked out later by SMS. The habit of "keeping options open" or the "multi-meeting" has also been enhanced by the use of mobile phones, i.e. users often make several approximate and tentative appointments, deciding only at the last minute the meeting they would attend (depending on the value they ascribe to it). On the other hand, it can be postulated that mobile phones have given users more responsibility and have facilitated accountability, e.g. between children and parents or employees and employers.

Although the quantity of communication has increased through the anywhere and anytime functionality of the mobile, the qualitative aspect of communication may not have been correspondingly improved. Furtive text messaging, for instance, can often give an illusion of strong communication, whereas it is a medium which clearly lacks some of the principal elements of human interaction, e.g. tone of voice, body language, facial expression and touch. Some sociologists argue that texting teenagers run the risk of affecting their capacity to interact with each other on a voice or face-to-face basis: many choose to text rather than to talk, particularly in awkward or emotionally-charged situations.

In another context, owning a mobile might seem to assuage an increasingly lonely urban existence. But is a virtual connection to anyone at anytime a real panacea to human isolation? The rise of spontaneous communication, for instance through trends such as multi-player location-based gaming and "bluejacking" (see Box 7.2) may provide an outlet for passing the time, but does not necessarily strengthen existing relationships. Moreover, the quality of face-to-face communications may be threatened by the always-on nature of mobile phones. Interaction with those that are co-present can be interrupted at any moment by interaction with a remote other.

It has been said that mobile phones tend to weaken *communities* (e.g. families or pre-determined static groups) while at the same time strengthening *networks* (i.e. decentralized and constantly evolving social groupings constructed by each individual).[17]

7.2.4 Human health and security

In less than a decade, stand-alone, single function black and white mobile handsets are giving way to new feature-rich colour models. With increased use of this technology comes increased public concern regarding their safety.

Are mobile phones safe: Looking for a link

Concern about the possibility of mobile phone's ill effects on health took shape in mid-1992 in a United States court. A lawsuit filed in the state of Florida by a certain David Reynard alleged that the use of a cell phone had caused his wife's fatal brain cancer. A Federal court dismissed the suit in 1995 for lack of valid scientific evidence, and similar suits since have been no more successful. However, they have raised questions for which no entirely satisfactory answers existed at the time they were filed. Driven in part by these disturbing allegations, a new wave of research is exploring possible links between cell phone radiation and cancer. Brain cancer is not the only health concern, but it currently dominates public discussion.

Box 7.2: Blue me up, Jack!
Coming soon from a stranger near you

A new fad has sprung up among mobile phone users. Named "bluejacking", it involves sending short anonymous text messages to other mobile phones, not via SMS, but through "bluetooth", a form of short-range radio technology. The technology works up to a range of 10 metres, and users with bluetooth-enabled phones are able to search for other phones in their vicinity that are similarly enabled to accept messages. There are a number of websites (such as www.bluejackers.co.uk) that provide information about this form of mobile texting, including bluejacking etiquette and how to get a date through bluejacking.

A November 2003 article in the International Herald Tribune describes one encounter: "A lanky young woman with long brown hair was waiting to take a train at London's Waterloo Station, when she got a surprising message on her mobile phone from a complete stranger. "I like your pink stripy top". The woman, who looked around in confusion had just been "bluejacked" by a 13-year old British girl named Ellie who goes by the nickname jellyellie".

Bluejacking works by sending a contact from one mobile device to the other via bluetooth. The bluejacker creates a new contact card and that contact card becomes the message. Bluejacking is free, and is an entirely unregulated form of communication. Though communicating in this way with strangers could get you a laugh or a date, it could also make life easy for marketeers looking for a way to send unsolicited messaging, raise a number of privacy concerns, and increase the possibilities for annoyance or even sexual harassment. But at the moment, the fad is a new one. And so far, it is being used for harmless spontaneous human communication, and not only by teenagers seeking a thrill.

Source: Bluejackers.co.uk, and various news sources, including "*New mobile messaging craze spreads*", BBC News, 4 November 2003, http://news.bbc.co.uk/1/hi/technology/3237755.stm and "*A new way to say 'Hello it's me*", International Herald Tribune, 17 November 2003, http://www.iht.com/articles/117854.html

The term "safe" brims with legal, regulatory, and ethical implications. Health agencies on the whole shy away from pronouncing technologies safe, but instead evaluate evidence for possible hazards. The World Health Organisation (WHO) issues mobile phone radiation health advice: - use short calls and hands-free devices, even though there is no definite evidence of health risk.

In contrast, mobile phone manufacturers must prove, not that their products are safe, but that they meet exposure limits a different matter entirely. The standards that set limits on exposure to energy from phones were developed largely on the basis of whole-body exposure data and engineering considerations.

Mobile phones are designed to transmit radio waves in all directions because base stations could be in any direction with respect to phone users. This means that a proportion of the radio waves they produce are directed towards the user's body. The radio waves are mainly radiated from the antenna of a mobile phone, although leakage onto the phone body shell does occur. The radio waves that are directed towards the head of the phone user penetrate into the body tissues for a few centimetres and tend to be absorbed. In being absorbed, they give up their energy to the tissues and this adds to the energy being produced by the body's metabolism. Up to a point, the body is able to accommodate extra energy being absorbed in its tissues, but beyond this point, temperature rises or thermoregulatory responses can occur. The quantity that is used to describe absorption of radio waves in the human head is the Specific Absorption Rate (SAR) of the energy. Until recently, there was no clear consensus over the best way to measure the SAR produced by a mobile phone. It was, however, advised that the SAR should not exceed 2 W kg^{-1} (watts per kilogram) when averaged over any 10 grams of contiguous tissue and over any 6-minute period in the head.

Identifying links between cancer and environmental exposure of any kind is surprisingly difficult because of the absence of a single cause of cancer and for a variety of other reasons. Even if mobile phones had no connection to cancer, thousands of users would develop brain cancer every year, given the hundreds of millions of mobile phone users around the world and given existing background rates of brain cancer. Pinpointing the direct effect of cell phones in this context requires carefully designed studies.

Whatever the outcome of the latest generation of studies, debate over the health effects of mobile phones will continue. Mobile phones will join other forms of electrical technology, such as police radar sets, computer display terminals, and power lines, that have triggered public fears because of their electromagnetic fields. Such issues are very difficult and time-consuming to resolve. How to respond appropriately to public fears, identifying any real hazard while avoiding unproductive controversy, is not a purely scientific matter but a question with deep social aspects.

Telemedicine

The advent of modern communication technology has unleashed a new wave of opportunities and threats to the delivery of health services. Telemedicine, a broad umbrella term for delivery of medical care at distance, has reached around the world, extending the reach of health professionals and health care. More precisely, telemedicine uses communications technology to connect doctors, patients, medical staff, emergency medical technicians and paramedics, who may be separated by a few hundred metres or a few thousand kilometres, as a means of sharing knowledge, performing diagnostic procedures, and even providing treatment. Collaboration between telecommunication operators and health care providers might guarantee a promising future for telemedicine, particularly for those with no current easy access to medical institutions or specialists.

When implemented effectively, telemedicine may allow developing countries to catch up with their industrialized neighbours in terms successful health care delivery. Local practitioners can provide adequate medical advice to their patients, who may no longer need to travel from small communities to large better-equipped urban centres. Moreover, using telemedicine facilities, trainees from countries like the United Kingdom, Canada, and the United States, may be able to gain experience in Bangladesh, Guatemala, or Nepal while continuing to pursue their learning objectives with mentors from their home institutions.

Phones that care for their owners

A mobile phone usually has just one unique user who keeps the handset within reach throughout the day. Highly sophisticated cellular phones are also starting to care for their owners by warning them of their health problems or by keeping them safe in the event of an emergency (Box 7.3). Mobile phones are considered the best medicine in some cases: they can help people suffering eating disorders or help them to give up smoking.

Box 7.3: Keeping healthy with the mobile Internet
Health body i-mode service

Healthy Body is an official i-mode (NTT DoCoMo) site that Roche developed in Japan as a new business venture within the concept of being healthy, cheerful and happy. Accessible via mobile phones in Japan, this site provides subscribers with a wide range of information content including health, news, diet recommendations, and advice on stress management and dietary supplements, plus much more.

The new service consists of sections, including:

1. SE-RE-BU-BO-BI: celebrities' healthcare profile.
2. Walking Assistant: pedometer application designed for mobile phones
3. Calorie Controller: calculates appropriate calorie intake and recommends a daily menu list
4. Personal Clinic: automatic analysis of current body & mind balance

Source: Roche Diagnostics at http://www.roche-diagnostics.com/press_lounge/press_releases/archive/2003_07_22.html

Innovative phones are being developed, equipped with a microchip that can measure the human body's glucose level, thereby keeping handset owners (e.g. diabetics) informed of their status. Such high-feature phones would also be able to send relevant data to the treating physician. This would enable patients to consult doctors and receive prescriptions without having to visit a medical facility. Diet phones and beauty phones are already on the market, in countries such as Japan and Korea. Such phones can, *inter alia,* keep track of calorie intake and ovulation periods. Future devices will also be able to gauge human body fat and skin humidity levels.

Portable Security

Mobile phones are able to protect their owners in times of trouble, in an emergency situation it can be difficult for a mobile phone caller to explain where he is and where an accident has occurred. Callers can panic and fail to supply the information that the emergency service urgently requires. For example, phones may be developed with security features, e.g. after the simple push of an emergency button in a dangerous situation, a photo can be sent to three designated persons along with location information. Both the United States and the European Union are working on initiatives to require certain levels of location accuracy from mobile operators (see Box 7.4).

For example, the London Ambulance Service became the first emergency service in the UK to be able to pinpoint the location of 999 emergency calls from a mobile phone[18]. It can now deploy vehicles far more quickly. Moreover, using photo messaging to relay photographs from the scene of an accident direct to the hospital can supply extra indications for doctors.

Box 7.4: Where are you - Mobiles to the rescue!
Access to emergency services

The mobile phones of today have already proved very useful for rescue operations, for instance in the case of avalanches or earthquakes, or simply when they are not able to make an outgoing call. Location-based technologies will further enhance the accuracy of information related to the location of a user.

In the United States the implementation of location technology for mobile phones has been greatly accelerated by the Enhanced 911 (e911) initiative, which requires all new handsets to be capable of automatic location identification, to precise accuracy requirements. The European Union is also promoting a similar service called the e112.

While the potential benefits of tailored mobile location technologies for emergency services are not in dispute, particularly after the events of September 11, 2001, such applications do raise complex civil liberty issues.

Source: http://www.fcc.gov/911/enhanced/ and http://europa.eu.int/comm/environment/civil/prote/112/112_en.htm

Mobile phones that can take pictures are becoming a more common way for victims and other witnesses to help police capture criminals. Since the phones are portable and always connected, it takes only a moment to photograph the face or license plate of an individual that might be committing a crime. This means that users have a form of crime-fighting device with them at all times. The crime-fighting aspects of cell phones are not limited to photos. Wireless companies might offer phones for law enforcement agencies, for remote access to a national criminal database, including mug shots of suspects.

Moreover, the data kept in mobile phones (e.g. call records and text messages) have helped police to solve cases apparently unresolved, thereby helping to solve cases such as those involving disappearing persons. Recently, mobile phones have been used as key evidence in criminal trials, and in this respect, have been referred to as the "new fingerprints".

7.2.5 Youth and technology

Being connected on the move, whether to other humans or to specific content, is crucial in today's world. In this respect, the youth market is an extremely technology-savvy one, a segment of society that has been active in transforming the application and use of portable digital technologies in unprecedented ways[19]. The average owner's age has been decreasing faster than ever, especially in countries like Japan where toddlers as young as three years old may own a mobile phone.

Moreover, a sense of security has become constructed around mobile devices, which youth in general have begun to perceive as a lifeline of sorts to their parents and friends. Parents feel the necessity to buy mobile phones for a "false sense of security" just to keep track of their children and in the case of emergencies.

Using everything from instant messaging on the Internet to text messaging on private mobile phones, teenagers have found more ways than ever to use technology to maintain their peer group status. They are also using mobile phones to assert their independence. Today, parents have less knowledge about their children's phone calls and social grouping. Particularly, after the advent of 3G mobile phones[20], with built-in cameras and Internet access, parents are becoming increasingly concerned about their children's safety, given the potential for youngsters to be exposed to pornography, gambling sites and other unsuitable content.

For teens in particular, portable devices are an integral part of their daily lives[21] and an extension of their personal identity as they customize them to suit their needs. They are more comfortable with using the mobile phone and playing with digital gadgets than their older counterparts. Savvy customers, they like their portable devices to be compact and well-designed. The mobile phone is a status symbol for young people who are grappling with the forces of peer pressure and conformity (Box 7.5). A key fashion accessory of the day, mobile phones now come with brightly coloured covers and all sorts of accessories. In Japan, mobile users personalize their phone with stickers and colourful beaded accessories. Fashionable wallpaper and screensavers are regularly downloaded to enhance the look of mobiles. "Designer mobiles" have also appeared on the market, with everything from imbedded precious stones to leather or fur covers for every occasion and mood. The mobile phones of young trend-setters have moved beyond the merely " functional" to the emotional, social and political[22]. An understanding of how young people use portable technology, and how old they are when they first adopt it, is a likely indicator of the probability of adult ownership in the future, and as such, of market potential[23].

7.3 Conclusion

Every new technical development requires a certain period of adjustment during which businesses and individuals come to terms with the opportunities and challenges that accompany it. Portable Internet technologies are likely to be very significant in both developing and developed economies alike, and will certainly shake up the current telecommunication landscape. The ensuing economic and regulatory impacts cannot be ignored. Operators (both fixed and mobile) will have to rethink their business models and governments will have to re-evaluate regulatory priorities. The proliferation of wireless technologies, portable voice and Internet devices, tagged consumer items, and the ensuing expansion of virtual worlds will require some time to get used to. In this respect, the current "transition" period is vital and may be best approached with cautious optimism.

Of course, many positive developments are brought about by the new technologies discussed above: increased convenience and security, advances in education and medical science, enhanced entertainment and better access for all. However, there are some areas of continued concern, notably the protection of minors, the effect on human health and the preservation of privacy. Furthermore, society as a whole should not allow technology alone to shape its social norms – it must strike a balance between technology and humanity. After all, we are human first and foremost, and the machines we create, use and wear, should be at our service and not in command. In this context, we should take the necessary steps to steer as far away from the apocalyptic scenarios depicted in Isaac Asimov's "I, Robot"[24] or Hollywood's "The Matrix"[25], in which humans lose control of the machines they build. Rather, we should bear in mind the more promising narratives of "Star Trek"[26], and boldly strive to humanize the technologies we create and depend on.

Box 7.5: Too mobile - too much?
Mobile phones as the new teen addiction

The number of young people using mobile telephones has risen dramatically during the past decade, and is expected to further increase at a rapid rate. The use of mobile phones by young people is typically higher and more varied than adults. The youth of today believe in the anytime, anyplace, anywhere mobile culture. For instance, they are seen constantly checking for, and writing new text messages. Indeed, mobile phones are more than just a fad for teenagers, and some argue that there is a tendency for "technology addiction" in this context. Some psychiatrists have gone so far as to say that addiction to mobile phones could be a form of obsessive-compulsive disorder among the young, which may become one of the biggest non-drug addictions of the 21st century.

Mobile phone addiction can have the effect of isolating users (i.e. from face-to-face contact) and has the potential to ruin them (or rather their parents) financially. Symptoms include: becoming disturbed when unable to communicate uninterrupted with their mobile phone and irritable if away from it for any period of time.

Mobile phone usage among the young not only increases the opportunity to bond with friends and to organize a social life on the move, it also provides a symbol for acceptance. This is important to a teenager's individuality and confidence. Therefore, teenagers that are struggling with their identity and social status are particularly vulnerable to this addiction syndrome.

Experts and parents are concerned that adolescents have wide access to portable technologies, but little advice on how to use them properly. Ramifications of this lack of awareness are yet to be fully appreciated.

Source: "*Mobile phones becoming a major addiction*", SMH.com.au, 10 December 2003 at
http://www.smh.com.au/articles/2003/12/10/1070732250532.html?from=storyrhs&oneclick=true

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[1] "The Mobile Phone: New Social Categories and Relations", Leopoldina Fortunati, University of Trieste, 2000.

[2] "Physical Place and CyberPlace: The Rise of Personalized Networking", Barry Wellman, University of Toronto, February 2001.

[3] If the user holds the handset to the top of the head, the back of the head, cheekbone or jaw and plugs his or her left ear with a finger for instance, the call will be heard internally on the left side. See "Japanese bone phone developed", Australian IT News, 22 January 2004, http://australianit.news.com.au/articles/0,7204,8460112^15841^^nbv^,00.html

[4] Many are afraid to leave home without it, and feel uncomfortable when others peruse their mobile menus or messages. In a 2003 UK survey, 46 per cent of mobile phone users described the loss of their mobile as a form of "bereavement". See "Mobilisation: the growing public interest in mobile technology", O2 and Demos, James Harkin, June 2003.

[5] "Social Shaping of UMTS: Preparing the 3G Customer", Report 26, UMTS Forum.

6 "On the mobile", on behalf of Motorola, Sadie Plant, 2000.

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11 "Camera-Phone Market Set to Double", 3g.co.uk, 19 August 2003.

12 See "Camera Phone to Erode 40% of Digital Camera Market", Korea Times, 21 July 2004, http://times.hankooki.com/lpage/tech/200407/kt2004072117425811790.htm

13 "Korea: Beeping Prevents Peeping", Wired News, 12 November 2003, http://www.wired.com/news/technology/0,1282,61197,00.html

14 See "Coming soon: Safe Zones that disable picture phones", The Register, 11 September 2003, http://www.theregister.co.uk/content/68/32784.html

15 "Social Shaping of UMTS: Preparing the 3G Customer", Report 26, UMTS Forum.

16 "On the mobile", on behalf of Motorola, Sadie Plant, 2000.

17 "Sociology of the Mobile Phone", Hans Geser, University of Zurich, August 2002. "The Network Community: An Introduction to Networks in the Global Village", Barry Wellman, 1999. "Physical Space and Cyber place: The Rise of Personalized Networking", Barry Wellmann, 2001.

18 See "London Ambulance Service locates calls from mobiles", 26 February 2004, http://www.informatics.nhs.uk/cgi-bin/item.cgi?id=546

19 See ITU, "Mobile phones and youth: A look at the U.S. student market", February 2004, available at http://www.itu.int/osg/spu/ni/futuremobile/

20 "Parents worried about 3G phones",6 May 2004, The Register at http://www.theregister.co.uk/2004/05/06/nch_3g_worries/

21 "In Italy, a 'love to talk' feeds cell phone bonanza", 28 April 2003, IHT at http://www.iht.com/articles/94596.html

22 ITU, "Social and human considerations for a more mobile world", Background Paper, March 2004, available at http://www.itu.int/osg/spu/ni/futuremobile/SocialconsiderationsBP.pdf

23 See ITU, "Mobile phones and youth: A look at the U.S. student market", February 2004, available at http://fpweb/osg/spu/ni/futuremobile/YouthPaper.pdf. See also "Youth drives India's mobile phone revolution", 5 April 2004, BBC News at http://news.bbc.co.uk/2/hi/business/3585257.stm

24 Isaac Asimov (1920-1992), a Russian-born American author and biochemist, was a highly successful and prolific writer best known for his works of science fiction. Hollywood has made his short stories entitled "I, Robot" into a film in 2004 – see http://www.irobotmovie.com/

25 See http://whatisthematrix.warnerbros.com/

26 See http://www.startrek.com/startrek/view/index.html

International Telecommunication Union

The Portable Internet

Statistical Annex

September 2004

International
Telecommunication
Union

TABLE OF CONTENTS

INTRODUCTION

Data are presented for 206 economies with populations greater than 40'000 and where sufficient data are available.

Economies are grouped by United States dollar (US$) income levels in 2002:

Gross National Income (GNI) per capita of:

Low	US$ 735 or less
Lower middle	US$ 736–2'935
Upper middle	US$ 2'936–9'075
High	US$ 9'075 or more

The income level classification is based on World Bank methodology. Economies are shown in alphabetical order within their income group in the tables. See Table A for a list of economies in alphabetical order and their location in the tables.

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, 1975-2003 is contained in the ITU World Telecommunication Indicators Database, available separately online or on CD-ROM.

Data refer to the reporting period that is closest to the end of year indicated. See Table A for the fiscal year reporting period used in each country.

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. 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:

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E-mail: indicators@itu.int

Additional information about Telecommunication Indicators can be found at the ITU's World Wide Web site at http://www.itu.int/ITU-D/ict/.

TABLE A: LIST OF ECONOMIES

Economy	*Location*	*Fiscal year*	*Region*
Afghanistan	1	Ending 31.12	Asia
Albania	64	Ending 31.12	Europe
Algeria	65	Ending 31.12	Africa
Andorra	151	Ending 31.12	Europe
Angola	2	Ending 31.12	Africa
Antigua & Barbuda	152	Beginning 01.04	Americas
Argentina	118	Ending 30.09	Americas
Armenia	66	Ending 31.12	Asia
Aruba	153	Ending 31.12	Americas
Australia	154	Ending 30.06	Oceania
Austria	155	Ending 31.12	Europe
Azerbaijan	3	Ending 31.12	Asia
Bahamas	156	Ending 31.12	Americas
Bahrain	157	Ending 31.12	Asia
Bangladesh	4	Ending 30.06	Asia
Barbados	158	Beginning 01.04	Americas
Belarus	67	Ending 31.12	Europe
Belgium	159	Ending 31.12	Europe
Belize	119	Beginning 01.04	Americas
Benin	5	Ending 31.12	Africa
Bermuda	160	Beginning 01.04	Americas
Bhutan	6	Ending 31.12	Asia
Bolivia	68	Ending 31.12	Americas
Bosnia	69	Ending 31.12	Europe
Botswana	120	Beginning 01.04	Africa
Brazil	70	Ending 31.12	Americas
Brunei Darussalam	161	Ending 31.12	Asia
Bulgaria	71	Ending 31.12	Europe
Burkina Faso	7	Ending 31.12	Africa
Burundi	8	Ending 31.12	Africa
Cambodia	9	Ending 31.12	Asia
Cameroon	10	Ending 31.12	Africa
Canada	162	Ending 31.12	Americas
Cape Verde	72	Ending 31.12	Africa
Central African Rep.	11	Ending 31.12	Africa
Chad	12	Ending 31.12	Africa
Chile	121	Ending 31.12	Americas
China	73	Ending 31.12	Asia
Colombia	74	Ending 31.12	Americas
Comoros	13	Ending 31.12	Africa
Congo	14	Ending 31.12	Africa
Costa Rica	122	Ending 31.12	Americas
Côte d'Ivoire	15	Ending 31.12	Africa
Croatia	123	Ending 31.12	Europe
Cuba	75	Ending 31.12	Americas
Cyprus	163	Ending 31.12	Europe
Czech Republic	124	Ending 31.12	Europe
D.P.R. Korea	16	Ending 31.12	Asia
D.R. Congo	17	Ending 31.12	Africa
Denmark	164	Ending 31.12	Europe
Djibouti	76	Ending 31.12	Africa
Dominica	125	Beginning 01.04	Americas
Dominican Rep.	77	Ending 31.12	Americas
Ecuador	78	Ending 31.12	Americas
Egypt	79	Ending 31.12	Africa
El Salvador	80	Ending 31.12	Americas
Equatorial Guinea	18	Ending 31.12	Africa
Eritrea	19	Ending 31.12	Africa
Estonia	126	Ending 31.12	Europe
Ethiopia	20	Ending 30.06	Africa
Faroe Islands	165	Ending 31.12	Europe
Fiji	81	Ending 31.12	Oceania
Finland	166	Ending 31.12	Europe
France	167	Ending 31.12	Europe
French Guiana	168	Ending 31.12	Americas
French Polynesia	169	Ending 31.12	Oceania
Gabon	127	Ending 31.12	Africa
Gambia	21	Beginning 01.04	Africa
Georgia	22	Ending 31.12	Asia
Germany	170	Ending 31.12	Europe
Ghana	23	Ending 31.12	Africa
Greece	171	Ending 31.12	Europe
Greenland	172	Ending 31.12	Europe
Grenada	128	Ending 31.12	Americas
Guadeloupe	129	Ending 31.12	Americas
Guam	173	Ending 31.12	Oceania
Guatemala	82	Ending 31.12	Americas
Guernsey	174	Ending 31.12	Europe
Guinea	24	Ending 31.12	Africa
Guinea-Bissau	25	Ending 31.12	Africa
Guyana	83	Ending 31.12	Americas
Haiti	26	Ending 31.12	Americas
Honduras	84	Ending 31.12	Americas
Hong Kong, China	175	Beginning 01.04	Asia
Hungary	130	Ending 31.12	Europe
Iceland	176	Ending 31.12	Europe
India	27	Beginning 01.04	Asia
Indonesia	28	Ending 31.12	Asia
Iran (I.R.)	85	Beginning 22.03	Asia
Iraq	86	Ending 30.06	Asia
Ireland	177	Beginning 01.04	Europe
Israel	178	Ending 31.12	Asia
Italy	179	Ending 31.12	Europe
Jamaica	87	Beginning 01.04	Americas
Japan	180	Beginning 01.04	Asia
Jersey	181	Ending 31.12	Europe
Jordan	88	Ending 31.12	Asia
Kazakhstan	89	Ending 31.12	Asia
Kenya	29	Ending 30.06	Africa
Kiribati	90	Ending 31.12	Oceania
Korea (Rep.)	182	Ending 31.12	Asia
Kuwait	183	Ending 31.12	Asia
Kyrgyzstan	30	Ending 31.12	Asia
Lao P.D.R.	31	Ending 31.12	Asia
Latvia	131	Ending 31.12	Europe
Lebanon	132	Ending 31.12	Asia
Lesotho	32	Beginning 01.04	Africa
Liberia	33	Ending 31.12	Africa
Libya	133	Ending 31.12	Africa
Lithuania	134	Ending 31.12	Europe
Luxembourg	184	Ending 31.12	Europe
Macao, China	185	Ending 31.12	Asia
Madagascar	34	Ending 31.12	Africa
Malawi	35	Ending 31.12	Africa
Malaysia	135	Ending 31.12	Asia
Maldives	91	Ending 31.12	Asia
Mali	36	Ending 31.12	Africa
Malta	186	Ending 31.12	Europe
Marshall Islands	92	Ending 31.12	Oceania
Martinique	187	Ending 31.12	Americas

Economy	*Location*	*Fiscal year*	*Region*
Mauritania	37	Ending 31.12	Africa
Mauritius	136	Ending 31.12	Africa
Mayotte	137	Ending 31.12	Africa
Mexico	138	Ending 31.12	Americas
Micronesia	93	Ending 31.12	Oceania
Moldova	38	Ending 31.12	Europe
Mongolia	39	Ending 31.12	Asia
Morocco	94	Ending 31.12	Africa
Mozambique	40	Ending 31.12	Africa
Myanmar	41	Ending 31.12	Asia
Namibia	95	Ending 30.09	Africa
Nepal	42	Ending 15.7	Asia
Neth. Antilles	188	Ending 31.12	Americas
Netherlands	189	Ending 31.12	Europe
New Caledonia	190	Ending 31.12	Oceania
New Zealand	191	Ending 30.06	Oceania
Nicaragua	43	Ending 31.12	Americas
Niger	44	Ending 31.12	Africa
Nigeria	45	Ending 31.12	Africa
Northern Marianas	139	Ending 31.12	Oceania
Norway	192	Ending 31.12	Europe
Oman	140	Ending 31.12	Asia
Pakistan	46	Ending 30.06	Asia
Palestine	96	Ending 31.12	Asia
Panama	141	Ending 31.12	Americas
Papua New Guinea	47	Ending 31.12	Oceania
Paraguay	97	Ending 31.12	Americas
Peru	98	Ending 31.12	Americas
Philippines	99	Ending 31.12	Asia
Poland	142	Ending 31.12	Europe
Portugal	193	Ending 31.12	Europe
Puerto Rico	194	Ending 31.12	Americas
Qatar	195	Ending 31.12	Asia
Réunion	196	Ending 31.12	Africa
Romania	100	Ending 31.12	Europe
Russia	101	Ending 31.12	Europe
Rwanda	48	Ending 31.12	Africa
S. Tomé & Principe	49	Ending 31.12	Africa
Samoa	102	Ending 31.12	Oceania
Saudi Arabia	143	Ending 31.12	Asia
Senegal	50	Ending 31.12	Africa
Serbia and Montenegro	103	Ending 31.12	Europe
Seychelles	144	Beginning 01.04	Africa

Economy	*Location*	*Fiscal year*	*Region*
Sierra Leone	51	Ending 31.12	Africa
Solomon Islands	52	Beginning 01.04	Oceania
Somalia	53	Ending 31.12	Africa
Singapore	197	Beginning 01.04	Asia
Slovak Republic	145	Ending 31.12	Europe
Slovenia	198	Ending 31.12	Europe
South Africa	104	Beginning 01.04	Africa
Spain	199	Ending 31.12	Europe
Sri Lanka	105	Ending 31.12	Asia
St. Kitts and Nevis	146	Beginning 01.04	Americas
St. Lucia	147	Beginning 01.04	Americas
St. Vincent	106	Beginning 01.04	Americas
Sudan	54	Ending 31.12	Africa
Suriname	107	Ending 31.12	Americas
Swaziland	108	Beginning 01.04	Africa
Sweden	200	Ending 31.12	Europe
Switzerland	201	Ending 31.12	Europe
Syria	109	Ending 31.12	Asia
Taiwan, China	202	Ending 31.12	Asia
Tajikistan	55	Ending 31.12	Asia
Tanzania	56	Ending 31.12	Africa
TFYR Macedonia	110	Ending 31.12	Europe
Thailand	111	Ending 30.09	Asia
Togo	57	Ending 31.12	Africa
Tonga	112	Ending 31.12	Oceania
Trinidad & Tobago	148	Beginning 01.04	Americas
Tunisia	113	Ending 31.12	Africa
Turkey	114	Ending 31.12	Europe
Turkmenistan	115	Ending 31.12	Asia
Uganda	58	Ending 30.06	Africa
Ukraine	116	Ending 31.12	Europe
United Arab Emirates	203	Ending 31.12	Asia
United Kingdom	204	Beginning 01.04	Europe
United States	205	Ending 31.12	Americas
Uruguay	149	Ending 31.12	Americas
Uzbekistan	59	Ending 31.12	Asia
Vanuatu	117	Ending 31.12	Oceania
Venezuela	150	Ending 31.12	Americas
Viet Nam	60	Ending 31.12	Asia
Virgin Islands (US)	206	Ending 31.12	Americas
Yemen	61	Ending 31.12	Asia
Zambia	62	Beginning 01.04	Africa
Zimbabwe	63	Ending 30.06	Africa

1. Basic indicators

		Population		*GDP*		*Total telephone subscribers*	
		Total (M) 2003	*Density (per km²) 2003*	*Total (B US$) 2002*	*per capita (US$) 2002*	*Total (k) 2003*	*per 100 inhabitants 2003*
1	Afghanistan	20.06	31	*20.7*	919	236.7	1.18
2	Angola	14.36	12	10.0	715	*215.0*	*1.54*
3	Azerbaijan	8.29	96	*3.9*	497	*1'793.8*	*22.03*
4	Bangladesh	135.12	938	47.2	354	2'107.0	1.56
5	Benin	7.03	62	2.8	413	302.7	4.31
6	Bhutan	0.71	15	*0.5*	734	33.2	4.69
7	Burkina Faso	12.26	45	2.6	220	292.4	2.39
8	Burundi	7.12	256	0.6	89	87.9	1.23
9	Cambodia	14.14	78	*3.4*	254	534.7	3.78
10	Cameroon	16.26	34	10.6	670	*812.4*	*5.13*
11	Central African Rep.	4.14	7	*1.0*	265	*21.6*	*0.55*
12	Chad	8.08	6	*1.6*	212	*46.0*	*0.58*
13	Comoros	0.80	429	*0.2*	303	15.2	1.91
14	Congo	3.50	10	3.2	967	337.0	9.63
15	Côte d'Ivoire	16.63	52	11.7	711	1'564.0	9.40
16	D.P.R. Korea	23.91	195	*15.7*	670	*916.0*	*3.87*
17	D.R. Congo	52.77	22	*7.5*	143	*570.0*	*1.08*
18	Equatorial Guinea	0.54	19	2.2	4'289	51.1	9.41
19	Eritrea	4.15	44	0.6	146	38.1	0.92
20	Ethiopia	69.36	57	*6.3*	96	532.8	0.77
21	Gambia	1.36	128	0.4	270	*138.3*	*10.42*
22	Georgia	4.89	70	3.3	673	1'172.8	23.97
23	Ghana	22.44	94	*4.4*	209	1'102.2	4.91
24	Guinea	7.75	32	*2.9*	381	137.7	1.78
25	Guinea-Bissau	1.28	35	0.2	173	11.8	0.92
26	Haiti	8.33	300	3.2	380	*270.0*	*3.25*
27	India	1'056.89	334	508.0	488	75'071.4	7.10
28	Indonesia	215.09	112	182.4	860	27'277.0	12.68
29	Kenya	31.71	54	12.3	391	1'919.1	6.05
30	Kyrgyzstan	5.21	26	1.6	315	*447.9*	*8.79*
31	Lao P.D.R.	5.68	24	1.8	328	*117.1*	*2.12*
32	Lesotho	2.17	72	0.7	330	*125.4*	*5.79*
33	Liberia	3.37	30	0.6	174	*8.8*	*0.28*
34	Madagascar	16.34	28	4.4	277	339.1	2.08
35	Malawi	10.49	111	2.0	192	220.1	2.10
36	Mali	10.86	9	3.4	318	*109.2*	*1.03*
37	Mauritania	2.75	3	1.0	365	*278.8*	*10.39*
38	Moldova	4.41	131	*1.5*	337	1'267.1	28.73
39	Mongolia	2.46	2	*1.1*	439	457.1	18.60
40	Mozambique	18.83	24	3.9	217	*338.5*	*1.87*
41	Myanmar	53.22	78	6.0	122	429.5	0.81
42	Nepal	23.68	167	5.4	233	422.2	1.78
43	Nicaragua	5.52	46	2.5	470	*374.4*	*6.97*
44	Niger	12.29	10	1.9	165	*39.0*	*0.33*
45	Nigeria	123.31	133	49.2	409	4'002.5	3.25
46	Pakistan	149.58	186	60.8	416	6'607.6	4.42
47	Papua New Guinea	5.64	12	*4.0*	777	*77.0*	*1.41*
48	Rwanda	8.40	319	1.7	210	*134.0*	*1.64*
49	S. Tomé & Principe	0.15	158	0.1	331	11.8	7.76
50	Senegal	10.36	53	5.1	506	804.8	7.77
51	Sierra Leone	4.97	69	1.0	199	*91.0*	*1.84*
52	Solomon Islands	0.48	16	*0.3*	611	7.7	1.62
53	Somalia	9.89	16	...	...	*135.0*	*1.37*
54	Sudan	33.29	13	14.0	426	1'550.0	4.66
55	Tajikistan	6.54	46	1.2	188	289.7	4.43
56	Tanzania	35.31	38	9.7	282	1'040.3	2.95
57	Togo	5.00	88	1.5	301	280.6	5.61
58	Uganda	25.60	106	6.0	243	837.2	3.27
59	Uzbekistan	25.61	57	6.5	257	2'037.9	7.96
60	Viet Nam	81.38	247	35.1	432	7'144.0	8.78
61	Yemen	20.15	106	10.0	513	*953.3*	*4.89*
62	Zambia	11.20	15	3.7	338	329.4	2.94
63	Zimbabwe	11.77	30	0.8	65	680.1	5.78
	Low Income	**2'514.88**	**76**	**1'117.5**	**455**	**149'596.1**	**5.96**

1. Basic indicators

		Population		GDP		Total telephone subscribers	
		Total (M) 2003	*Density (per km²) 2003*	*Total (B US$) 2002*	*per capita (US$) 2002*	*Total (k) 2003*	*per 100 inhabitants 2003*
64	Albania	3.07	107	*4.1*	1'332	1'355.0	44.10
65	Algeria	31.76	13	55.9	1'787	3'646.6	11.48
66	Armenia	3.80	127	2.4	623	677.0	17.81
67	Belarus	9.87	48	14.2	1'438	4'189.3	42.43
68	Bolivia	8.41	8	7.8	935	2'001.6	23.81
69	Bosnia	3.83	75	*4.7*	1'232	1'988.0	51.88
70	Brazil	175.96	21	452.6	2'603	88'690.3	50.40
71	Bulgaria	7.51	68	15.5	1'992	5'637.8	75.11
72	Cape Verde	0.46	114	0.6	1'407	125.1	27.26
73	China	1'256.95	131	1'236.7	963	532'700.0	42.38
74	Colombia	43.78	38	81.1	1'874	14'954.3	34.16
75	Cuba	11.31	99	*17.1*	1'518	*583.0*	*5.19*
76	Djibouti	0.67	30	*0.6*	894	32.5	4.86
77	Dominican Rep.	7.81	161	21.3	2'586	3'022.2	38.68
78	Ecuador	13.00	28	*13.6*	1'076	3'943.4	30.33
79	Egypt	68.65	69	84.8	1'260	14'533.2	21.17
80	El Salvador	6.52	305	14.2	2'203	1'902.4	29.20
81	Fiji	0.83	45	1.0	1'164	211.9	25.66
82	Guatemala	12.32	113	23.3	1'939	*2'423.1*	*20.20*
83	Guyana	0.89	4	*0.7*	828	*167.7*	*19.08*
84	Honduras	6.86	61	6.6	980	*649.0*	*9.69*
85	Iran (I.R.)	66.15	40	*379.6*	5'876	17'947.7	27.13
86	Iraq	24.92	57	...	...	*695.0*	*2.87*
87	Jamaica	2.65	232	8.4	3'206	*1'844.4*	*70.22*
88	Jordan	5.48	57	9.3	1'742	1'947.9	35.54
89	Kazakhstan	15.84	6	23.7	1'485	*3'108.9*	*19.47*
90	Kiribati	0.09	130	-	464	*5.0*	*5.68*
91	Maldives	0.29	962	*0.6*	2'258	*70.5*	*25.11*
92	Marshall Islands	0.05	29	*0.1*	1'893	5.1	9.38
93	Micronesia	0.11	78	0.3	2'370	17.0	15.77
94	Morocco	30.12	46	36.1	1'218	8'552.0	28.39
95	Namibia	1.92	2	2.9	1'523	351.1	18.25
96	Palestine	3.62	601	3.0	873	795.8	21.99
97	Paraguay	5.93	15	5.6	967	2'043.6	34.46
98	Peru	27.42	21	56.8	2'124	4'748.0	17.31
99	Philippines	81.10	270	77.9	980	25'200.0	31.07
100	Romania	20.99	88	45.7	2'107	11'200.0	53.35
101	Russia	146.41	9	347.4	2'370	*53'108.8*	*36.23*
102	Samoa	0.18	64	*0.3*	1'428	23.8	13.05
103	Serbia and Montenegro	10.76	105	15.6	1'451	6'246.3	58.05
104	South Africa	46.37	39	104.2	2'293	*18'546.0*	*40.80*
105	Sri Lanka	19.16	292	16.5	873	2'332.4	12.17
106	St. Vincent	0.12	306	*0.3*	3'028	*37.3*	*31.88*
107	Suriname	0.53	3	0.9	1'860	247.9	47.12
108	Swaziland	1.04	60	1.2	1'130	134.2	12.85
109	Syria	17.48	94	*19.2*	1'185	*2'499.3*	*14.67*
110	TFYR Macedonia	2.08	81	*3.4*	1'705	*925.4*	*44.83*
111	Thailand	62.53	122	126.5	2'044	*22'616.8*	*36.55*
112	Tonga	0.10	142	*0.1*	1'322	*14.6*	*14.67*
113	Tunisia	9.89	60	21.0	2'152	3'063.8	30.98
114	Turkey	68.28	88	183.1	2'722	46'804.3	68.54
115	Turkmenistan	4.87	10	*4.4*	988	*382.2*	*7.88*
116	Ukraine	49.98	83	41.5	827	*15'033.3*	*29.98*
117	Vanuatu	0.21	14	*0.2*	1'113	14.3	6.90
	Lower Middle Income	**2'400.94**	**43**	**3'594.5**	**1'504**	**933'995.7**	**38.95**

1. Basic indicators

		Population		GDP		Total telephone subscribers	
		Total (M) 2003	*Density (per km²) 2003*	*Total (B US$) 2002*	*per capita (US$) 2002*	*Total (k) 2003*	*per 100 inhabitants 2003*
118	Argentina	36.98	13	409.2	11'180	*14'509.4*	*39.64*
119	Belize	0.30	13	*0.8*	3'128	93.7	31.73
120	Botswana	1.76	3	5.1	2'939	654.6	37.19
121	Chile	14.71	20	66.4	4'413	10'771.1	73.24
122	Costa Rica	4.17	82	16.8	4'064	*1'497.7*	*36.15*
123	Croatia	4.37	77	22.4	5'125	*4'165.0*	*95.22*
124	Czech Republic	10.06	128	69.5	6'852	13'334.7	132.49
125	Dominica	0.08	104	0.3	3'256	*33.1*	*42.39*
126	Estonia	1.28	28	6.4	4'732	*1'356.0*	*100.07*
127	Gabon	1.34	5	*4.6*	3'611	338.4	25.31
128	Grenada	0.11	326	*0.4*	4'348	74.9	66.67
129	Guadeloupe	0.44	258	...	...	*502.5*	*116.60*
130	Hungary	10.33	111	65.8	6'486	11'547.5	111.74
131	Latvia	2.31	36	8.4	3'597	1'873.4	81.20
132	Lebanon	3.50	337	*16.7*	4'988	*1'453.9*	*42.58*
133	Libya	5.53	3	19.4	3'484	850.0	15.37
134	Lithuania	3.26	50	13.8	3'977	2'994.1	91.93
135	Malaysia	25.17	76	94.9	3'870	15'695.7	62.36
136	Mauritius	1.22	655	4.8	3'957	810.6	66.39
137	Mayotte	0.17	444	...	...	*31.7*	*19.78*
138	Mexico	103.41	52	636.9	6'252	46'408.8	44.88
139	Northern Marianas	0.08	161	...	...	*24.0*	*35.28*
140	Oman	2.60	10	20.6	8'097	*698.8*	*27.53*
141	Panama	3.12	40	*11.0*	3'812	*912.7*	*30.36*
142	Poland	38.59	123	189.3	4'902	29'700.0	76.96
143	Saudi Arabia	22.54	9	188.2	8'571	10'740.9	47.65
144	Seychelles	0.08	198	0.7	8'647	*66.5*	*82.25*
145	Slovak Republic	5.38	110	23.7	4'404	4'973.4	92.49
146	St. Kitts and Nevis	0.05	184	*0.3*	7'450	*28.5*	*60.64*
147	St. Lucia	0.16	263	0.7	4'201	*65.4*	*40.90*
148	Trinidad & Tobago	1.30	254	9.3	7'166	*687.0*	*52.78*
149	Uruguay	3.41	18	12.3	3'640	*1'598.5*	*47.22*
150	Venezuela	25.70	28	*126.2*	5'105	*9'305.3*	*36.92*
	Upper Middle Income	**333.50**	**25**	**2'044.9**	**6'223**	**187'798.1**	**56.50**

1. Basic indicators

		Population		GDP		Total telephone subscribers	
		Total (M) 2003	*Density (per km²) 2003*	*Total (B US$) 2002*	*per capita (US$) 2002*	*Total (k) 2003*	*per 100 inhabitants 2003*
151	Andorra	0.08	181	...	...	97.0	115.15
152	Antigua & Barbuda	0.08	178	0.7	9'103	*76.3*	*97.76*
153	Aruba	0.11	592	...	...	*90.1*	*85.03*
154	Australia	19.94	3	397.8	20'230	25'162.0	126.18
155	Austria	8.07	96	204.5	25'393	10'975.5	135.95
156	Bahamas	0.32	23	4.8	15'442	*248.3*	*79.59*
157	Bahrain	0.69	979	7.6	11'312	628.9	90.60
158	Barbados	0.27	627	*2.5*	9'500	274.0	101.59
159	Belgium	10.37	339	245.2	23'681	*13'255.9*	*128.00*
160	Bermuda	0.07	1'211	2.1	33'469	*86.0*	*132.31*
161	Brunei Darussalam	0.36	63	*4.3*	12'447	*225.4*	*65.92*
162	Canada	31.72	3	735.6	23'417	33'172.7	104.58
163	Cyprus	0.74	80	10.2	14'194	1'052.3	141.90
164	Denmark	5.39	125	172.2	32'033	8'395.3	155.66
165	Faroe Islands	0.05	36	*1.1*	24'102	*53.7*	*112.62*
166	Finland	5.22	14	131.8	25'314	7'248.0	138.88
167	France	59.90	110	1'434.7	24'057	75'588.5	126.19
168	French Guiana	0.18	2	...	...	*126.3*	*74.86*
169	French Polynesia	0.25	63	*3.9*	16'310	*143.2*	*58.34*
170	Germany	82.51	231	1'990.9	24'122	119'150.0	144.41
171	Greece	11.46	87	133.1	12'084	14'141.3	123.43
172	Greenland	0.06	-	...	...	*45.3*	*79.85*
173	Guam	0.16	360	*3.4*	22'086	*112.6*	*71.63*
174	Guernsey	0.06	858	*1.8*	32'428	*86.5*	*153.83*
175	Hong Kong, China	6.81	6'413	159.9	23'566	11'155.6	163.81
176	Iceland	0.29	3	*7.6*	26'617	469.8	162.56
177	Ireland	4.03	58	122.0	31'041	5'355.0	133.03
178	Israel	6.77	306	103.6	15'619	*9'340.0*	*140.76*
179	Italy	54.95	182	1'187.1	21'024	82'514.0	150.16
180	Japan	127.62	338	3'991.8	31'324	146'873.5	115.09
181	Jersey	0.09	759	...	...	*135.3*	*155.24*
182	Korea (Rep.)	47.93	487	546.9	11'481	59'392.2	123.93
183	Kuwait	2.46	101	35.8	15'140	1'906.9	77.63
184	Luxembourg	0.45	175	21.1	47'255	784.0	173.64
185	Macao, China	0.45	18'845	6.7	15'249	538.7	120.10
186	Malta	0.40	1'266	3.9	9'839	498.3	124.57
187	Martinique	0.39	356	*0.9*	2'296	*458.1*	*118.44*
188	Neth. Antilles	0.22	278	...	...	...	...
189	Netherlands	16.29	396	418.9	25'866	22'504.0	138.19
190	New Caledonia	0.23	12	*3.1*	13'940	*132.0*	*58.93*
191	New Zealand	4.01	15	58.4	14'832	4'397.0	109.67
192	Norway	4.58	14	191.9	42'149	7'431.4	162.24
193	Portugal	10.34	112	122.0	11'800	13'620.2	131.78
194	Puerto Rico	3.88	433	*44.2*	11'519	*3'076.5*	*79.73*
195	Qatar	0.64	56	17.5	28'295	561.0	87.90
196	Réunion	0.76	301	1.3	1'893	*721.1*	*98.65*
197	Singapore	4.20	6'147	87.0	20'894	5'467.0	130.28
198	Slovenia	2.00	99	22.0	11'020	2'551.5	127.77
199	Spain	40.94	81	654.6	16'091	55'074.2	134.53
200	Sweden	8.98	20	240.2	26'864	*14'528.2*	*162.45*
201	Switzerland	7.32	177	267.5	36'738	*11'071.3*	*152.05*
202	Taiwan, China	22.60	628	280.4	12'453	38'444.7	170.07
203	United Arab Emirates	4.04	48	71.0	18'919	4'108.1	101.68
204	United Kingdom	58.12	237	1'558.1	26'369	*84'575.0*	*143.13*
205	United States	292.30	31	10'445.6	36'223	340'321.9	116.43
206	Virgin Islands (US)	0.11	321	...	...	*110.4*	*101.01*
	High Income	**972.23**	**29**	**26'159.6**	**27'064**	**1'238'551.9**	**127.34**
	WORLD	**6'221.54**	**46**	**32'916.5**	**5'359**	**2'509'941.8**	**40.40**
	Africa	**825.45**	**28**	**532.9**	**663**	**71'111.7**	**8.66**
	Americas	**855.53**	**21**	**13'196.0**	**15'633**	**587'982.1**	**68.87**
	Asia	**3'624.28**	**122**	**8'410.9**	**2'328**	**1'044'405.8**	**28.84**
	Europe	**795.13**	**33**	**10'215.6**	**12'822**	**768'483.1**	**96.50**

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. Mobile subscribers

		Cellular mobile subscribers					As % of total telephone subscribers
		(k)		CAGR (%)	Per 100 inhabitants	% Digital	
		1998	2003	1998-03	2003	2003	2003
1	Afghanistan	-	200.0	-	1.00	...	84.5
2	Angola	9.8	*130.0*	*90.7*	*0.93*	...	*60.5*
3	Azerbaijan	65.0	*870.0*	*91.3*	*10.69*	*92.0*	*48.5*
4	Bangladesh	75.0	1'365.0	78.7	1.01	99.5	64.8
5	Benin	6.3	236.2	106.5	3.36	...	78.0
6	Bhutan	-	8.0	-	1.13	100.0	24.1
7	Burkina Faso	2.7	227.0	142.1	1.85	...	77.6
8	Burundi	0.6	64.0	152.8	0.90	...	72.8
9	Cambodia	61.3	498.4	52.0	3.52	...	93.2
10	Cameroon	5.0	1'077.0	192.9	6.62	...	90.7
11	Central African Rep.	1.6	40.0	89.6	0.97	...	81.6
12	Chad	-	65.0	-	0.80	100.0	84.6
13	Comoros	-	2.0	-	0.25	...	13.1
14	Congo	3.4	330.0	149.8	9.43	...	97.9
15	Côte d'Ivoire	91.2	1'280.7	69.6	7.70	100.0	79.6
16	D.P.R. Korea	-	-	-	-	-	-
17	D.R. Congo	10.0	1'000.0	151.2	1.89	...	99.0
18	Equatorial Guinea	0.3	41.5	168.6	7.64	...	81.2
19	Eritrea	-	-	-	-	-	-
20	Ethiopia	-	97.8	-	0.14	...	18.4
21	Gambia	5.0	*100.0*	*111.0*	*7.53*	...	*72.3*
22	Georgia	60.0	522.3	54.2	10.68	...	44.5
23	Ghana	41.8	799.9	80.5	3.56	...	72.6
24	Guinea	21.6	111.5	38.9	1.44	...	81.0
25	Guinea-Bissau	-	1.3	-	0.10	...	10.8
26	Haiti	10.0	*140.0*	*93.4*	*1.69*	...	*51.9*
27	India	1'195.4	26'154.4	85.4	2.47	100.0	34.8
28	Indonesia	1'065.8	18'800.0	77.5	8.74	...	68.9
29	Kenya	10.8	1'590.8	171.6	5.02	...	82.9
30	Kyrgyzstan	1.4	*53.1*	*150.4*	*1.04*	...	*11.9*
31	Lao P.D.R.	6.5	*55.2*	*71.0*	*1.00*	*100.0*	*47.1*
32	Lesotho	9.8	*96.8*	*77.2*	*4.47*	*100.0*	*77.2*
33	Liberia	-	*2.0*	-	*0.06*	...	*22.7*
34	Madagascar	12.8	279.5	85.3	1.71	...	82.4
35	Malawi	10.5	135.1	66.7	1.29	...	61.4
36	Mali	4.5	250.0	123.6	2.30	...	81.5
37	Mauritania	-	300.0	-	10.90	...	90.5
38	Moldova	7.0	475.9	132.5	10.79	...	37.6
39	Mongolia	9.0	319.0	104.0	12.98	100.0	69.8
40	Mozambique	6.7	428.9	129.6	2.28	100.0	83.7
41	Myanmar	8.5	66.5	50.8	0.12	78.0	15.5
42	Nepal	-	50.4	-	0.21	100.0	11.9
43	Nicaragua	18.3	*202.8*	*82.4*	*3.78*	...	*54.2*
44	Niger	1.3	24.0	77.8	0.20	...	51.7
45	Nigeria	20.0	3'149.5	175.1	2.55	...	78.7
46	Pakistan	206.9	2'624.8	66.2	1.75	...	39.7
47	Papua New Guinea	5.6	*15.0*	*28.2*	*0.27*	...	*19.5*
48	Rwanda	5.0	134.0	93.0	1.60	...	85.2
49	S. Tomé & Principe	-	4.8	-	3.17	100.0	40.9
50	Senegal	27.5	575.9	83.8	5.56	...	71.6
51	Sierra Leone	-	*67.0*	-	*1.35*	...	*73.6*
52	Solomon Islands	0.7	1.5	16.2	0.31	...	19.3
53	Somalia	-	*35.0*	-	*0.36*	...	*25.9*
54	Sudan	8.6	650.0	137.5	1.95	...	41.9
55	Tajikistan	0.4	47.6	157.6	0.73	...	16.4
56	Tanzania	37.9	891.2	88.0	2.52	...	85.7
57	Togo	7.5	220.0	96.5	4.40	90.9	78.4
58	Uganda	30.0	776.2	91.7	3.03	...	92.7
59	Uzbekistan	26.8	320.8	64.3	1.25	...	15.7
60	Viet Nam	222.7	2'742.0	65.2	3.37	...	38.4
61	Yemen	16.1	700.0	112.5	3.47	...	56.4
62	Zambia	8.3	241.0	96.3	2.15	...	73.2
63	Zimbabwe	19.0	379.1	82.0	3.22	...	55.8
	Low Income	**3'482.0**	**72'067.4**	**83.3**	**2.87**		**47.6**

2. Mobile subscribers

		Cellular mobile subscribers					*As % of total*
				CAGR	*Per 100*	*%*	*telephone*
		(k)		*(%)*	*inhabitants*	*Digital*	*subscribers*
		1998	*2003*	*1998-03*	*2003*	*2003*	*2003*
64	Albania	5.6	1'100.0	187.5	35.80	...	81.2
65	Algeria	18.0	1'447.0	140.5	4.56	...	39.7
66	Armenia	7.8	114.4	71.0	3.01	...	16.9
67	Belarus	12.2	1'118.0	147.0	11.32	...	26.7
68	Bolivia	239.3	1'401.5	42.4	16.67	...	70.0
69	Bosnia	25.2	1'050.0	110.9	27.40	...	52.8
70	Brazil	7'368.2	46'373.3	44.5	26.36	98.7	52.3
71	Bulgaria	127.0	2'781.7	85.4	37.06	...	49.3
72	Cape Verde	1.0	53.3	120.6	11.63	...	42.7
73	China	23'863.0	269'953.0	62.4	21.48	100.0	50.7
74	Colombia	1'800.2	6'186.2	28.0	14.13	...	41.4
75	Cuba	4.1	*17.9*	*44.8*	*0.16*	...	*3.0*
76	Djibouti	0.2	23.0	153.4	3.44	...	70.8
77	Dominican Rep.	209.4	2'120.4	58.9	27.14	...	70.2
78	Ecuador	242.8	2'394.4	58.0	18.41	...	60.7
79	Egypt	90.8	5'797.5	129.6	8.45	100.0	39.9
80	El Salvador	137.1	1'149.8	53.0	17.65	...	60.4
81	Fiji	8.0	109.9	68.9	13.31	100.0	51.9
82	Guatemala	111.4	*1'577.1*	*94.0*	*13.15*	...	*65.1*
83	Guyana	1.5	*87.3*	*178.4*	*9.93*	...	*52.0*
84	Honduras	34.9	*326.5*	*74.9*	*4.87*	*85.1*	*50.3*
85	Iran (I.R.)	390.0	3'376.5	54.0	5.10	100.0	18.8
86	Iraq	-	*20.0*	-	*0.08*	...	*2.9*
87	Jamaica	78.6	*1'400.0*	*105.4*	*53.30*	*100.0*	*75.9*
88	Jordan	82.4	1'325.3	74.3	24.18	...	68.0
89	Kazakhstan	29.7	*1'027.0*	*142.5*	*6.43*	...	*33.0*
90	Kiribati	-	0.5	88.7	0.59	...	10.5
91	Maldives	1.6	*41.9*	*126.0*	*14.91*	*100.0*	*59.4*
92	Marshall Islands	0.3	0.6	11.6	1.11	...	11.8
93	Micronesia	-	5.9	-	5.44	-	34.5
94	Morocco	116.6	7'332.8	128.9	24.34	...	85.7
95	Namibia	19.5	223.7	62.9	11.63	100.0	63.7
96	Palestine	100.0	480.0	36.9	13.27	...	60.3
97	Paraguay	231.5	1'770.3	50.2	29.85	...	86.6
98	Peru	742.6	2'908.8	31.4	10.61	...	61.3
99	Philippines	1'733.7	21'860.0	66.0	26.95	9.7	86.7
100	Romania	643.0	6'900.0	60.7	32.87	...	61.6
101	Russia	747.2	*17'608.8*	*120.3*	*12.01*	...	*33.2*
102	Samoa	1.5	10.5	48.0	5.76	...	44.1
103	Serbia and Montenegro	240.0	3'634.6	72.2	33.78	...	58.2
104	South Africa	3'337.0	16'860.0	38.3	36.36	...	77.7
105	Sri Lanka	174.2	1'393.4	51.6	7.27	...	59.7
106	St. Vincent	0.8	*10.0*	*91.0*	*8.53*	...	*26.8*
107	Suriname	6.0	168.1	94.7	31.95	...	67.8
108	Swaziland	4.7	88.0	79.7	8.43	100.0	65.6
109	Syria	-	*400.0*	-	*2.35*	*100.0*	*16.0*
110	TFYR Macedonia	30.1	*365.3*	*86.7*	*17.70*	*100.0*	*39.5*
111	Thailand	1'977.0	*16'117.0*	*69.0*	*26.04*	*89.8*	*71.3*
112	Tonga	0.1	*3.4*	*125.4*	*3.38*	*100.0*	*23.0*
113	Tunisia	39.0	1'899.9	117.6	19.21	...	62.0
114	Turkey	3'506.1	27'887.5	51.4	40.84	...	59.6
115	Turkmenistan	3.0	*8.2*	*28.5*	*0.17*	...	*2.1*
116	Ukraine	115.5	*4'200.0*	*145.6*	*8.38*	...	*27.9*
117	Vanuatu	0.2	7.8	104.1	3.76	...	54.4
	Lower Middle Income	**48'659.6**	**484'517.8**	**58.4**	**20.20**		**51.7**

2. Mobile subscribers

		Cellular mobile subscribers					As % of total
		(k)		CAGR (%)	Per 100 inhabitants	% Digital	telephone subscribers
		1998	2003	1998-03	2003	2003	2003
118	Argentina	2'530.0	6'500.0	26.6	17.76	...	44.8
119	Belize	3.5	60.4	76.4	20.46	...	64.5
120	Botswana	15.2	522.8	102.9	29.71	...	79.9
121	Chile	964.2	7'520.3	50.8	51.14	...	69.8
122	Costa Rica	108.8	459.8	43.4	11.10	100.0	30.7
123	Croatia	182.5	2'553.0	69.5	58.37	...	58.3
124	Czech Republic	965.5	9'708.7	58.7	96.46	...	72.8
125	Dominica	0.7	9.4	94.8	12.00	100.0	28.3
126	Estonia	247.0	881.0	37.4	65.02	100.0	65.0
127	Gabon	9.7	300.0	98.7	22.44	100.0	88.6
128	Grenada	1.4	42.3	97.4	37.63	...	56.4
129	Guadeloupe	14.2	323.5	118.4	74.32	...	60.6
130	Hungary	1'070.2	7'944.6	49.3	76.88	100.0	68.8
131	Latvia	167.5	1'219.6	48.8	52.86	...	65.1
132	Lebanon	505.3	775.1	11.3	22.70	...	53.3
133	Libya	20.0	100.0	38.0	1.81	...	11.8
134	Lithuania	267.6	2'169.9	52.0	66.62	...	72.5
135	Malaysia	2'200.0	11'124.1	38.3	44.20	...	70.9
136	Mauritius	60.4	462.4	50.2	37.87	...	57.0
137	Mayotte	-	36.0	-	21.56	...	78.3
138	Mexico	3'349.5	30'097.7	55.1	29.11	...	64.9
139	Northern Marianas	...	...	...	...	...	...
140	Oman	103.0	464.9	45.7	18.32	100.0	66.5
141	Panama	85.9	834.0	57.6	26.76	...	68.3
142	Poland	1'928.0	17'400.0	55.3	45.09	...	58.6
143	Saudi Arabia	627.3	7'238.2	63.1	32.11	100.0	67.4
144	Seychelles	5.2	54.5	60.1	68.18	...	71.5
145	Slovak Republic	473.2	3'678.8	50.7	68.42	...	74.0
146	St. Kitts and Nevis	0.4	5.0	83.6	10.64	...	17.5
147	St. Lucia	1.9	14.3	65.7	8.95	...	21.9
148	Trinidad & Tobago	26.3	361.9	92.6	27.81	...	52.7
149	Uruguay	151.3	652.0	44.1	19.26	...	40.8
150	Venezuela	2'009.8	6'463.6	33.9	25.64	...	69.5
	Upper Middle Income	**18'095.5**	**119'977.7**	**46.0**	**36.09**		**63.7**

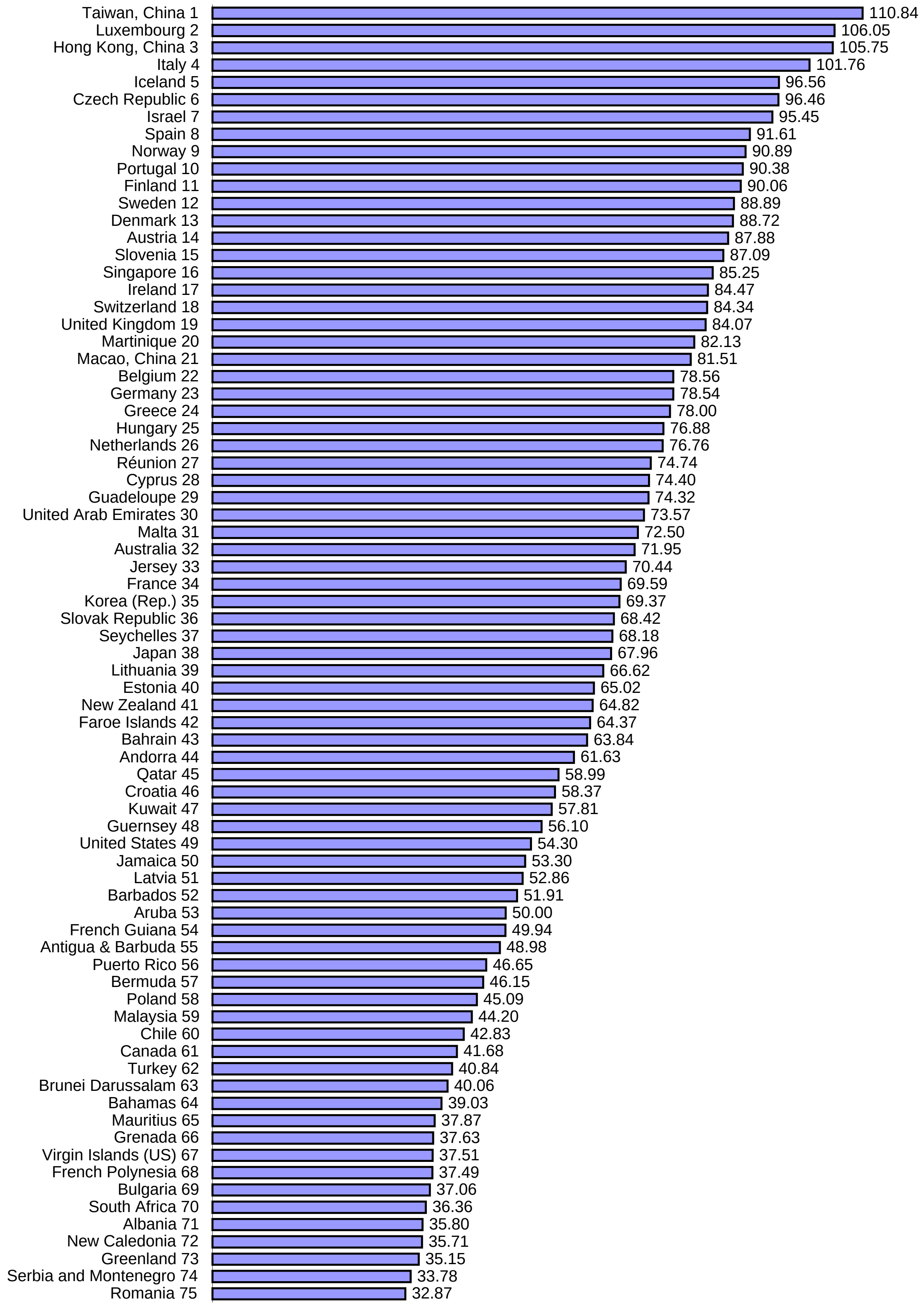
2. Mobile subscribers

		Cellular mobile subscribers					*As % of total telephone subscribers*
		(k)		*CAGR (%)*	*Per 100 inhabitants*	*% Digital*	
		1998	*2003*	*1998-03*	*2003*	*2003*	*2003*
151	Andorra	14.1	51.9	29.7	61.63	100.0	53.5
152	Antigua & Barbuda	1.5	*38.2*	*124.7*	*48.98*	...	*50.1*
153	Aruba	5.4	*53.0*	*114.4*	*50.00*	...	*58.8*
154	Australia	4'918.0	14'347.0	23.9	71.95	100.0	57.0
155	Austria	2'292.9	7'094.5	25.3	87.88	...	64.6
156	Bahamas	8.1	*121.8*	*97.1*	*39.03*	...	*49.0*
157	Bahrain	92.1	443.1	36.9	63.84	100.0	70.5
158	Barbados	12.0	140.0	63.5	51.91	...	51.1
159	Belgium	1'756.3	*8'135.5*	*46.7*	*78.56*	*100.0*	*61.4*
160	Bermuda	12.6	*30.0*	*24.3*	*46.15*	...	*34.9*
161	Brunei Darussalam	49.1	*137.0*	*40.8*	*40.06*	*100.0*	*60.8*
162	Canada	5'365.5	13'221.8	19.8	41.68	...	39.9
163	Cyprus	116.4	551.8	36.5	74.40	...	52.4
164	Denmark	1'931.1	4'785.3	19.9	88.72	...	57.0
165	Faroe Islands	6.5	*30.7*	*47.3*	*64.37*	...	*57.2*
166	Finland	2'846.0	4'700.0	10.6	90.06	...	64.8
167	France	11'210.1	41'683.1	30.0	69.59	...	55.1
168	French Guiana	4.0	*87.3*	*116.1*	*49.94*	*100.0*	*63.1*
169	French Polynesia	11.1	*90.0*	*68.9*	*36.67*	*100.0*	*62.9*
170	Germany	13'913.0	64'800.0	36.0	78.54	...	54.4
171	Greece	2'047.0	8'936.2	34.3	78.00	...	63.2
172	Greenland	8.9	*19.9*	*22.3*	*35.15*	...	*44.0*
173	Guam	12.8	*32.6*	*36.4*	*20.74*	...	*29.0*
174	Guernsey	11.7	*31.5*	*39.3*	*56.10*	*100.0*	*36.5*
175	Hong Kong, China	3'174.4	7'349.2	18.3	107.92	100.0	65.9
176	Iceland	104.3	279.1	21.8	96.56	...	59.4
177	Ireland	946.0	3'400.0	29.2	84.47	...	63.5
178	Israel	2'147.0	*6'334.0*	*31.1*	*95.45*	*100.0*	*67.8*
179	Italy	20'489.0	55'918.0	22.2	101.76	...	67.8
180	Japan	47'307.6	86'655.0	12.9	67.90	100.0	59.0
181	Jersey	18.2	*61.4*	*49.9*	*70.44*	*100.0*	*45.4*
182	Korea (Rep.)	14'018.6	33'591.8	19.1	70.09	100.0	56.6
183	Kuwait	250.0	1'420.0	41.5	57.81	...	74.5
184	Luxembourg	130.5	539.0	32.8	119.38	100.0	68.8
185	Macao, China	82.1	364.0	34.7	81.17	100.0	67.6
186	Malta	22.5	290.0	66.7	72.50	...	58.2
187	Martinique	55.0	*319.9*	*55.3*	*82.13*	*100.0*	*65.0*
188	Neth. Antilles	16.0	...	...	...	...	...
189	Netherlands	3'351.0	12'500.0	30.1	76.76	...	55.5
190	New Caledonia	13.0	*80.0*	*57.4*	*35.71*	*100.0*	*60.6*
191	New Zealand	790.0	2'599.0	26.9	64.83	...	59.1
192	Norway	2'106.4	4'163.4	14.6	90.89	...	56.0
193	Portugal	3'074.6	9'341.4	24.9	90.38	...	68.6
194	Puerto Rico	580.0	*1'800.0*	*32.7*	*46.65*	...	*58.5*
195	Qatar	65.8	376.5	41.8	58.99	...	67.1
196	Réunion	50.3	565.0	62.2	74.74	...	65.3
197	Singapore	1'094.7	3'577.5	26.7	85.25	100.0	65.4
198	Slovenia	161.6	1'739.1	60.8	87.09	...	68.2
199	Spain	6'437.4	37'506.7	42.3	91.61	...	68.1
200	Sweden	4'109.0	*7'949.0*	*17.9*	*88.89*	...	*54.7*
201	Switzerland	1'698.6	6'172.0	29.4	84.34	100.0	53.6
202	Taiwan, China	4'727.0	25'089.6	39.6	110.99	100.0	65.3
203	United Arab Emirates	493.3	2'972.3	43.2	73.57	...	72.4
204	United Kingdom	14'878.0	*49'677.0*	*35.2*	*84.07*	*100.0*	*58.7*
205	United States	69'209.3	158'722.0	18.1	54.30	93.4	46.6
206	Virgin Islands (US)	25.0	*41.0*	*17.9*	*37.51*	...	*37.1*
	High Income	**248'272.4**	**690'955.1**	**22.7**	**71.03**		**55.8**
	WORLD	**318'509.6**	**1'367'518.1**	**33.8**	**22.00**		**54.4**
	Africa	**4'156.9**	**50'962.7**	**65.1**	**6.18**		**67.4**
	Americas	**95'066.8**	**293'498.6**	**25.3**	**34.37**		**49.9**
	Asia	**108'320.6**	**559'206.6**	**38.9**	**15.44**		**53.5**
	Europe	**104'382.0**	**442'838.4**	**33.5**	**55.60**		**57.6**
	Oceania	**5'748.5**	**17'264.6**	**24.6**	**54.41**		**57.2**

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.

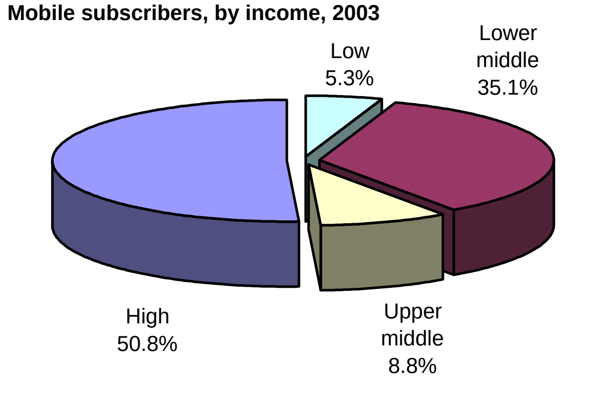
2. Mobile subscribers



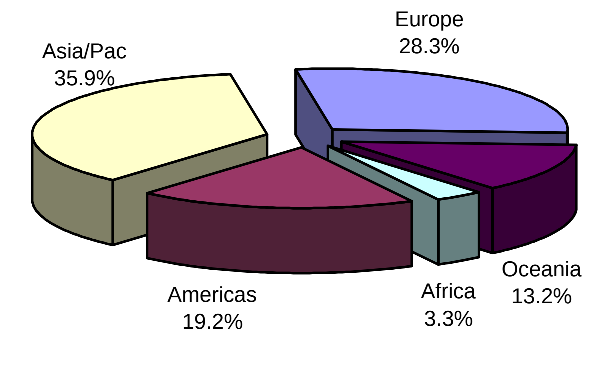
Mobile subscribers per 100 inhabitants, top 75, 2003

2. Mobile subscribers

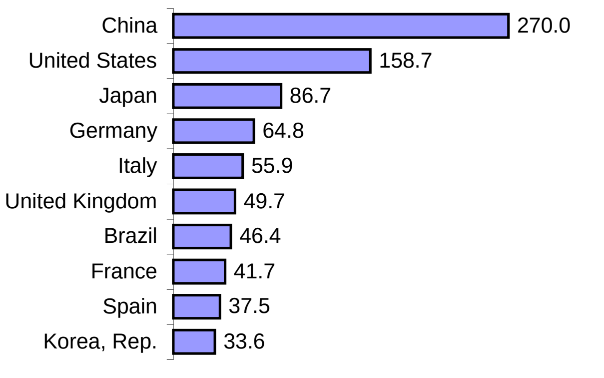
Mobile subscribers, by income, 2003



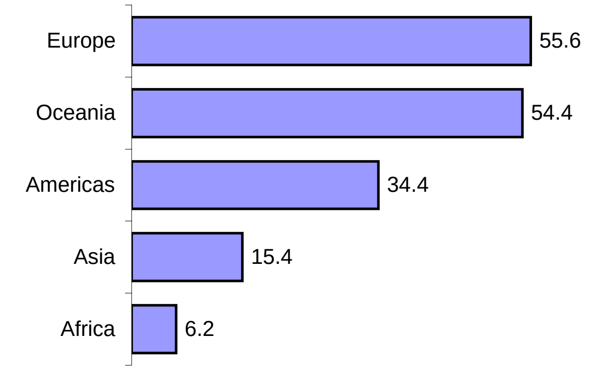
Mobile subscribers, by region, 2003



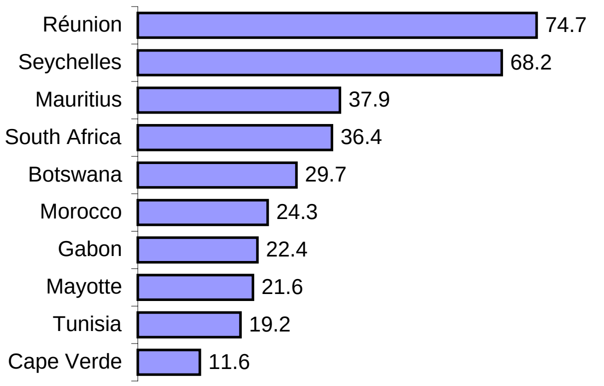
Total mobile subscribers, top 10, 2003, millions



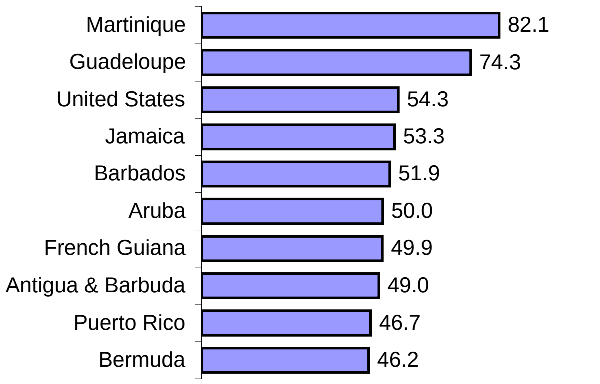
Mobile penetration*, by region, 2003



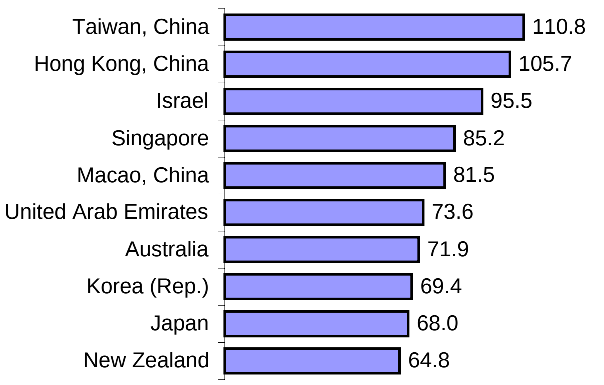
Africa: Mobile penetration, top 10, 2003



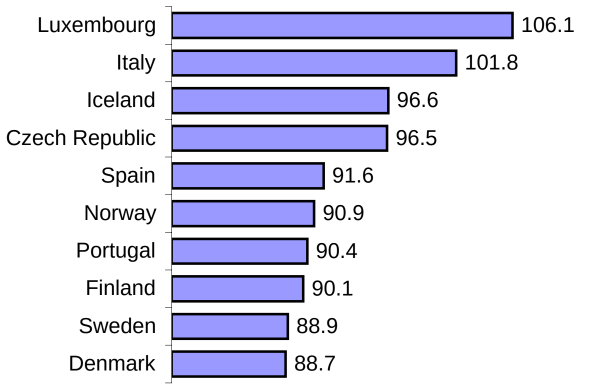
Americas: Mobile penetration, top 10, 2003



Asia/Pacific: Mobile penetration, top 10, 2003



Europe: Mobile penetration, top 10, 2003



* Penetration = subscribers per 100 inhabitants

3. Mobile prices

		Connection charge (US$)	Per minute local call (US$)		Cost of a local SMS (US$)
			Peak	Off-peak	
		2003	2003	2003	2003
1	Afghanistan	…	…	…	…
2	Angola	…	…	…	…
3	Azerbaijan	13.81	…	…	*0.07*
4	Bangladesh	9.89	0.10	0.09	…
5	Benin	34.41	0.41	0.20	…
6	Bhutan	*	*	*	*
7	Burkina Faso	52.31	0.34	0.34	*0.13*
8	Burundi	9.24	0.27	0.23	*0.02*
9	Cambodia	*0.59*	0.08	0.04	*0.03*
10	Cameroon	34.41	0.43	0.34	*0.12*
11	Central African Rep.	34.41	0.17	0.17	…
12	Chad	…	…	…	…
13	Comoros	…	0.23	0.23	*0.17*
14	Congo	…	…	…	…
15	Côte d'Ivoire	43.01	0.77	0.77	*0.09*
16	D.P.R. Korea	…	…	…	…
17	D.R. Congo	…	…	…	…
18	Equatorial Guinea	…	…	…	…
19	Eritrea	*	*	*	*
20	Ethiopia	*53.27*	*0.08*	*0.04*	…
21	Gambia	*15.06*	…	…	…
22	Georgia	6.98	0.13	0.13	*0.03*
23	Ghana	31.12	0.29	0.22	*0.07*
24	Guinea	37.45	0.20	0.15	*0.05*
25	GuineaoBissau	*	*	*	*
26	Haiti	…	…	…	…
27	India	3.93	0.05	0.05	*0.02*
28	Indonesia	*11.66*	0.17	0.14	…
29	Kenya	13.04	0.20	0.20	*0.07*
30	Kyrgyzstan	10.08	0.20	0.15	…
31	Lao P.D.R.	9.51	0.07	0.07	…
32	Lesotho	…	0.38	0.21	*0.10*
33	Liberia	…	…	…	…
34	Madagascar	4.03	0.19	0.19	*0.10*
35	Malawi	…	*0.29*	*0.22*	*0.11*
36	Mali	51.62	…	…	…
37	Mauritania	…	…	…	…
38	Moldova	*12.20*	*0.20*	*0.20*	*0.06*
39	Mongolia	7.85	0.25	0.25	*0.03*
40	Mozambique	…	0.14	0.12	*0.04*
41	Myanmar	…	…	…	…
42	Nepal	13.13	0.06	0.06	*0.01*
43	Nicaragua	…	0.51	0.51	-
44	Niger	…	…	…	…
45	Nigeria	46.43	0.39	0.31	*0.12*
46	Pakistan	17.30	0.10	0.10	*0.03*
47	Papua New Guinea	7.02	0.45	0.17	…
48	Rwanda	…	0.24	0.19	*0.09*
49	S. Tomé & Principe	*53.49*	*0.26*	*0.26*	*0.24*
50	Senegal	26.15	0.38	0.21	*0.11*
51	Sierra Leone	13.41	0.16	0.14	*0.04*
52	Solomon Islands	45.39	0.40	0.40	…
53	Somalia	…	…	…	…
54	Sudan	23.15	0.10	0.10	*0.02*
55	Tajikistan	…	…	…	…
56	Tanzania	…	0.23	0.23	*0.05*
57	Togo	*34.24*	*0.28*	*0.28*	-
58	Uganda	12.73	0.17	0.14	*0.05*
59	Uzbekistan	…	…	…	…
60	Viet Nam	9.67	0.21	0.15	…
61	Yemen	…	…	…	…
62	Zambia	*13.73*	*0.28*	*0.24*	*0.04*
63	Zimbabwe	53.21	0.10	0.09	*0.02*
	Low Income	**23.48**	**0.24**	**0.20**	**0.07**

3. Mobile prices

		Connection charge (US$)	*Per minute local call (US$)*		*Cost of a local SMS (US$)*
			Peak	*Off-peak*	
		2003	*2003*	*2003*	*2003*
64	Albania	*24.62*	*0.57*	*0.49*	*0.21*
65	Algeria	64.59	0.26	0.26	*0.13*
66	Armenia	*6.34*	*0.10*	*0.07*	*0.02*
67	Belarus	-	0.06	0.04	*0.06*
68	Bolivia	…	0.13	0.13	*0.05*
69	Bosnia	28.32	0.23	0.20	*0.05*
70	Brazil	…	0.54	0.27	…
71	Bulgaria	*17.27*	*0.67*	*0.67*	*0.10*
72	Cape Verde	41.36	0.36	0.26	*0.15*
73	China	-	0.07	0.07	*0.02*
74	Colombia	…	…	…	…
75	Cuba	120.00	0.48	0.40	*0.16*
76	Djibouti	5.63	0.17	0.11	…
77	Dominican Rep.	5.37	0.21	0.21	*0.05*
78	Ecuador	10.00	0.64	0.64	*0.13*
79	Egypt	67.52	0.26	0.26	*0.09*
80	El Salvador	…	0.30	0.25	*0.09*
81	Fiji	47.91	1.04	0.21	*0.11*
82	Guatemala	…	0.11	0.11	*0.06*
83	Guyana	…	0.19	0.15	…
84	Honduras	*9.57*	*0.47*	*0.47*	-
85	Iran (I.R.)	…	…	…	…
86	Iraq	…	…	…	…
87	Jamaica	19.92	0.17	0.14	*0.05*
88	Jordan	15.49	0.25	0.20	*0.42*
89	Kazakhstan	3.95	0.22	0.22	*0.06*
90	Kiribati	…	…	…	…
91	Maldives	39.06	0.27	0.27	*0.08*
92	Marshall Islands	…	…	…	…
93	Micronesia	-	0.10	0.10	*0.10*
94	Morocco	26.12	0.31	0.21	*0.10*
95	Namibia	11.24	0.30	0.14	*0.10*
96	Palestine	…	*0.17*	*0.17*	*0.04*
97	Paraguay	…	0.27	0.05	*0.01*
98	Peru	…	0.29	0.29	*0.14*
99	Philippines	3.14	0.15	0.07	*0.02*
100	Romania	-	*0.35*	*0.15*	*0.10*
101	Russia	…	0.39	0.31	*0.06*
102	Samoa	9.76	0.27	0.08	*0.07*
103	Serbia and Montenegro	*10.22*	*0.19*	*0.08*	*0.04*
104	South Africa	19.71	0.38	0.21	*0.11*
105	Sri Lanka	10.88	0.11	0.08	*0.02*
106	St. Vincent	-	0.28	0.24	*0.09*
107	Suriname	*16.92*	*0.17*	*0.17*	*0.04*
108	Swaziland	6.61	0.34	0.34	*0.11*
109	Syria	97.09	0.19	0.19	*0.10*
110	TFYR Macedonia	36.45	0.66	0.29	*0.09*
111	Thailand	9.64	0.12	0.12	*0.07*
112	Tonga	*15.91*	0.18	0.15	…
113	Tunisia	93.02	0.17	0.14	*0.05*
114	Turkey	…	*0.50*	*0.50*	*0.10*
115	Turkmenistan	…	…	…	…
116	Ukraine	20.00	0.40	0.14	*0.06*
117	Vanuatu	40.92	0.33	0.33	*0.16*
	Lower Middle Income	**25.12**	**0.30**	**0.22**	**0.09**

3. Mobile prices

		Connection charge (US$)	Per minute local call (US$)		Cost of a local SMS (US$)
			Peak	Off-peak	
		2003	2003	2003	2003
118	Argentina	…	0.12	0.12	*0.04*
119	Belize	*20.00*	*0.43*	*0.30*	*0.13*
120	Botswana	27.27	0.40	0.09	*0.04*
121	Chile	…	0.39	0.39	*0.07*
122	Costa Rica	…	…	…	…
123	Croatia	*29.85*	*0.18*	…	*0.06*
124	Czech Republic	*123.89*	*0.24*	*0.10*	*0.12*
125	Dominica	…	0.69	0.69	…
126	Estonia	1.96	0.31	0.17	*0.12*
127	Gabon	…	0.33	0.15	…
128	Grenada	…	0.33	0.28	*0.15*
129	Guadeloupe	22.47	0.42	0.42	*0.17*
130	Hungary	-	0.37	0.13	*0.11*
131	Latvia	5.09	0.47	0.47	*0.09*
132	Lebanon	8.00	0.56	0.56	*0.28*
133	Libya	…	…	…	…
134	Lithuania	…	0.08	0.08	*0.05*
135	Malaysia	33.68	0.14	0.10	*0.04*
136	Mauritius	16.38	0.04	0.04	*0.02*
137	Mayotte	…	…	…	…
138	Mexico	…	…	…	…
139	Northern Marianas	…	…	…	…
140	Oman	78.95	1.84	1.84	*0.03*
141	Panama	…	…	…	…
142	Poland	…	…	…	…
143	Saudi Arabia	53.33	0.32	0.32	*0.13*
144	Seychelles	9.07	0.74	0.74	*0.09*
145	Slovak Republic	…	…	…	…
146	St. Kitts and Nevis	50.00	0.50	0.50	…
147	St. Lucia	-	0.28	0.24	*0.09*
148	Trinidad & Tobago	…	0.47	0.32	*0.04*
149	Uruguay	…	…	…	…
150	Venezuela	…	0.39	0.18	…
	Upper Middle Income	**30.00**	**0.42**	**0.36**	**0.09**

3. Mobile prices

		Connection charge (US$)	Per minute local call (US$)		Cost of a local SMS (US$)
			Peak	Off-peak	
		2003	2003	2003	2003
151	Andorra	…	…	…	…
152	Antigua & Barbuda	…	0.33	0.33	…
153	Aruba	-	0.39	0.21	*0.08*
154	Australia	-	0.63	0.63	*0.16*
155	Austria	-	0.80	0.34	*0.24*
156	Bahamas	…	…	…	…
157	Bahrain	52.63	0.13	0.11	*0.09*
158	Barbados	35.00	0.50	0.50	*0.15*
159	Belgium	11.24	0.45	0.28	*0.17*
160	Bermuda	-	0.50	0.50	*0.10*
161	Brunei Darussalam	22.99	0.23	0.11	*0.06*
162	Canada	-	0.24	0.24	*0.11*
163	Cyprus	*63.02*	*0.17*	*0.17*	*0.04*
164	Denmark	…	…	…	…
165	Faroe Islands	…	…	…	…
166	Finland	*56.18*	*0.30*	*0.30*	*0.21*
167	France	22.47	0.51	0.51	*0.17*
168	French Guiana	…	…	…	…
169	French Polynesia	23.95	0.94	0.94	*0.47*
170	Germany	44.33	0.55	0.33	*0.21*
171	Greece	*16.85*	*0.45*	*0.45*	*0.12*
172	Greenland	…	…	…	…
173	Guam	…	…	…	…
174	Guernsey	…	…	…	…
175	Hong Kong, China	…	0.04	0.04	*0.13*
176	Iceland	…	…	…	…
177	Ireland	…	0.56	0.17	*0.15*
178	Israel	…	…	…	…
179	Italy	22.47	0.07	0.07	…
180	Japan	…	…	…	…
181	Jersey	…	…	…	…
182	Korea (Rep.)	…	…	…	…
183	Kuwait	66.67	1.33	1.33	*0.67*
184	Luxembourg	-	0.13	0.13	*0.13*
185	Macao, China	-	0.17	0.14	*0.03*
186	Malta	…	0.53	0.32	*0.05*
187	Martinique	…	…	…	…
188	Neth. Antilles	16.73	0.47	0.47	…
189	Netherlands	…	…	…	…
190	New Caledonia	21.94	0.54	0.54	*0.18*
191	New Zealand	20.35	0.52	0.52	*0.12*
192	Norway	…	…	…	…
193	Portugal	-	*0.18*	*0.14*	*0.11*
194	Puerto Rico	…	0.35	0.35	…
195	Qatar	82.42	0.20	0.20	*0.08*
196	Réunion	…	…	…	…
197	Singapore	…	0.16	0.16	*0.06*
198	Slovenia	-	0.10	0.10	*0.09*
199	Spain	13.48	0.37	0.37	*0.17*
200	Sweden	11.74	0.69	0.61	*0.19*
201	Switzerland	29.63	0.67	0.67	*0.19*
202	Taiwan, China	5.76	0.17	0.10	*0.07*
203	United Arab Emirates	20.44	0.08	0.06	*0.08*
204	United Kingdom	…	0.33	0.16	*0.20*
205	United States	-	0.35	0.10	*0.10*
206	Virgin Islands (US)	…	…	…	…
	High Income	**21.30**	**0.40**	**0.33**	**0.15**
	World	**24.29**	**0.33**	**0.27**	**0.10**
	Africa	**29.96**	**0.27**	**0.21**	**0.08**
	Americas	**19.18**	**0.36**	**0.31**	**0.08**
	Asia	**21.97**	**0.24**	**0.22**	**0.09**
	Europe	**21.47**	**0.37**	**0.28**	**0.12**
	Oceania	**21.19**	**0.49**	**0.37**	**0.17**

Note: Prices given are prepaid cellular tariffs. For data comparability and coverage, see the technical notes.
Figures in italics are estimates or refer to years other than those specified. * indicates there is no network.

Source: ITU.

4. Internet subscribers

		Internet subscribers		CAGR	Dial-up		Broadband
		Total	per 100 inhabitants	%	Total	as % of total subscribers	subscribers
		2003	2003	2000-03	2003	2003	2003
1	Afghanistan	700	0.00	…	…	100.0	-
2	Angola	9'000	0.06	…	…	100.0	-
3	Azerbaijan	12'000	0.14	…	…	100.0	-
4	Bangladesh	81'000	0.06	10.5	81'000	100.0	-
5	Benin	6'770	0.10	31.7	2'482	100.0	-
6	Bhutan	2'000	0.28	39.0	1'584	100.0	-
7	Burkina Faso	10'619	0.09	49.3	8'000	99.3	75
8	Burundi	840	0.01	-5.0	…	100.0	-
9	Cambodia	7'152	0.05	19.2	…	95.1	350
10	Cameroon	5'500	0.03	…	…	100.0	-
11	Central African Rep.	2'000	0.05	41.6	…	100.0	-
12	Chad	1'802	0.02		1'517	100.0	-
13	Comoros	1'000	0.13	26.8	896	100.0	-
14	Congo	650	0.02	86.6	…	100.0	-
15	Côte d'Ivoire	15'225	0.09	…	14'982	100.0	-
16	D.P.R. Korea	0	0.00	…	0	…	-
17	D.R. Congo	6'040	0.01	…	2'050	100.0	-
18	Equatorial Guinea	1'000	0.18	30.5	…	100.0	-
19	Eritrea	3'000	0.07	18.6	3'000	100.0	-
20	Ethiopia	11'418	0.02	66.8	11'361	99.5	57
21	Gambia	4'000	0.29	…	1'200	100.0	-
22	Georgia	4'100	0.08	…	2'700	65.6	1'410
23	Ghana	20'120	0.09	…	…	100.0	-
24	Guinea	11'000	0.14	97.3	…	100.0	-
25	GuineaoBissau	221	0.02	…	…	100.0	-
26	Haiti	30'000	0.36	…	…	100.0	-
27	India	4'140'000	0.39	11.7	3'557'591	96.6	140'362
28	Indonesia	865'706	0.40	31.1	378'500	96.4	36'300
29	Kenya	45'000	0.14	…	45'000	100.0	-
30	Kyrgyzstan	4'566	0.09	…	…	100.0	-
31	Lao P.D.R.	2'555	0.04	…	2'555	100.0	-
32	Lesotho	1'694	0.08	…	1'694	100.0	-
33	Liberia	…	...	…	…	…	-
34	Madagascar	23'000	0.14	31.6	18'000	100.0	-
35	Malawi	12'600	0.12	31.0	13'450	99.5	69
36	Mali	15'000	0.14	…	3'500	100.0	-
37	Mauritania	960	0.03	…	…	100.0	-
38	Moldova	15'952	0.36	7.9	13'347	97.4	762
39	Mongolia	46'000	1.87	79.2	41'000	99.1	500
40	Mozambique	6'100	0.03	…	…	100.0	-
41	Myanmar	16'201	0.03	85.3	7'457	93.9	-
42	Nepal	20'000	0.08	…	20'000	100.0	-
43	Nicaragua	21'000	0.38	…	…	89.0	2'319
44	Niger	2'399	0.02	…	1'966	100.0	-
45	Nigeria	53'240	0.04	…	31'282	100.0	-
46	Pakistan	256'957	0.17	24.3	…	100.0	-
47	Papua New Guinea	27'000	0.48	…	…	100.0	-
48	Rwanda	2'310	0.03	…	…	100.0	-
49	S. Tomé & Principe	1'113	0.73	43.3	1'100	100.0	-
50	Senegal	9'587	0.09	…	…	87.5	2'100
51	Sierra Leone	750	0.02	…	…	100.0	-
52	Solomon Islands	1'000	0.21	-4.6	672	100.0	205
53	Somalia	5'000	0.05	…	…	100.0	-
54	Sudan	60'000	0.18	88.2	30'000	83.3	10'000
55	Tajikistan	452	0.01	87.1	381	97.8	10
56	Tanzania	50'000	0.14	71.0	…	100.0	-
57	Togo	12'500	0.25	27.7	…	100.0	-
58	Uganda	7'024	0.03	7.8	…	100.0	-
59	Uzbekistan	37'420	0.15	112.8	…	92.6	2'757
60	Viet Nam	917'121	1.13	107.8	195'699	99.2	7'228
61	Yemen	15'000	0.07	…	15'000	100.0	-
62	Zambia	12'000	0.11	25.4	11'599	99.6	-
63	Zimbabwe	83'722	0.71	40.8	79'104	94.5	4'618
	Low Income	**7'038'086**	**0.28**	**20.8**			**209'122**

4. Internet subscribers

		Internet subscribers		CAGR	Dial-up		Broadband
		Total	per 100 inhabitants	%	Total	as % of total subscribers	subscribers
		2003	2003	2000-03	2003	2003	2003
64	Albania	20'000	0.65	…	…	*100.0*	-
65	Algeria	*60'000*	*0.19*	…	…	*100.0*	-
66	Armenia	70'000	1.84	78.3	…	*100.0*	*6*
67	Belarus	22'714	0.23	69.3	*6'605*	*99.9*	123
68	Bolivia	52'549	0.62	9.5	…	*100.0*	-
69	Bosnia	*87'000*	*2.27*	…	*37'641*	*99.8*	*213*
70	Brazil	*7'900'000*	*4.49*	…	…	*90.7*	*731'000*
71	Bulgaria	*8'500*	*0.11*	…	2'872	100.0	*43'520*
72	Cape Verde	5'011	1.09	26.8	…	*100.0*	-
73	China	67'746'500	5.39	95.8	56'531'000	84.5	10'519'000
74	Colombia	712'868	1.63	43.8	…	*95.1*	45'108
75	Cuba	…	...	…	…	…	-
76	Djibouti	2'100	0.31	48.1	*1'600*	*100.0*	6
77	Dominican Rep.	96'391	1.23	22.2	…	*100.0*	-
78	Ecuador	107'350	0.83	22.7	*94'164*	…	8'742
79	Egypt	…	...	…	…	…	4'850
80	El Salvador	112'575	1.73	…	…	*100.0*	93'435
81	Fiji	9'000	1.09	37.0	*7'520*	*100.0*	-
82	Guatemala	…	...	…	…	…	-
83	Guyana	*20'000*	*2.25*	…	…	*100.0*	-
84	Honduras	*75'000*	*1.09*	…	*28'000*	*100.0*	-
85	Iran (I.R.)	*816'171*	*1.23*	…	*800'000*	*98.0*	*16'171*
86	Iraq	…	...	…	…	…	-
87	Jamaica	*95'000*	*3.59*	…	…	…	-
88	Jordan	95'847	1.75	44.2	*59'673*	*94.8*	4'996
89	Kazakhstan	…	...	…	…	…	-
90	Kiribati	*758*	*0.85*	…	*758*	*100.0*	-
91	Maldives	*1'067*	*0.37*	…	…	*82.2*	*190*
92	Marshall Islands	695	1.29	19.3	*654*	*100.0*	-
93	Micronesia	1'913	1.77	8.9	1'913	100.0	-
94	Morocco	60'000	0.20	17.5	*36'000*	*95.5*	2'700
95	Namibia	15'500	0.81	15.7	…	*100.0*	-
96	Palestine	40'000	1.11	78.7	…	*100.0*	-
97	Paraguay	35'000	0.59	6.4	…	*98.6*	500
98	Peru	*409'189*	*1.49*	…	…	*91.6*	*81'786*
99	Philippines	*800'000*	*0.99*	…	*625'000*	*97.4*	*21'000*
100	Romania	860'000	4.10	…	*350'000*	*98.2*	143'300
101	Russia	*1'890'500*	*1.29*	…	…	*99.4*	-
102	Samoa	*1'320*	*0.72*	…	…	*100.0*	-
103	Serbia and Montenegro	335'000	3.11	…	…	*100.0*	-
104	South Africa	*1'000'000*	*2.16*	…	*937'526*	*99.7*	*2'669*
105	Sri Lanka	85'500	0.45	28.3	*52'455*	*99.3*	817
106	St. Vincent	*5'982*	*5.03*	…	*3'178*	*81.8*	*1'086*
107	Suriname	*5'529*	*1.05*	…	*5'435*	*96.9*	166
108	Swaziland	19'000	1.82	56.0	*3'500*	*100.0*	-
109	Syria	*73'000*	*0.42*	…	*73'000*	*100.0*	-
110	TFYR Macedonia	*30'000*	*1.44*	…	…	*100.0*	-
111	Thailand	*1'500'000*	*2.40*	…	…	*99.0*	*15'900*
112	Tonga	*1'893*	*1.90*	…	*1'870*	*99.4*	*11*
113	Tunisia	91'800	0.93	37.9	*59'000*	*97.2*	2'590
114	Turkey	3'500'000	5.13	32.6	…	*98.4*	56'500
115	Turkmenistan	*2'174*	*0.04*	…	…	*100.0*	-
116	Ukraine	…	...	…	…	…	-
117	Vanuatu	1'500	0.72	2.3	…	*100.0*	15
	Lower Middle Income	**88'881'896**	**3.70**	**87.0**			**11'796'400**

4. Internet subscribers

		Internet subscribers Total	Internet subscribers per 100 inhabitants	CAGR %	Dial-up Total	Dial-up as % of total subscribers	Broadband subscribers
		2003	2003	2000-03	2003	2003	2003
118	Argentina	*1'430'000*	*3.87*	…	*755'000*	*92.0*	*110'400*
119	Belize	5'133	1.74	6.1	*5'190*	*100.0*	*585*
120	Botswana	*15'000*	*0.85*	…	…	*100.0*	-
121	Chile	841'396	5.72	12.8	*569'306*	*77.6*	348'975
122	Costa Rica	*96'382*	*2.31*	…	…	*99.6*	*363*
123	Croatia	*538'000*	*12.30*	…	*650'000*	*97.8*	*12'000*
124	Czech Republic	2'112'631	20.99	71.6	…	*99.3*	*15'300*
125	Dominica	*4'474*	*5.72*	…	…	*92.8*	*320*
126	Estonia	*121'000*	*9.42*	…	*74'500*	*62.2*	*46'500*
127	Gabon	7'800	0.58	16.0	…	*99.4*	50
128	Grenada	4'700	4.18	19.2	*2'742*	*74.5*	1'200
129	Guadeloupe	*25'000*	*5.69*	…	…	*100.0*	-
130	Hungary	673'732	6.52	45.1	*327'480*	*83.5*	228'270
131	Latvia	*37'693*	*1.63*	…	*36'693*	*73.5*	19'196
132	Lebanon	*130'000*	*3.71*	…	…	*73.1*	*35'000*
133	Libya	…	...	…	…	…	-
134	Lithuania	161'349	4.95	44.7	*59'217*	*87.6*	47'229
135	Malaysia	3'007'481	11.95	21.9	2'897'377	96.3	110'104
136	Mauritius	*58'000*	*4.75*	…	60'000	99.5	*285*
137	Mayotte	…	...	…	…	…	-
138	Mexico	*2'044'000*	*1.98*	…	…	*91.3*	*86'600*
139	Northern Marianas	…	...	…	…	…	-
140	Oman	*48'232*	*1.86*	…	…	*100.0*	-
141	Panama	*65'961*	*2.12*	…	*40'520*	*100.0*	-
142	Poland	*1'605'846*	*4.16*	…	…	*99.1*	*131'684*
143	Saudi Arabia	600'000	2.66	44.2	…	*98.7*	8'000
144	Seychelles	*3'332*	*4.17*	…	*1'285*	*96.4*	*120*
145	Slovak Republic	182'143	3.39	25.6	*97'560*	*100.0*	7'708
146	St. Kitts and Nevis	*4'600*	*9.60*	…	…	*89.1*	*500*
147	St. Lucia	…	...	…	…	…	-
148	Trinidad & Tobago	*37'000*	*2.84*	…	*31'599*	*99.5*	*176*
149	Uruguay	…	...	…	…	…	-
150	Venezuela	*337'012*	*1.31*	…	*269'610*	*66.1*	*114'272*
	Upper Middle Income	**14'197'897**	**4.26**	**32.8**			**1'324'837**

4. Internet subscribers

		Internet subscribers		CAGR	Dial-up		Broadband
		Total	per 100 inhabitants	%	Total	as % of total subscribers	subscribers
		2003	2003	2000-03	2003	2003	2003
151	Andorra	6'308	7.49	…	…	…	*3'601*
152	Antigua & Barbuda	…	...	…	…	…	-
153	Aruba	*8'000*	*7.01*	…	…	*100.0*	-
154	Australia	5'076'000	25.45	9.0	4'510'000	94.9	596'500
155	Austria	1'300'000	16.10	7.4	*750'000*	*58.5*	601'000
156	Bahamas	27'742	8.75	49.2	…	*29.6*	*22'941*
157	Bahrain	*52'865*	*7.62*	…	*47'885*	*90.6*	*9'737*
158	Barbados	…	...	…	…	…	27'319
159	Belgium	*1'694'384*	*16.34*	…	*289'184*	*48.7*	*872'400*
160	Bermuda	…	...	…	…	…	-
161	Brunei Darussalam	*23'000*	*6.35*	…	…	*100.0*	-
162	Canada	*5'624'000*	*17.73*	…	*3'100'000*	*17.3*	4'653'000
163	Cyprus	*79'000*	*10.65*	…	*72'700*	*87.3*	10'033
164	Denmark	2'715'868	50.35	17.3	*1'724'472*	*83.8*	717'083
165	Faroe Islands	*8'642*	*17.11*	…	…	*100.0*	-
166	Finland	1'319'100	25.27	28.9	…	*79.3*	491'100
167	France	10'524'727	17.57	24.6	*7'469'000*	*84.0*	3'361'288
168	French Guiana	*12'000*	*6.63*	…	…	*100.0*	-
169	French Polynesia	13'000	5.34	22.9	12'100	100.0	946
170	Germany	23'000'000	27.88	35.2	…	*86.1*	4'560'000
171	Greece	785'817	6.86	42.6	*269'331*	*100.0*	360
172	Greenland	*9'071*	*15.83*	…	*5'947*	*100.0*	-
173	Guam	…	...	…	…	…	*1'750*
174	Guernsey	*760*	*1.36*	…	…	…	-
175	Hong Kong, China	2'321'013	33.89	2.0	1'071'299	46.2	1'230'607
176	Iceland	*50'000*	*17.30*	…	…	*51.5*	40'419
177	Ireland	*1'108'000*	*27.53*	…	…	*99.0*	30'200
178	Israel	*956'000*	*14.13*	…	*800'000*	*32.0*	650'000
179	Italy	17'000'000	30.94	43.1	…	*95.0*	2'200'000
180	Japan	33'905'035	26.59	23.2	18'987'870	59.4	14'917'165
181	Jersey	…	...	…	…	…	-
182	Korea (Rep.)	11'178'498	23.32	29.7	*375'125*	*0.0*	11'179'121
183	Kuwait	227'000	9.24	…	…	*94.3*	13'000
184	Luxembourg	107'601	23.83	63.8	92'250	94.7	15'351
185	Macao, China	59'552	13.28	29.4	31'808	53.4	27'744
186	Malta	76'814	19.20	30.7	…	*77.0*	22'736
187	Martinique	40'000	10.20	38.7	…	*100.0*	*6'000*
188	Neth. Antilles	…	...	…	…	…	-
189	Netherlands	5'000'000	30.70	-5.4	…	*78.6*	1'850'000
190	New Caledonia	30'000	13.10	18.6	…	*97.7*	*700*
191	New Zealand	782'000	19.51	16.1	…	*94.4*	83'000
192	Norway	1'278'086	27.90	2.8	*1'197'866*	*83.9*	385'917
193	Portugal	7'211'208	69.77	50.6	*4'902'294*	*96.4*	499'921
194	Puerto Rico	*256'000*	*6.60*	…	…	*91.1*	*22'732*
195	Qatar	28'062	4.40	38.6	*19'286*	*90.0*	2'800
196	Réunion	*47'720*	*6.31*	…	…	…	-
197	Singapore	2'202'800	52.49	37.2	1'778'200	80.9	421'800
198	Slovenia	240'479	12.04	19.8	*130'000*	*76.4*	57'992
199	Spain	5'217'453	12.74	17.4	…	*76.1*	2'134'193
200	Sweden	*3'186'960*	*35.50*	…	*2'178'000*	*69.6*	967'464
201	Switzerland	*2'275'000*	*31.09*	…	*1'800'000*	*80.0*	837'000
202	Taiwan, China	7'822'117	34.56	19.0	*5'341'395*	*61.6*	3'022'678
203	United Arab Emirates	317'202	7.85	14.8	*274'336*	*92.1*	25'335
204	United Kingdom	*13'100'000*	*22.54*	…	*12'700'000*	*86.1*	*1'821'000*
205	United States	*70'000'000*	*23.95*	…	…	*64.1*	27'150'746
206	Virgin Islands (US)	…	...	…	…	…	-
	High Income	**238'304'884**	**24.51**	**24.4**			**85'544'679**
	WORLD	**348'422'763**	**5.60**	**35.8**			**98'875'038**
	Africa	**1'899'467**	**0.23**	**38.5**			**29'331**
	Americas	**90'541'833**	**10.52**	**22.9**			**31'235'610**
	Asia	**140'538'046**	**3.81**	**43.7**			**41'267'288**
	Europe	**109'497'338**	**13.77**	**28.2**			**14'323'445**
	Oceania	**5'946'079**	**18.38**	**9.9**			**304'061**

Note: Data in italics refer to an earlier year.
Source: ITU.

5. Information technology

		Internet				Estimated PCs	
		Hosts Total 2003	Hosts per 10'000 inhab. 2003	Users (k) 2003	Users per 10'000 inhab. 2003	Total (k) 2003	Per 100 inhab. 2003
1	Afghanistan	4	-	20.0	9.97	...	...
2	Angola	17	0.01	41.0	29.42	27	0.19
3	Azerbaijan	571	0.69	300.0	368.51	...	...
4	Bangladesh	1	-	243.0	17.98	1'050	0.78
5	Benin	854	1.22	70.0	99.64	26	0.37
6	Bhutan	985	13.91	15.0	211.83	10	1.45
7	Burkina Faso	442	0.36	48.0	39.16	26	0.21
8	Burundi	22	0.03	14.0	19.67	13	0.18
9	Cambodia	818	0.58	35.0	24.75	27	0.20
10	Cameroon	477	0.29	60.0	37.90	90	0.57
11	Central African Rep.	6	0.01	6.0	14.49	8	0.20
12	Chad	11	0.01	15.0	19.06	13	0.17
13	Comoros	11	0.14	5.0	62.58	5	0.58
14	Congo	46	0.13	15.0	42.86	15	0.43
15	Côte d'Ivoire	3'791	2.28	240.0	144.30	154	0.93
16	D.P.R. Korea	...	...	-	-	...	...
17	D.R. Congo	153	0.03	50.0	9.50	...	...
18	Equatorial Guinea	3	0.06	1.8	35.64	4	0.69
19	Eritrea	1'045	2.52	9.5	22.89	12	0.29
20	Ethiopia	9	-	75.0	10.81	150	0.22
21	Gambia	568	4.16	25.0	188.30	19	1.43
22	Georgia	4'927	10.07	150.5	307.60	156	3.16
23	Ghana	389	0.17	170.0	78.43	82	0.38
24	Guinea	372	0.48	40.0	51.61	43	0.55
25	Guinea-Bissau	2	0.02	19.0	148.44	...	...
26	Haiti	-	-	80.0	96.41	...	...
27	India	86'871	0.82	18'481.0	174.86	7'500	0.72
28	Indonesia	62'036	2.88	8'080.0	375.65	2'519	1.19
29	Kenya	8'325	2.63	400.0	126.98	204	0.65
30	Kyrgyzstan	5'705	10.96	152.0	298.33	65	1.27
31	Lao P.D.R.	937	1.65	15.0	27.11	18	0.33
32	Lesotho	119	0.55	21.0	96.91	...	...
33	Liberia	14	0.04	1.0	3.22	...	...
34	Madagascar	773	0.47	70.5	43.15	80	0.49
35	Malawi	18	0.02	36.0	34.32	16	0.15
36	Mali	187	0.17	25.0	23.52	15	0.14
37	Mauritania	25	0.09	10.0	37.28	29	1.08
38	Moldova	11'984	27.17	288.0	653.06	77	1.75
39	Mongolia	40	0.16	142.8	581.13	190	7.73
40	Mozambique	3'249	1.73	50.0	27.65	82	0.45
41	Myanmar	3	-	28.0	5.26	300	0.56
42	Nepal	917	0.39	80.0	34.48	85	0.37
43	Nicaragua	7'094	12.84	90.0	167.60	150	2.79
44	Niger	134	0.11	15.0	12.77	7	0.06
45	Nigeria	1'094	0.09	750.0	60.82	853	0.71
46	Pakistan	15'124	1.01	1'500.0	102.77	600	0.42
47	Papua New Guinea	389	0.69	75.0	137.26	321	5.87
48	Rwanda	1'495	1.78	25.0	30.60	...	...
49	S. Tomé & Principe	1'069	70.33	15.0	986.84	...	...
50	Senegal	672	0.65	225.0	217.20	220	2.12
51	Sierra Leone	277	0.56	8.0	16.16	...	...
52	Solomon Islands	398	8.34	2.5	52.41	18	4.05
53	Somalia	4	-	89.0	90.29	...	...
54	Sudan	-	-	300.0	90.13	200	0.61
55	Tajikistan	75	0.11	4.1	6.30	...	...
56	Tanzania	5'534	1.57	250.0	70.80	200	0.57
57	Togo	82	0.16	210.0	420.00	160	3.20
58	Uganda	2'561	1.00	125.0	48.83	103	0.40
59	Uzbekistan	1'040	0.41	492.0	192.08	...	...
60	Viet Nam	340	0.04	3'500.0	430.10	800	0.98
61	Yemen	138	0.07	100.0	51.30	145	0.74
62	Zambia	1'880	1.68	68.2	60.88	95	0.85
63	Zimbabwe	4'501	3.83	500.0	429.75	620	5.27
	Low Income	**240'628**	**0.97**	**37'971.9**	**151.62**	**17'600**	**0.76**

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		Internet				Estimated PCs	
		Hosts Total 2003	*Hosts per 10'000 inhab. 2003*	*Users (k) 2003*	*Users per 10'000 inhab. 2003*	*Total (k) 2003*	*Per 100 inhab. 2003*
64	Albania	250	0.81	30.0	97.63	*36*	*1.17*
65	Algeria	866	0.27	*500.0*	*159.78*	*242*	*0.77*
66	Armenia	2'080	5.47	200.0	526.29	*60*	*1.58*
67	Belarus	4'971	5.03	1'391.9	1'409.78	...	...
68	Bolivia	7'080	8.42	*270.0*	*323.70*	*190*	*2.28*
69	Bosnia	7'233	18.87	*100.0*	*262.12*	...	...
70	Brazil	3'163'349	179.78	*14'300.0*	*822.41*	*13'000*	*7.48*
71	Bulgaria	49'969	66.57	1'545.1	2'058.38	*405*	*5.19*
72	Cape Verde	63	1.37	20.4	444.14	*35*	*7.77*
73	China	160'421	1.28	79'500.0	632.48	*35'500*	*2.76*
74	Colombia	115'158	26.30	2'732.2	624.04	*2'133*	*4.93*
75	Cuba	1'529	1.35	*120.0*	*106.79*	*359*	*3.18*
76	Djibouti	670	10.03	6.5	97.31	15	2.17
77	Dominican Rep.	64'197	82.16	500.0	639.90	...	...
78	Ecuador	3'188	2.45	569.7	438.14	*403*	*3.11*
79	Egypt	3'338	0.49	2'700.0	393.31	1'500	2.19
80	El Salvador	4'084	6.27	550.0	844.14	*163*	*2.52*
81	Fiji	493	5.97	55.0	665.98	*40*	*4.88*
82	Guatemala	20'360	16.53	*400.0*	*333.42*	*173*	*1.44*
83	Guyana	613	6.90	*125.0*	*1'422.07*	*24*	*2.73*
84	Honduras	1'944	2.83	*168.6*	*251.66*	*91*	*1.36*
85	Iran (I.R.)	5'052	0.76	4'300.0	650.09	*4'900*	*7.50*
86	Iraq	1	-	*25.0*	*10.31*	*200*	*0.83*
87	Jamaica	1'480	5.59	*600.0*	*2'284.50*	*141*	*5.37*
88	Jordan	3'123	5.70	457.0	833.91	*200*	*3.75*
89	Kazakhstan	21'339	13.47	*250.0*	*156.56*	...	...
90	Kiribati	17	1.91	*2.0*	*228.42*	*1*	*1.14*
91	Maldives	532	18.55	*15.0*	*533.81*	*20*	*7.12*
92	Marshall Islands	6	1.11	1.4	259.45	*3*	*5.64*
93	Micronesia	686	63.58	10.0	926.78	...	...
94	Morocco	3'561	1.18	800.0	265.57	600	1.99
95	Namibia	3'164	16.44	65.0	337.84	191	9.93
96	Palestine	...	...	145.0	400.73	*125*	*3.62*
97	Paraguay	9'243	15.59	120.0	202.34	*200*	*3.46*
98	Peru	65'868	24.02	2'850.0	1'039.33	*1'149*	*4.30*
99	Philippines	27'996	3.45	*3'500.0*	*440.38*	*2'200*	*2.77*
100	Romania	47'428	22.59	4'000.0	1'905.27	*1'800*	*8.30*
101	Russia	617'730	42.19	*6'000.0*	*409.32*	*13'000*	*8.87*
102	Samoa	8'225	451.41	*4.0*	*221.73*	*1*	*0.67*
103	Serbia and Montenegro	19'831	18.43	847.0	787.17	*290*	*2.71*
104	South Africa	288'633	62.25	*3'100.0*	*682.01*	*3'300*	*7.26*
105	Sri Lanka	1'882	0.98	225.0	117.41	*250*	*1.32*
106	St. Vincent	4	0.34	*7.0*	*598.29*	*14*	*11.97*
107	Suriname	18	0.34	*20.0*	*415.67*	*20*	*4.55*
108	Swaziland	1'401	13.42	27.0	258.62	30	2.87
109	Syria	11	0.01	*220.0*	*129.11*	*330*	*1.94*
110	TFYR Macedonia	3'596	17.25	*100.0*	*484.50*	...	...
111	Thailand	103'700	16.58	6'031.3	964.53	*2'461*	*3.98*
112	Tonga	18'906	1'900.10	*2.9*	*292.34*	*2*	*2.02*
113	Tunisia	271	0.27	630.0	637.01	400	4.05
114	Turkey	359'188	52.60	5'500.0	805.46	*3'000*	*4.46*
115	Turkmenistan	544	1.12	*8.0*	*16.55*	...	...
116	Ukraine	91'342	18.28	*900.0*	*179.51*	*951*	*1.90*
117	Vanuatu	512	24.65	7.5	361.10	*3*	*1.48*
	Lower Middle Income	**5'317'146**	**22.18**	**146'554.6**	**612.07**	**90'151**	**3.80**

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		Internet				Estimated PCs	
		Hosts Total 2003	*Hosts per 10'000 inhab. 2003*	*Users (k) 2003*	*Users per 10'000 inhab. 2003*	*Total (k) 2003*	*Per 100 inhab. 2003*
118	Argentina	742'358	200.75	*4'100.0*	*1'120.22*	*3'000*	*8.20*
119	Belize	2'613	88.52	*30.0*	*1'088.53*	*35*	*12.70*
120	Botswana	1'920	10.91	*60.0*	*348.84*	*70*	*4.07*
121	Chile	202'429	137.64	4'000.0	2'719.85	*1'796*	*11.93*
122	Costa Rica	10'826	25.94	*800.0*	*1'930.97*	*817*	*19.72*
123	Croatia	29'644	67.77	1'014.0	2'318.24	*760*	*17.38*
124	Czech Republic	276'186	274.41	2'700.0	2'682.67	*1'800*	*17.74*
125	Dominica	681	87.08	*12.5*	*1'602.56*	*7*	*8.97*
126	Estonia	64'048	498.86	*444.0*	*3'276.75*	*285*	*21.03*
127	Gabon	283	2.12	35.0	261.78	30	2.24
128	Grenada	18	1.60	19.0	1'690.39	*14*	*13.21*
129	Guadeloupe	434	9.87	*50.0*	*1'148.64*	*111*	*25.50*
130	Hungary	369'720	357.76	2'400.0	2'322.39	*1'100*	*10.84*
131	Latvia	41'263	178.84	936.0	4'056.87	*400*	*17.17*
132	Lebanon	7'552	21.58	*400.0*	*1'171.30*	*275*	*8.05*
133	Libya	67	0.12	160.0	289.33	*130*	*2.34*
134	Lithuania	66'373	203.79	695.7	2'136.01	*380*	*10.97*
135	Malaysia	107'971	42.90	8'692.1	3'453.31	*3'600*	*14.68*
136	Mauritius	3'985	32.64	150.0	1'228.50	*180*	*14.87*
137	Mayotte	-	-	...	...	...	...
138	Mexico	1'333'406	128.95	12'250.3	1'184.65	*8'353*	*8.20*
139	Northern Marianas	17	2.21	...	...	...	...
140	Oman	726	2.79	*180.0*	*709.22*	*95*	*3.74*
141	Panama	7'129	22.87	*120.0*	*413.94*	*115*	*3.83*
142	Poland	786'522	203.82	8'970.0	2'324.50	*4'079*	*10.56*
143	Saudi Arabia	15'830	7.02	1'500.0	665.52	*3'003*	*13.67*
144	Seychelles	264	33.00	*11.7*	*1'452.10*	*13*	*16.08*
145	Slovak Republic	114'088	212.18	1'375.8	2'558.69	*970*	*18.04*
146	St. Kitts and Nevis	51	10.65	*10.0*	*2'127.66*	*9*	*19.15*
147	St. Lucia	41	2.53	*13.0*	823.96	*24*	*15.00*
148	Trinidad & Tobago	8'003	61.42	*138.0*	*1'060.32*	*104*	*7.95*
149	Uruguay	87'630	257.04	*400.0*	*1'190.12*	*370*	*11.01*
150	Venezuela	35'301	13.74	*1'274.4*	505.63	*1'536*	*6.09*
	Upper Middle Income	**4'317'379**	**129.46**	**52'941.6**	**1'594.91**	**33'460**	**10.15**

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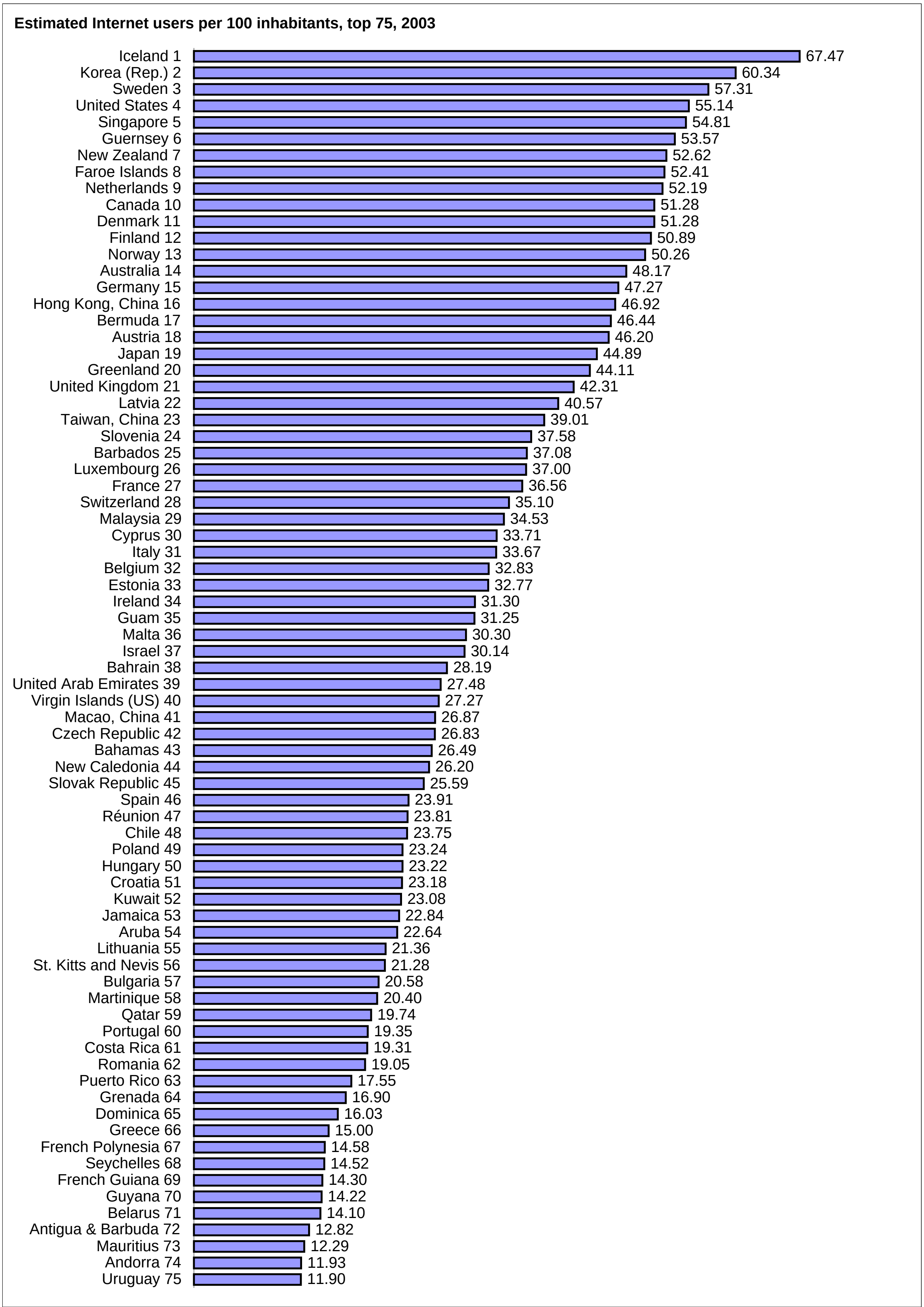
		Internet				Estimated PCs	
		Hosts Total 2003	*Hosts per 10'000 inhab. 2003*	*Users (k) 2003*	*Users per 10'000 inhab. 2003*	*Total (k) 2003*	*Per 100 inhab. 2003*
151	Andorra	4'138	491.45	10.0	1'193.47	...	...
152	Antigua & Barbuda	1'665	211.83	*10.0*	*1'282.05*	...	...
153	Aruba	3'630	317.86	*24.0*	*2'264.15*	...	...
154	Australia	2'847'763	1'428.07	11'300.0	5'666.63	*11'100*	*56.45*
155	Austria	575'903	713.37	3'730.0	4'620.34	*3'013*	*37.41*
156	Bahamas	302	9.52	84.0	2'649.01	...	...
157	Bahrain	1'334	19.22	195.7	2'819.48	*107*	*15.92*
158	Barbados	204	7.56	100.0	3'707.82	*28*	*10.41*
159	Belgium	210'168	202.62	*3'400.0*	*3'283.17*	*2'500*	*24.14*
160	Bermuda	8'808	1'346.79	*30.0*	*4'643.96*	*34*	*52.31*
161	Brunei Darussalam	6'409	176.90	*35.0*	*1'023.39*	*27*	*7.67*
162	Canada	3'210'081	1'011.99	*16'110.0*	*5'128.29*	*15'300*	*48.70*
163	Cyprus	5'778	77.91	250.0	3'371.09	*193*	*26.99*
164	Denmark	1'248'296	2'314.45	*2'756.0*	*5'128.15*	*3'100*	*57.68*
165	Faroe Islands	2'584	511.68	*25.0*	*5'240.65*	...	...
166	Finland	1'271'634	2'436.55	*2'650.0*	*5'089.30*	*2'300*	*44.17*
167	France	2'403'459	401.24	21'900.0	3'656.08	*20'700*	*34.71*
168	French Guiana	1	0.06	*25.0*	*1'430.12*	*29*	*16.59*
169	French Polynesia	5'123	204.92	35.0	1'400.00	*70*	*28.52*
170	Germany	2'603'007	315.48	39'000.0	4'726.70	*35'600*	*43.13*
171	Greece	195'291	170.46	1'718.4	1'499.93	*900*	*8.17*
172	Greenland	2'616	456.54	*25.0*	*4'411.04*	...	...
173	Guam	93	5.74	*50.0*	*3'125.00*	...	...
174	Guernsey	1'734	310.75	*30.0*	*5'357.14*	...	...
175	Hong Kong, China	591'993	869.29	3'212.8	4'717.70	*2'864*	*42.20*
176	Iceland	109'521	3'789.65	195.0	6'747.40	*130*	*45.14*
177	Ireland	158'832	394.58	1'260.0	3'130.20	*1'654*	*42.08*
178	Israel	435'625	643.87	*2'000.0*	*3'014.05*	*1'610*	*24.26*
179	Italy	626'536	114.02	18'500.0	3'366.60	*13'025*	*23.07*
180	Japan	12'962'065	1'015.68	61'600.0	4'826.87	*48'700*	*38.22*
181	Jersey	1'672	190.00	...	...	...	...
182	Korea (Rep.)	253'242	52.84	29'220.0	6'096.99	26'741	55.80
183	Kuwait	2'709	11.03	567.0	2'308.16	*285*	*12.06*
184	Luxembourg	28'214	624.89	170.0	3'765.23	*265*	*59.42*
185	Macao, China	89	1.98	120.0	2'675.59	117	26.09
186	Malta	7'117	177.93	*120.0*	*3'030.30*	*101*	*25.51*
187	Martinique	318	8.11	80.0	2'039.67	80	20.40
188	Neth. Antilles	124	5.57	...	...	...	...
189	Netherlands	3'521'932	2'162.66	8'500.0	5'219.46	*7'557*	*46.66*
190	New Caledonia	4'449	194.28	60.0	2'620.09	...	...
191	New Zealand	474'395	1'183.27	2'110.0	5'262.90	*1'630*	*41.38*
192	Norway	570'710	1'245.93	1'583.3	3'456.53	*2'405*	*52.83*
193	Portugal	227'002	219.63	*2'000.0*	*1'935.07*	*1'394*	*13.49*
194	Puerto Rico	85	0.22	*677.0*	*1'754.57*	...	...
195	Qatar	221	3.46	126.0	1'973.99	*110*	*17.82*
196	Réunion	20	0.26	180.0	2'380.95	*53*	*7.13*
197	Singapore	484'825	1'155.31	2'135.0	5'087.65	*2'590*	*62.20*
198	Slovenia	42'888	214.76	*750.0*	*3'757.52*	*600*	*30.06*
199	Spain	910'677	222.44	9'789.0	2'391.08	*7'972*	*19.60*
200	Sweden	943'139	1'050.72	*5'125.0*	*5'730.74*	*5'556*	*62.13*
201	Switzerland	548'044	748.93	*2'556.0*	*3'510.38*	*5'160*	*70.87*
202	Taiwan, China	2'777'085	1'228.55	8'830.0	3'906.29	10'655	47.14
203	United Arab Emirates	56'169	139.02	1'110.2	2'747.83	*450*	*11.99*
204	United Kingdom	3'169'318	545.33	*25'000.0*	*4'230.98*	*23'972*	*40.57*
205	United States	162'208'993	5'549.40	*159'000.0*	*5'513.77*	*190'000*	*65.89*
206	Virgin Islands (US)	3'783	341.73	*30.0*	*2'727.27*	...	...
	High Income	**205'731'813**	**2'116.08**	**450'099.5**	**4'648.18**	**450'677**	**46.82**
	WORLD	**215'606'966**	**348.09**	**687'567.6**	**1'109.15**	**591'888**	**9.91**
	Africa	**348'699**	**4.22**	**12'273.6**	**149.71**	**10'305**	**1.38**
	Americas	**171'316'940**	**2'002.47**	**221'973.7**	**2'620.29**	**239'717**	**28.95**
	Asia	**18'211'053**	**50.30**	**248'093.7**	**685.94**	**160'740**	**4.52**
	Europe	**22'338'832**	**280.95**	**190'190.3**	**2'388.30**	**167'430**	**21.44**
	Oceania	**3'360'659**	**1'053.02**	**13'653.3**	**4'301.93**	**13'188**	**42.39**

Note: For data comparability and coverage, see the technical notes.
Figures in italics are estimates or refer to years other than those specified.

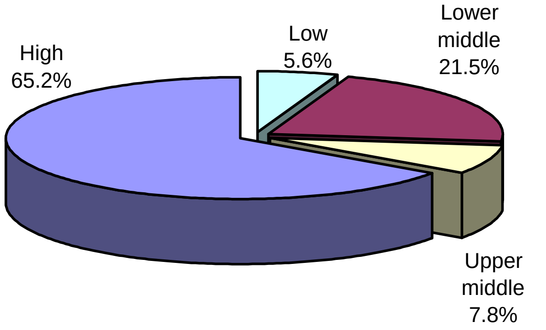
Source: ITU (Internet host data: Network Wizards, RIPE).

5. Information technology: Internet users

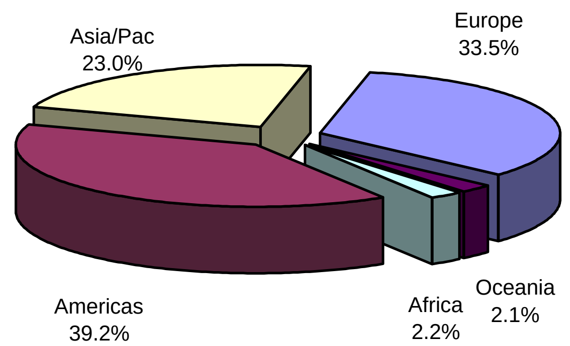


5. Information technology: Internet users

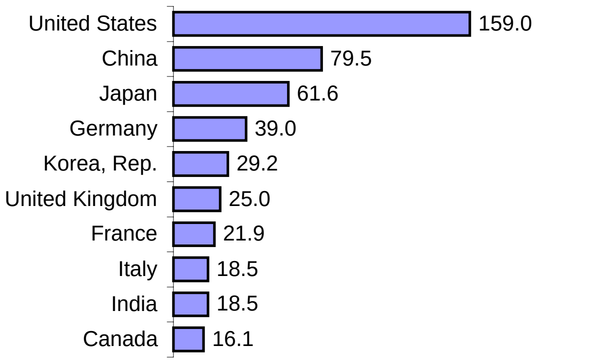
Internet users, by income, 2003



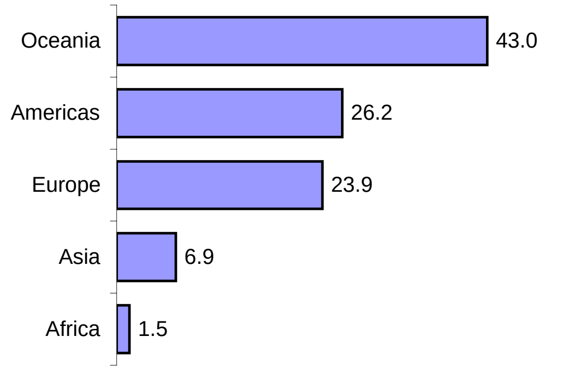
Internet users, by region, 2003



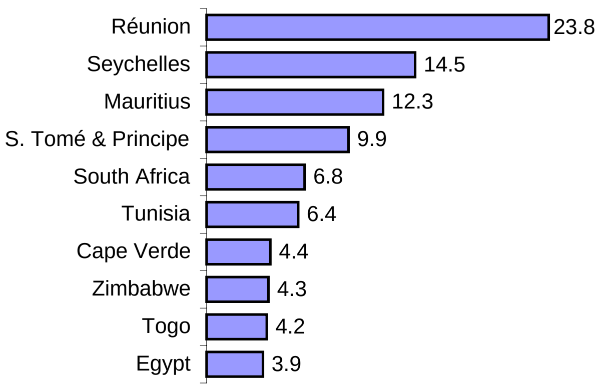
Internet users, top 10, 2003, millions



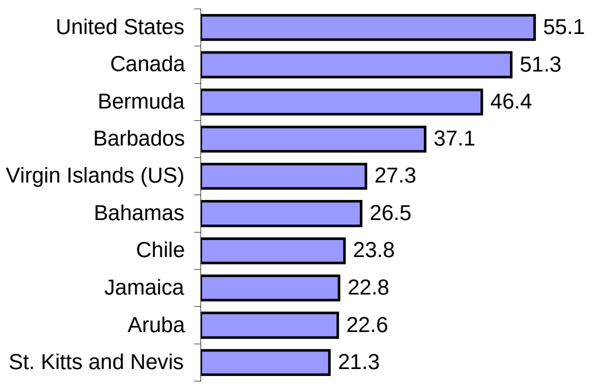
Internet users/100 inhabitants, by region, 2003



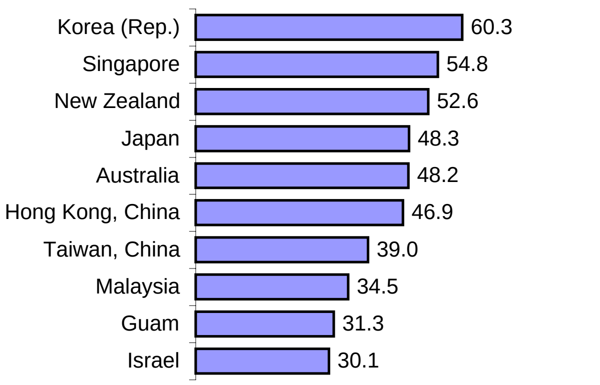
Africa: Internet users/100 inhab, top 10, 2003



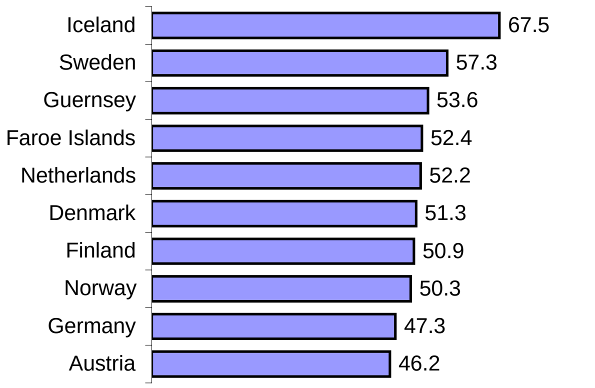
Americas: Internet users/100 inhab, top 10, 2003



Asia/Pacific: Internet users/100 inhab, top 10, 2003



Europe: Internet users/100 inhab, top 10, 2003



* Penetration = subscribers per 100 inhabitants

6. Broadband subscribers

		DSL		Cable modem	Other	Total broadband subscribers	
		Total	*as % of residential telephone*	*Total*	*Total*	*Total*	*per 100 inhabitants*
		2003	*2003*	*2003*	*2003*	*2003*	*2003*
1	Afghanistan	-	-	-	…	-	-
2	Angola	-	-	-	…	-	-
3	Azerbaijan	-	-	-	…	-	-
4	Bangladesh	-	-	-	-	-	-
5	Benin	-	-	-	…	-	-
6	Bhutan	-	-	-	-	-	-
7	Burkina Faso	75	0.11	-	-	75	0.00
8	Burundi	-	-	-	…	-	-
9	Cambodia	350	0.96	-	…	350	0.00
10	Cameroon	-	-	-	…	-	-
11	Central African Rep.	-	-	-	…	-	-
12	Chad	-	-	-	…	-	-
13	Comoros	-	-	-	…	-	-
14	Congo	-	-	-	…	-	-
15	Côte d'Ivoire	-	-	-	…	-	-
16	D.P.R. Korea	-	-	-	…	-	-
17	D.R. Congo	-	-	-	…	-	-
18	Equatorial Guinea	-	-	-	…	-	-
19	Eritrea	-	-	-	-	-	-
20	Ethiopia	57	0.01	-	-	57	0.00
21	Gambia	-	-	-	…	-	-
22	Georgia	400	0.06	1'010	…	1'410	0.03
23	Ghana	-	-	-	…	-	-
24	Guinea	-	-	-	…	-	-
25	GuineaoBissau	-	-	-	…	-	-
26	Haiti	-	-	-	…	-	-
27	India	53'073	0.11	87'289	…	140'362	0.01
28	Indonesia	*31'300*	*0.37*	*5'000*	…	*36'300*	*0.02*
29	Kenya	-	-	-	…	-	-
30	Kyrgyzstan	-	-	-	…	-	-
31	Lao P.D.R.	-	-	-	…	-	-
32	Lesotho	-	-	-	…	-	-
33	Liberia	-	-	-	…	-	-
34	Madagascar	-	-	-	…	-	-
35	Malawi	-	-	69	-	69	0.00
36	Mali	-	-	-	…	-	-
37	Mauritania	-	-	-	…	-	-
38	Moldova	331	0.04	401	*30*	762	0.02
39	Mongolia	370	0.27	50	80	500	0.02
40	Mozambique	-	-	-	…	-	-
41	Myanmar	-	-	-	…	-	-
42	Nepal	-	-	-	…	-	-
43	Nicaragua	-	-	*2'319*	…	*2'319*	*0.04*
44	Niger	-	-	-	…	-	-
45	Nigeria	-	-	-	…	-	-
46	Pakistan	-	-	-	…	-	-
47	Papua New Guinea	-	-	-	…	-	-
48	Rwanda	-	-	-	…	-	-
49	S. Tomé & Principe	-	-	-	…	-	-
50	Senegal	2'100	0.92	-	…	2'100	0.02
51	Sierra Leone	-	-	-	…	-	-
52	Solomon Islands	205	3.29	-	…	205	0.04
53	Somalia	-	-	-	…	-	-
54	Sudan	10'000	1.11	-	…	10'000	0.03
55	Tajikistan	-	-	10	…	10	0.00
56	Tanzania	-	-	-	…	-	-
57	Togo	-	-	-	…	-	-
58	Uganda	-	-	-	…	-	-
59	Uzbekistan	1'690	0.10	1'067	…	2'757	0.01
60	Viet Nam	7'228	0.16	-	…	7'228	0.01
61	Yemen	-	-	-	-	-	-
62	Zambia	-	-	-	…	-	-
63	Zimbabwe	-	-	3'436	1'182	4'618	0.04
	Low Income	**107'179**	**0.14**	**100'651**	**1'292**	**209'122**	**0.01**

6. Broadband subscribers

		DSL		Cable modem	Other	Total broadband subscribers	
		Total	as % of residential telephone	Total	Total	Total	per 100 inhabitants
		2003	2003	2003	2003	2003	2003
64	Albania	-	-	-	…	-	-
65	Algeria	-	-	-	…	-	-
66	Armenia	*6*	*0.00*	…	…	*6*	*0.00*
67	Belarus	123	0.00	-	…	123	0.00
68	Bolivia	-	-	-	…	-	-
69	Bosnia	-	-	-	*213*	*213*	*0.01*
70	Brazil	*600'000*	*1.42*	*131'000*	…	*731'000*	*0.42*
71	Bulgaria	-	-	43'520	…	*43'520*	*0.58*
72	Cape Verde	-	-	-	-	-	-
73	China	8'119'000	3.09	2'400'000	…	10'519'000	0.84
74	Colombia	6'434	0.07	38'674	…	45'108	0.10
75	Cuba	-	-	-	…	-	-
76	Djibouti	-	-	-	*6*	6	0.00
77	Dominican Rep.	-	-	-	…	-	-
78	Ecuador	443	0.03	1'800	*6'499*	8'742	0.07
79	Egypt	4'850	0.06	-	…	4'850	0.01
80	El Salvador	40	0.01	93'395	…	93'435	1.43
81	Fiji	-	-	-	…	-	-
82	Guatemala	-	-	-	…	-	-
83	Guyana	-	-	-	…	-	-
84	Honduras	-	-	-	…	-	-
85	Iran (I.R.)	*16'051*	*0.11*	-	*120*	*16'171*	*0.02*
86	Iraq	-	-	-	…	-	-
87	Jamaica	…	…	…	…	-	-
88	Jordan	4'996	0.80	-	…	4'996	0.09
89	Kazakhstan	-	-	-	…	-	-
90	Kiribati	-	-	-	…	-	-
91	Maldives	*190*	*0.66*	-	…	*190*	*0.07*
92	Marshall Islands	-	-	-	…	-	-
93	Micronesia	-	-	-	-	-	-
94	Morocco	2'700	0.22	-	…	2'700	0.01
95	Namibia	-	-	-	…	-	-
96	Palestine	-	-	-	…	-	-
97	Paraguay	-	-	500	…	500	0.01
98	Peru	66'693	3.63	*15'093*	…	*81'786*	*0.30*
99	Philippines	*21'000*	*0.63*	-	…	*21'000*	*0.03*
100	Romania	6'700	0.16	32'600	*104'000*	143'300	0.68
101	Russia	-	-	-	…	-	-
102	Samoa	-	-	-	…	-	-
103	Serbia and Montenegro	-	-	-	…	-	-
104	South Africa	*2'669*	*0.06*	-	…	*2'669*	*0.01*
105	Sri Lanka	350	0.04	395	*72*	817	0.00
106	St. Vincent	*782*	*2.86*	*304*	…	*1'086*	*0.91*
107	Suriname	86	0.11	-	*80*	166	0.03
108	Swaziland	-	-	-	…	-	-
109	Syria	-	-	-	…	-	-
110	TFYR Macedonia	-	-	-	…	-	-
111	Thailand	*15'000*	*0.23*	*900*	…	*15'900*	*0.03*
112	Tonga	*11*	*0.10*	-	…	*11*	*0.01*
113	Tunisia	2'590	0.22	-	…	2'590	0.03
114	Turkey	15'500	0.08	41'000	…	56'500	0.08
115	Turkmenistan	-	-	-	…	-	-
116	Ukraine	-	-	-	…	-	-
117	Vanuatu	-	-	15	…	15	0.01
	Lower Middle Income	**8'886'214**	**1.96**	**2'799'196**	**110'990**	**11'796'400**	**0.49**

6. Broadband subscribers

		DSL		*Cable modem*	*Other*	*Total broadband subscribers*	
		Total	*as % of residential telephone*	*Total*	*Total*	*Total*	*per 100 inhabitants*
		2003	*2003*	*2003*	*2003*	*2003*	*2003*
118	Argentina	*64'400*	*0.80*	*46'000*	…	*110'400*	*0.30*
119	Belize	585	1.76	-	…	*585*	*0.20*
120	Botswana	-	-	-	…	-	-
121	Chile	165'837	5.10	161'623	*21'515*	348'975	2.37
122	Costa Rica	*363*	*0.03*	-	…	*363*	*0.01*
123	Croatia	*12'000*	*0.66*	-	…	*12'000*	*0.27*
124	Czech Republic	-	-	*15'300*	…	*15'300*	*0.15*
125	Dominica	*170*	*0.72*	*150*	…	*320*	*0.41*
126	Estonia	*33'000*	*6.95*	*12'700*	*800*	*46'500*	*3.62*
127	Gabon	50	0.13	-	…	50	0.00
128	Grenada	1'200	3.68	-	…	1'200	1.07
129	Guadeloupe	-	-	-	…	-	-
130	Hungary	114'813	3.19	77'189	*36'268*	228'270	2.21
131	Latvia	19'196	2.94	-	…	19'196	0.83
132	Lebanon	-	-	*35'000*	…	*35'000*	*1.00*
133	Libya	-	-	-	…	-	-
134	Lithuania	27'246	3.31	19'983	…	47'229	1.45
135	Malaysia	110'104	2.41	-	…	110'104	0.44
136	Mauritius	*285*	*0.08*	-	…	*285*	*0.02*
137	Mayotte	-	-	-	…	-	-
138	Mexico	*66'600*	*0.41*	*20'000*	…	*86'600*	*0.08*
139	Northern Marianas	…	…	…	…	-	-
140	Oman	-	-	-	…	-	-
141	Panama	-	-	-	…	-	-
142	Poland	*121'684*	*0.99*	*10'000*	…	*131'684*	*0.34*
143	Saudi Arabia	8'000	0.23	-	…	8'000	0.04
144	Seychelles	*120*	*0.55*	-	…	*120*	*0.15*
145	Slovak Republic	4'210	0.33	3'498	-	7'708	0.14
146	St. Kitts and Nevis	*500*	*2.13*	-	…	*500*	*1.04*
147	St. Lucia	-	-	-	…	-	-
148	Trinidad & Tobago	*176*	*0.05*	-	…	*176*	*0.01*
149	Uruguay	…	…	…	…	-	-
150	Venezuela	*46'870*	*1.65*	*67'402*	…	*114'272*	*0.44*
	Upper Middle Income	**797'409**	**1.17**	**468'845**	**58'583**	**1'324'837**	**0.40**

6. Broadband subscribers

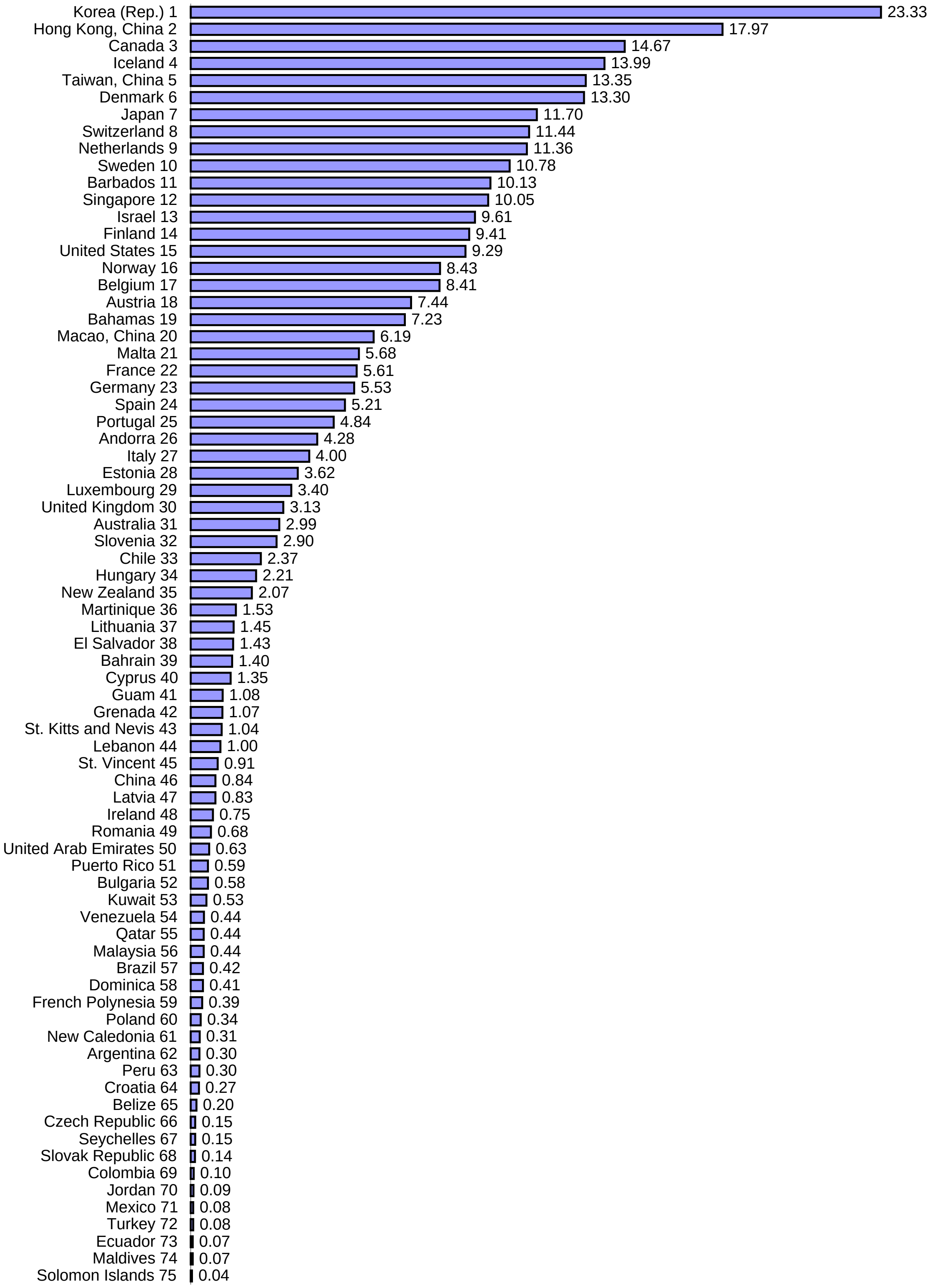
		DSL		Cable modem	Other	Total broadband subscribers	
		Total	*as % of residential telephone*	*Total*	*Total*	*Total*	*per 100 inhabitants*
		2003	*2003*	*2003*	*2003*	*2003*	*2003*
151	Andorra	3'601	7.99	…	…	*3'601*	*4.28*
152	Antigua & Barbuda	-	-	-	…	-	-
153	Aruba	-	-	-	…	-	-
154	Australia	372'000	3.44	215'400	*9'100*	596'500	2.99
155	Austria	261'000	6.73	340'000	…	601'000	7.44
156	Bahamas	10'941	8.31	*12'000*	…	*22'941*	*7.23*
157	Bahrain	9'737	5.24	-	…	*9'737*	*1.40*
158	Barbados	10'000	7.46	17'319	…	27'319	10.13
159	Belgium	*518'919*	*10.13*	*353'481*	…	*872'400*	*8.41*
160	Bermuda	-	-	-	…	-	-
161	Brunei Darussalam	-	-	-	…	-	-
162	Canada	2'170'000	10.88	2'483'000	…	4'653'000	14.67
163	Cyprus	10'033	2.00	-	…	10'033	1.35
164	Denmark	473'481	13.12	243'602	…	717'083	13.30
165	Faroe Islands	-	-	-	…	-	-
166	Finland	405'700	15.92	85'400	…	491'100	9.41
167	France	2'967'434	8.75	393'854	…	3'361'288	5.61
168	French Guiana	-	-	-	…	-	-
169	French Polynesia	900	1.68	-	46	946	0.39
170	Germany	4'500'000	8.28	60'000	…	4'560'000	5.53
171	Greece	360	0.01	-	…	360	0.00
172	Greenland	-	-	-	…	-	-
173	Guam	*1'050*	*1.31*	*700*	…	*1'750*	*1.08*
174	Guernsey	…	…	…	…	-	-
175	Hong Kong, China	609'824	16.04	258'000	362'783	1'230'607	17.97
176	Iceland	40'419	21.19	-	…	40'419	13.99
177	Ireland	25'300	1.29	4'900	…	30'200	0.75
178	Israel	430'000	14.30	220'000	…	650'000	9.61
179	Italy	2'200'000	8.27	-	…	2'200'000	4.00
180	Japan	11'196'830	15.74	2'578'000	1'142'335	14'917'165	11.70
181	Jersey	-	-	-	…	-	-
182	Korea (Rep.)	6'435'955	24.95	3'828'166	915'000	11'179'121	23.33
183	Kuwait	13'000	2.67	-	…	13'000	0.53
184	Luxembourg	13'322	5.44	2'029	-	15'351	3.40
185	Macao, China	27'744	15.89	-	-	27'744	6.19
186	Malta	13'001	6.24	9'735	…	22'736	5.68
187	Martinique	6'000	3.49	-	…	*6'000*	*1.53*
188	Neth. Antilles	-	-	-	…	-	-
189	Netherlands	920'000	9.20	930'000	…	1'850'000	11.36
190	New Caledonia	*700*	*1.35*	-	…	*700*	*0.31*
191	New Zealand	75'000	4.17	2'400	5'600	83'000	2.07
192	Norway	308'516	9.44	69'734	*7'667*	385'917	8.43
193	Portugal	184'344	4.31	315'577	…	499'921	4.84
194	Puerto Rico	*21'661*	*1.70*	*1'071*	…	*22'732*	*0.59*
195	Qatar	2'800	1.52	-	…	2'800	0.44
196	Réunion	…	…	…	…	-	-
197	Singapore	256'100	13.55	165'700	…	421'800	10.05
198	Slovenia	36'838	4.53	21'154	…	57'992	2.90
199	Spain	1'562'479	8.89	571'714	…	2'134'193	5.21
200	Sweden	573'312	8.71	206'034	188'118	967'464	10.78
201	Switzerland	487'000	9.13	350'000	…	837'000	11.44
202	Taiwan, China	2'552'164	19.11	452'459	*18'055*	3'022'678	13.35
203	United Arab Emirates	24'880	2.19	-	*455*	25'335	0.63
204	United Kingdom	*854'000*	*2.45*	*960'000*	*7'000*	*1'821'000*	*3.13*
205	United States	9'333'000	5.14	15'777'000	*2'040'746*	27'150'746	9.29
206	Virgin Islands (US)	-	-	-	…	-	-
	High Income	**49'919'345**	**8.93**	**30'928'429**	**4'696'905**	**85'544'679**	**8.80**
	WORLD	**59'710'147**	**5.15**	**34'297'121**	**4'867'770**	**98'875'038**	**1.59**
	Africa	**25'496**	**0.10**	**3'505**	**1'188**	**30'189**	**0.00**
	Americas	**12'572'781**	**4.24**	**18'868'650**	**2'068'840**	**33'510'271**	**3.89**
	Asia	**29'948'142**	**6.01**	**10'033'046**	**2'438'900**	**42'420'088**	**1.15**
	Europe	**16'713'862**	**5.12**	**5'173'405**	**344'096**	**22'231'363**	**2.79**
	Oceania	**449'866**	**3.45**	**218'515**	**14'746**	**683'127**	**2.11**

Source: ITU.

Note: Exchange rates valid July 11, 2003, see technical notes for more details.

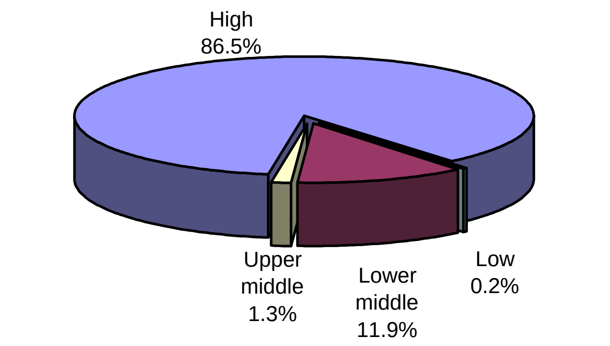
6. Broadband subscribers

Broadband penetration per 100 inhabitants, top 75, 2003

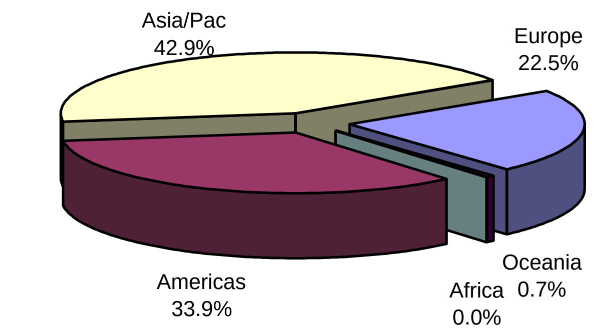


6. Broadband Subscribers

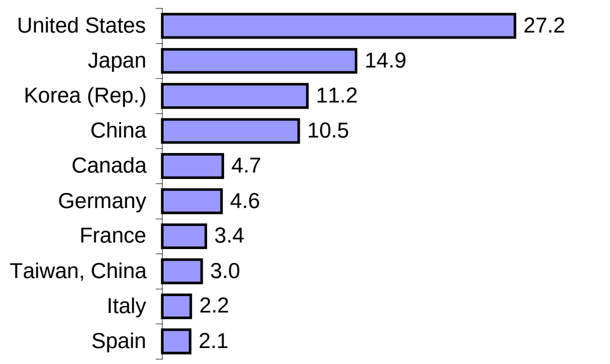
Broadband subscribers, by income, 2003



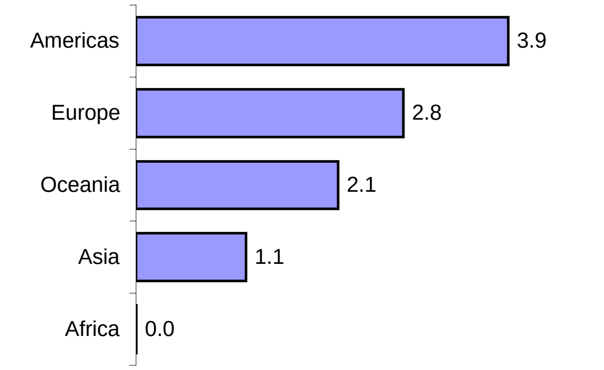
Broadband subscribers, by region, 2003



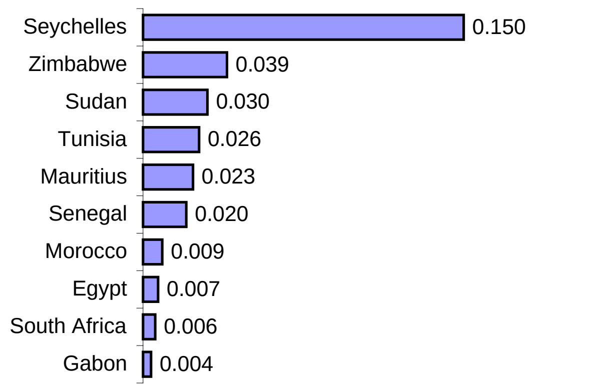
Total broadband subs, top 10, 2003, millions



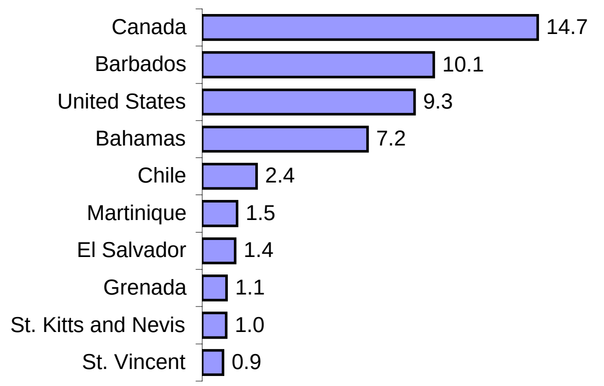
Broadband subs/100 inhabitants, by region, 2003



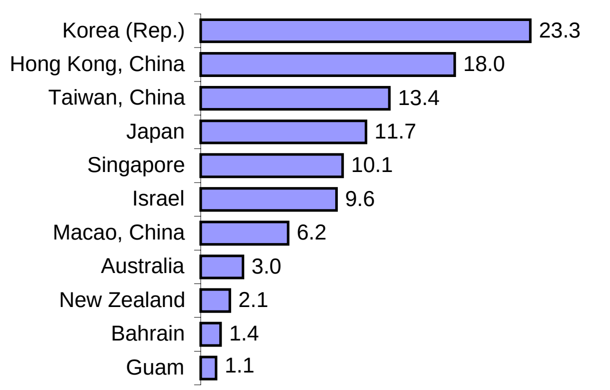
Africa: Broadband subs/100 inhab, top 10, 2003



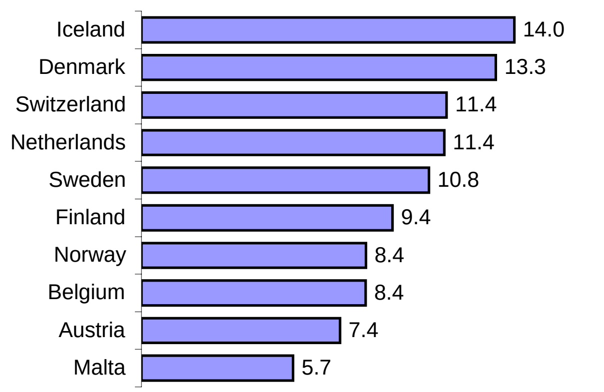
Americas: Broadband subs/100 inhab, top 10, 2003



Asia/Pacific: Broadband subs/100 inhab, top 10, 2003



Europe: Broadband subs/100 inhab, top 10, 2003



* Penetration = subscribers per 100 inhabitants

7. Broadband prices

		Lower speed		Higher speed		Lowest sampled cost		
		Monthly charge US$	*Speed (kbit/s) Down*	*Monthly charge US$*	*Speed (kbit/s) Down*	*US$ per 100 kbit/s*	*as a % of monthly income (GNI)*	*ISP*
1	Afghanistan	...	...	...	...	...	...	...
2	Angola	871.00	256	...	...	340.23	551.73	Nexus
3	Azerbaijan	...	...	...	...	...	...	...
4	Bangladesh	...	...	...	...	...	...	...
5	Benin	275.84	256	1'838.95	2'000	91.95	250.77	OPT
6	Bhutan	1'680.67	256	2'689.08	512	525.21	954.93	DrukNet
7	Burkina Faso	...	...	...	...	...	...	...
8	Burundi	...	...	...	...	...	...	...
9	Cambodia	199.00	256	399.00	512	77.73	300.91	Online
10	Cameroon	4'523.81	256	4'523.81	1'024	441.78	828.33	Camnet
11	Central African Rep.	...	...	...	...	...	...	...
12	Chad	...	...	...	...	...	...	...
13	Comoros	...	...	...	...	...	...	...
14	Congo	...	...	...	...	...	...	...
15	Côte d'Ivoire	64.36	256	...	...	25.14	45.71	Aviso
16	D.P.R. Korea	...	...	...	...	...	...	...
17	D.R. Congo	...	...	...	...	...	...	...
18	Equatorial Guinea	...	...	...	...	...	...	...
19	Eritrea	...	...	...	...	...	...	...
20	Ethiopia	...	...	...	...	...	...	...
21	Gambia	...	...	...	...	...	...	...
22	Georgia	799.00	256	...	...	312.11	451.24	Georgia Online
23	Ghana	...	...	...	...	...	...	...
24	Guinea	...	...	...	...	...	...	...
25	Guinea-Bissau	...	...	...	...	...	...	...
26	Haiti	...	...	...	...	...	...	...
27	India	43.06	256	...	...	16.82	38.09	MTNL Net
28	Indonesia	38.35	256	71.23	512	13.91	20.61	CBN
29	Kenya	...	...	...	...	...	...	...
30	Kyrgyzstan	100.00	256	120.00	512	23.44	85.23	ElCat
31	Lao P.D.R.	300.00	256	500.00	512	97.66	366.21	Lao Telecom
32	Lesotho	...	...	...	...	...	...	...
33	Liberia	...	...	...	...	...	...	...
34	Madagascar	...	...	...	...	...	...	...
35	Malawi	...	...	...	...	...	...	...
36	Mali	...	...	...	...	...	...	...
37	Mauritania	...	...	...	...	...	...	...
38	Moldova	80.00	768	...	...	10.42	21.19	Transtelecom
39	Mongolia	149.00	256	299.00	1'024	29.20	73.00	Micom
40	Mozambique	1'320.00	256	2'488.00	512	485.94	2776.79	TDM
41	Myanmar	4'794.52	256	6'849.32	512	1'337.76	...	Bagan Net
42	Nepal	1'388.89	256	...	...	542.53	2712.67	NTCnet
43	Nicaragua	61.00	400	92.00	600	15.25	25.07	Terra ADSL
44	Niger	...	...	...	...	...	...	...
45	Nigeria	...	...	...	...	...	...	...
46	Pakistan	1'372.21	256	...	...	536.02	1368.56	Multinet Broadband
47	Papua New Guinea	...	...	...	...	...	...	...
48	Rwanda	...	...	...	...	...	...	...
49	S. Tomé & Principe	...	...	...	...	...	...	...
50	Senegal	26.92	256	52.44	512	10.24	22.35	Sonatel
51	Sierra Leone	...	...	...	...	...	...	...
52	Solomon Islands	...	...	...	...	...	...	...
53	Somalia	...	...	...	...	...	...	...
54	Sudan	250.81	512	...	...	48.99	127.79	Sudatel
55	Tajikistan	...	...	...	...	...	...	...
56	Tanzania	...	...	...	...	...	...	...
57	Togo	...	...	...	...	...	...	...
58	Uganda	3'480.00	256	5'760.00	512	1'125.00	5625.00	Uganda Telecom
59	Uzbekistan	...	...	...	...	...	...	...
60	Viet Nam	...	...	...	...	...	...	...
61	Yemen	...	...	...	...	...	...	...
62	Zambia	...	...	...	...	...	...	...
63	Zimbabwe	...	...	...	...	...	...	...
	Low Income	**1'038.97**	**299**	**1'975.60**	**712**	**290.83**	**832.31**	

7. Broadband prices

		Lower speed		Higher speed		Lowest sampled cost		
		Monthly charge US$	Speed (kbit/s) Down	Monthly charge US$	Speed (kbit/s) Down	US$ per 100 kbit/s	as a % of monthly income (GNI)	ISP
64	Albania	57.83	256	867.47	2'048	22.59	15.58	Albania Online
65	Algeria	532.06	256	718.63	512	140.36	89.12	Wanadoo
66	Armenia	...	...	...	...	...	...	...
67	Belarus	17.43	512	...	...	3.41	2.57	Beltelecom
68	Bolivia	100.00	256	200.00	512	39.06	52.67	Acelerate
69	Bosnia	47.53	512	...	...	9.28	7.23	Bihnet
70	Brazil	26.07	300	52.81	600	8.69	3.85	Speedy
71	Bulgaria	61.35	256	130.67	384	23.96	13.50	Telecom Bulgaria
72	Cape Verde	...	...	...	...	...	...	...
73	China	9.66	512	...	...	1.89	2.06	81890.net - China
74	Colombia	44.48	256	...	...	17.37	11.52	ETB
75	Cuba	85.71	256	...	...	33.48	...	Citmatel
76	Djibouti	...	...	...	...	...	...	...
77	Dominican Rep.	33.98	384	...	...	8.85	5.13	Verizon
78	Ecuador	360.00	256	880.00	512	140.63	94.27	IT Net
79	Egypt	...	...	...	...	...	...	...
80	El Salvador	69.00	512	...	...	13.48	7.35	Navegante
81	Fiji	...	...	...	...	...	...	...
82	Guatemala	164.00	256	288.00	1'024	28.13	17.67	Turbonet
83	Guyana	...	...	...	...	...	...	...
84	Honduras	...	...	...	...	...	...	...
85	Iran (I.R.)	68.78	256	...	...	26.87	16.12	Pars Online
86	Iraq	...	...	...	...	...	...	...
87	Jamaica	93.00	256	129.00	768	16.80	7.30	Cable & Wireless
88	Jordan	14.08	512	70.42	1'024	2.75	1.78	Jordan Telecom
89	Kazakhstan	1'924.83	512	...	...	375.94	253.44	Almatytelecom
90	Kiribati	...	...	...	...	...	...	...
91	Maldives	50.13	256	82.84	256	19.58	10.22	Dhirragu
92	Marshall Islands	...	...	...	...	...	...	...
93	Micronesia	...	...	...	...	...	...	...
94	Morocco	32.97	256	55.02	512	10.75	9.77	Menara
95	Namibia	...	...	...	...	...	...	...
96	Palestine	...	...	...	...	...	...	...
97	Paraguay	60.00	1'536	...	...	3.91	4.26	Parnet
98	Peru	67.00	400	100.00	600	16.67	9.30	Telefonica
99	Philippines	50.11	256	...	...	19.57	21.75	Now Cable Internet
100	Romania	110.00	256	...	...	42.97	22.32	Astral
101	Russia	168.00	256	228.00	512	44.53	20.47	Wplus
102	Samoa	...	...	...	...	...	...	...
103	Serbia and Montenegro	...	...	...	...	...	...	...
104	South Africa	108.80	512	...	...	21.25	9.17	Telkom
105	Sri Lanka	21.71	512	65.14	2'048	3.18	4.10	Sri Lanka Telecom
106	St. Vincent	92.22	256	221.85	768	28.89	10.50	Cable & Wireless
107	Suriname	...	...	...	...	...	...	...
108	Swaziland	...	...	...	...	...	...	...
109	Syria	...	...	...	...	...	...	...
110	TFYR Macedonia	...	...	...	...	...	...	...
111	Thailand	34.03	256	55.91	512	10.92	5.98	Internet East
112	Tonga	167.00	256	...	...	65.23	52.54	Tonga
113	Tunisia	157.48	384	192.91	512	37.68	20.18	Hexabyte Internet
114	Turkey	42.96	256	174.91	2'000	8.75	3.76	Superonline
115	Turkmenistan	...	...	...	...	...	...	...
116	Ukraine	25.00	512	...	...	4.88	6.04	Ukrtelecom
117	Vanuatu	...	...	...	...	...	...	...
	Lower Middle Income	**148.40**	**378**	**250.75**	**839**	**37.95**	**25.36**	

7. Broadband prices

	Lower speed		Higher speed		Lowest sampled cost		
	Monthly charge US$	*Speed (kbit/s) Down*	*Monthly charge US$*	*Speed (kbit/s) Down*	*US$ per 100 kbit/s*	*as a % of monthly income (GNI)*	*ISP*
118 Argentina	68.35	256	107.07	512	20.91	6.88	Millicom
119 Belize	...	...	...	...	...	...	...
120 Botswana	69.05	512	...	...	13.49	4.72	Tiscali
121 Chile	40.68	256	...	...	15.89	4.34	Entel Internet
122 Costa Rica	46.00	256	76.00	512	14.84	4.16	Grupoice
123 Croatia	21.01	384	45.44	768	5.47	1.23	Htnet
124 Czech Republic	24.77	512	...	...	4.84	0.86	Contactel
125 Dominica	...	...	...	...	...	...	...
126 Estonia	26.64	512	38.22	1'000	3.82	0.92	Elion
127 Gabon	...	...	...	...	...	...	...
128 Grenada	92.22	256	...	...	36.02	11.41	Cable & Wireless
129 Guadeloupe	36.14	512	...	...	7.06	...	France Telecom
130 Hungary	62.85	512	82.34	768	10.72	2.03	Online Aruhaz
131 Latvia	72.22	512	150.00	2'048	7.32	2.16	Vernet
132 Lebanon	...	...	...	...	...	...	...
133 Libya	...	...	...	...	...	...	...
134 Lithuania	13.64	256	...	...	5.33	1.42	Lietuvos Telekomas
135 Malaysia	26.05	512	...	...	5.09	1.62	myStreamyx
136 Mauritius	87.99	512	...	...	17.18	5.04	Telecom Plus
137 Mayotte	...	...	...	...	...	...	...
138 Mexico	30.61	256	52.54	512	10.26	1.98	Prodigy
139 Northern Marianas	...	...	...	...	...	...	...
140 Oman	47.37	256	100.00	384	18.50	2.84	Omantel
141 Panama	49.00	256	89.00	512	17.38	4.91	Inter.net
142 Poland	100.55	512	...	...	19.64	4.47	TP
143 Saudi Arabia	103.73	256	210.40	512	40.52	5.70	Sahara DSL
144 Seychelles	482.63	256	675.68	512	131.97	21.17	Atlas
145 Slovak Republic	14.77	256	26.83	512	5.24	1.28	Slovak Telecom
146 St. Kitts and Nevis	73.70	256	147.78	768	19.24	3.36	Cable & Wireless
147 St. Lucia	92.22	256	221.85	768	28.89	8.56	Cable & Wireless
148 Trinidad & Tobago	...	...	...	...	...	...	...
149 Uruguay	74.10	256	170.97	512	28.95	9.16	Netgate
150 Venezuela	36.96	256	171.96	1'536	11.20	3.85	Cantv
Upper Middle Income	**71.73**	**353**	**147.88**	**759**	**19.99**	**4.75**	

7. Broadband prices

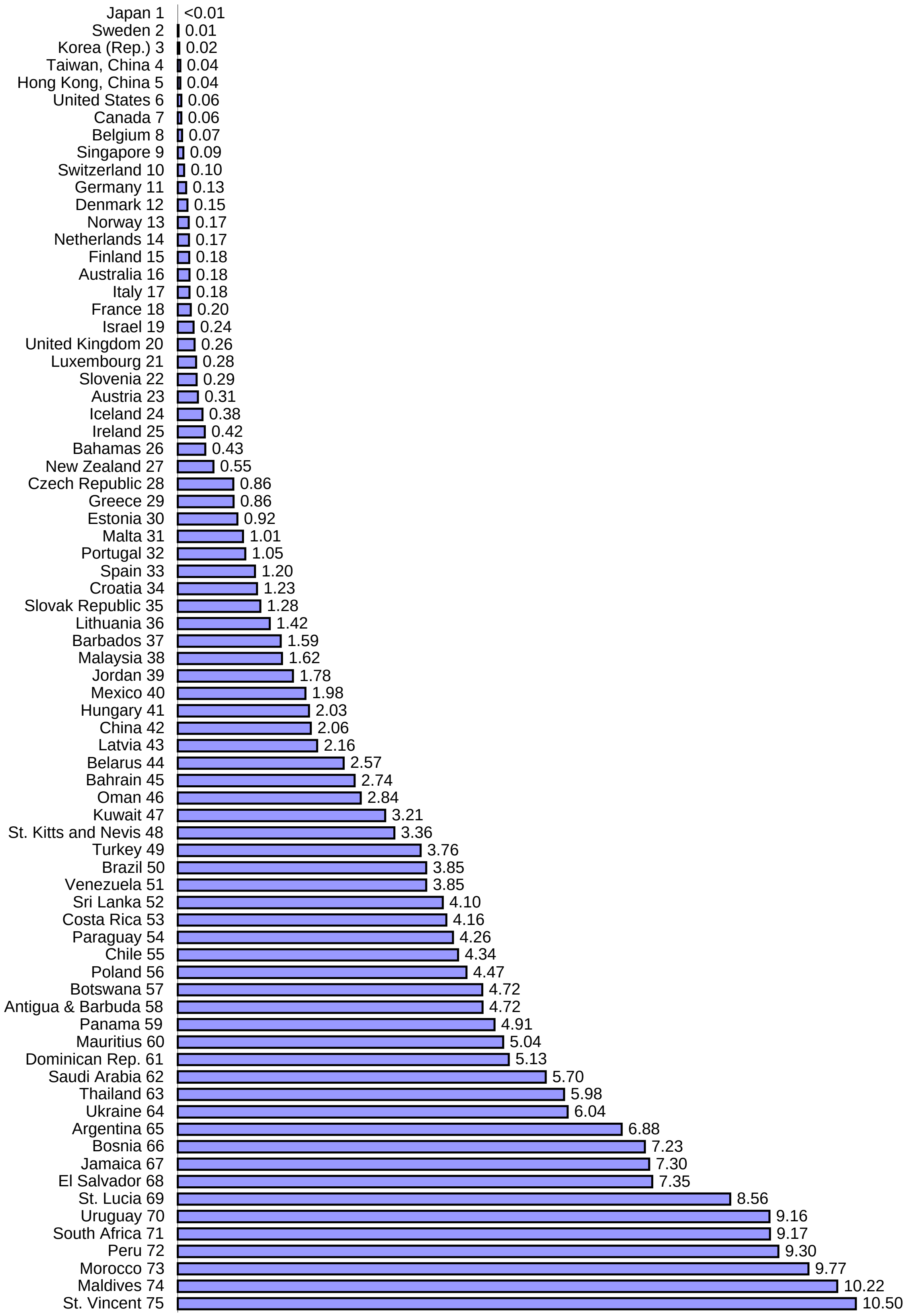
	Lower speed		Higher speed		Lowest sampled cost		
	Monthly charge US$	*Speed (kbit/s) Down*	*Monthly charge US$*	*Speed (kbit/s) Down*	*US$ per 100 kbit/s*	*as a % of monthly income (GNI)*	*ISP*
151 Andorra	49.40	256	96.39	512	18.83	...	Asta ADSL
152 Antigua & Barbuda	92.22	256	370.00	1'024	36.02	4.72	Cable & Wireless
153 Aruba	122.35	256	...	...	47.79	...	Setar
154 Australia	21.13	256	49.30	1'500	3.29	0.18	Bigpond
155 Austria	53.01	768	...	...	6.90	0.31	AON speed
156 Bahamas	35.00	384	55.00	1'024	5.37	0.43	Batelnet
157 Bahrain	105.26	256	131.58	512	25.70	2.74	Batelco
158 Barbados	31.50	256	126.50	768	12.30	1.59	CaribSurf
159 Belgium	36.14	512	48.19	3'300	1.46	0.07	Belgacom
160 Bermuda	90.00	256	89.00	1'500	5.93	...	BTC
161 Brunei Darussalam	173.26	256	289.53	512	56.55	...	E Speed
162 Canada	34.09	3'000	...	...	1.14	0.06	Bell
163 Cyprus	25.00	256	31.25	512	6.10	...	I - choice
164 Denmark	55.37	512	86.32	2'048	4.21	0.15	Tele2
165 Faroe Islands	45.60	256	96.91	512	17.81	...	Tele.fo
166 Finland	45.78	256	81.93	2'048	4.00	0.18	Sonera
167 France	36.14	512	42.17	1'024	4.12	0.20	Wanadoo
168 French Guiana	30.12	512	...	...	5.88	...	France Telecom
169 French Polynesia	263.00	256	377.00	512	73.63	...	Mana
170 Germany	27.71	1'000	...	...	2.77	0.13	Freenet.de
171 Greece	25.30	256	54.22	512	9.88	0.86	Forthnet.ADSL
172 Greenland	...	...	...	...	...	...	...
173 Guam	800.00	256	1'600.00	512	312.50	...	Kuentos
174 Guernsey	54.55	500	...	...	10.91	...	Cable & Wireless
175 Hong Kong, China	25.38	640	51.03	6'000	0.85	0.04	Netvigator
176 Iceland	35.00	256	49.01	500	9.80	0.38	Vodafone
177 Ireland	48.19	512	...	...	9.41	0.42	Eircom
178 Israel	23.58	256	64.82	2'000	3.24	0.24	Actcom
179 Italy	44.58	640	42.17	1'280	3.29	0.18	Libero
180 Japan	16.78	1'024	25.86	47'000	0.06	0.00	KDDI
181 Jersey	...	...	...	...	...	...	...
182 Korea (Rep.)	23.93	2'048	47.86	20'000	0.24	0.02	Hanaro
183 Kuwait	137.93	256	224.14	512	43.78	3.21	Qualitynet
184 Luxembourg	40.96	256	106.02	1'024	10.35	0.28	Cegecom
185 Macao, China	18.68	1'500	...	...	1.25	...	CTM
186 Malta	40.00	512	...	...	7.81	1.01	WebWaves
187 Martinique	92.77	512	...	...	18.12	...	OOL
188 Neth. Antilles	...	...	...	...	...	...	...
189 Netherlands	27.71	512	42.17	1'120	3.77	0.17	Wanadoo
190 New Caledonia	105.27	250	273.71	500	42.11	...	Can'L
191 New Zealand	31.21	400	43.95	600	7.32	0.55	Fast ADSL
192 Norway	47.06	704	62.98	1'024	6.15	0.17	Tele2
193 Portugal	54.22	512	...	...	10.59	1.05	Sapo ADSL
194 Puerto Rico	40.00	256	...	...	15.63	...	Coqui.Net
195 Qatar	54.95	256	82.42	512	16.10	...	barQ ADSL
196 Réunion	72.29	512	...	...	14.12	...	Agence France
197 Singapore	87.21	512	46.51	3'000	1.55	0.09	StarHub
198 Slovenia	29.57	1'024	...	...	2.89	0.29	Siol ADSL
199 Spain	43.37	256	90.36	512	16.94	1.20	Terra
200 Sweden	38.51	512	58.62	24'000	0.24	0.01	Bredbandsbolaget
201 Switzerland	38.58	600	77.95	2'400	3.25	0.10	Bluewin
202 Taiwan, China	19.39	256	35.30	8'000	0.44	0.04	Chunghwa
203 United Arab Emirates	51.77	256	177.11	2'000	8.86	...	Emirates Internet &
204 United Kingdom	43.64	512	61.82	...	6.18	0.26	Pipex
205 United States	45.00	256	53.00	3'000	1.77	0.06	Comcast
206 Virgin Islands (US)	...	...	...	...	...	...	...
High Income	**69.80**	**525**	**140.58**	**3'873**	**18.06**	**0.61**	
WORLD	**245.33**	**419**	**445.94**	**2'141**	**67.16**	**158.50**	
Africa	**344.00**	**344**	**1'811.71**	**734**	**184.75**	**692.51**	
Americas	**421.76**	**422**	**175.92**	**873**	**21.52**	**11.64**	
Asia	**424.35**	**424**	**528.69**	**4'120**	**123.41**	**231.15**	
Europe	**461.76**	**462**	**110.48**	**2'095**	**10.02**	**3.63**	
Oceania	**279.00**	**279**	**468.79**	**725**	**84.01**	**17.76**	

Source: ITU.

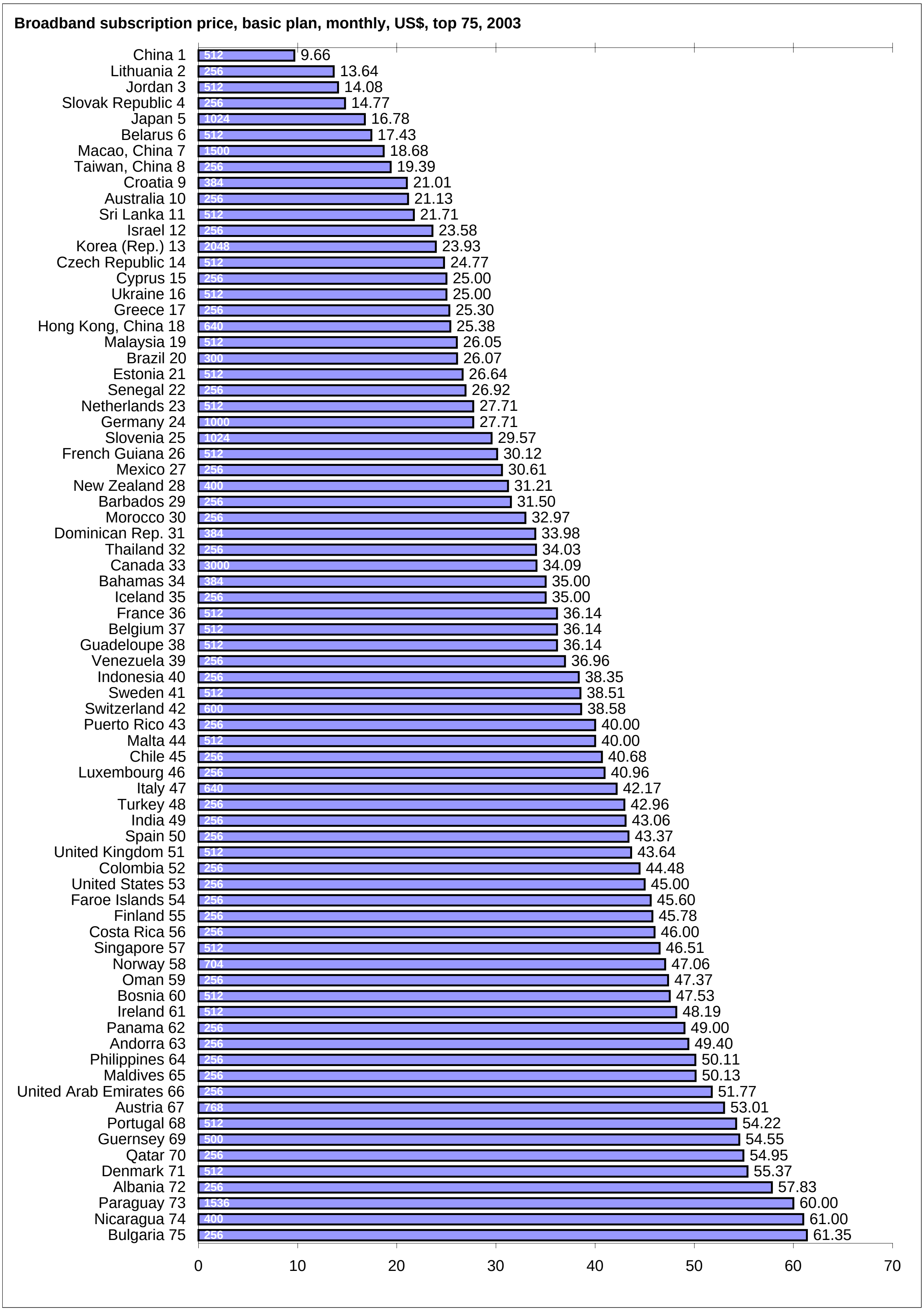
Note: Exchange rates valid July 30, 2004. See technical notes for more details.

7. Broadband Prices

Broadband prices per 100 kbit/s as percentage of monthly income, top 75, 2003



7. Broadband Prices



Note: The download speed of the sampled connection is given just after the name of the economy.

8. Network penetration

		Effective Teledensity	Rank	Internet subs per 100 inhabitants	Rank	Broadband subscribers per 100 inhabitants	Rank	Broadband as % of total Internet subscribers	Internet subscribers as % of telephone
		2003	2003	2003	2003	2003	2003	2003	2003
1	Afghanistan	1.00	194	0.00	186	-	…	-	1.9
2	Angola	0.93	195	0.06	163	-	…	-	9.3
3	Azerbaijan	11.35	129	0.14	142	-	…	-	1.3
4	Bangladesh	1.01	193	0.06	164	-	…	-	10.9
5	Benin	3.36	164	0.10	152	-	…	-	10.2
6	Bhutan	3.56	162	0.28	132	-	…	-	7.9
7	Burkina Faso	1.85	179	0.09	157	0.00	110	0.11	16.2
8	Burundi	0.90	197	0.01	183	-	…	-	3.5
9	Cambodia	2.76	169	0.05	165	0.00	106	0.96	19.7
10	Cameroon	6.62	145	0.03	172	-	…	-	5.0
11	Central African Rep.	0.31	202	0.05	167	-	…	-	22.2
12	Chad	0.80	199	0.02	177	-	…	-	15.2
13	Comoros	1.66	182	0.13	148	-	…	-	7.6
14	Congo	9.43	134	0.02	179	-	…	-	9.3
15	Côte d'Ivoire	7.43	142	0.09	154	-	…	-	4.6
16	D.P.R. Korea	2.11	177	-	187	-	…	-	-
17	D.R. Congo	1.89	178	0.01	184	-	…	-	60.4
18	Equatorial Guinea	7.64	140	0.18	138	-	…	-	10.4
19	Eritrea	0.92	196	0.07	162	-	…	-	7.9
20	Ethiopia	0.63	201	0.02	181	0.00	113	0.01	2.6
21	Gambia	7.53	141	0.29	131	-	…	-	10.4
22	Georgia	13.30	122	0.08	159	0.03	81	0.22	0.6
23	Ghana	3.56	161	0.09	155	-	…	-	6.7
24	Guinea	1.44	187	0.14	144	-	…	-	42.0
25	GuineaoBissau	0.82	198	0.02	180	-	…	-	2.1
26	Haiti	1.69	181	0.36	129	-	…	-	23.1
27	India	4.63	154	0.39	125	0.01	92	0.29	8.5
28	Indonesia	5.52	148	0.40	124	0.02	90	0.43	10.2
29	Kenya	5.02	151	0.14	143	-	…	-	13.7
30	Kyrgyzstan	7.75	138	0.09	156	-	…	-	1.2
31	Lao P.D.R.	1.12	191	0.04	168	-	…	-	4.1
32	Lesotho	4.47	156	0.08	160	-	…	-	5.9
33	Liberia	0.22	203	…	…	-	…	-	…
34	Madagascar	1.71	180	0.14	146	-	…	-	38.6
35	Malawi	1.29	189	0.12	149	0.00	109	0.08	14.8
36	Mali	2.30	174	0.14	147	-	…	-	26.5
37	Mauritania	10.90	131	0.03	171	-	…	-	3.0
38	Moldova	16.07	116	0.36	128	0.02	89	0.10	2.0
39	Mongolia	8.89	135	1.87	83	0.02	87	0.36	33.3
40	Mozambique	2.28	175	0.03	174	-	…	-	7.3
41	Myanmar	0.72	200	0.03	173	-	…	-	4.5
42	Nepal	1.57	184	0.08	158	-	…	-	5.4
43	Nicaragua	3.78	158	0.38	126	0.04	76	1.35	12.2
44	Niger	0.20	204	0.02	178	-	…	-	10.7
45	Nigeria	2.55	172	0.04	170	-	…	-	6.2
46	Pakistan	2.66	171	0.17	140	-	…	-	6.5
47	Papua New Guinea	1.13	190	0.48	121	-	…	-	43.5
48	Rwanda	1.60	183	0.03	175	-	…	-	10.0
49	S. Tomé & Principe	4.59	155	0.73	113	-	…	-	16.0
50	Senegal	5.56	147	0.09	153	0.02	88	0.92	4.2
51	Sierra Leone	1.35	188	0.02	182	-	…	-	3.1
52	Solomon Islands	1.49	185	0.21	135	0.04	75	3.29	16.0
53	Somalia	1.01	192	0.05	166	-	…	-	5.0
54	Sudan	2.70	170	0.18	139	0.03	80	1.11	6.7
55	Tajikistan	3.70	160	0.01	185	0.00	112	0.00	0.2
56	Tanzania	2.52	173	0.14	145	-	…	-	33.5
57	Togo	4.40	157	0.25	133	-	…	-	20.6
58	Uganda	3.03	166	0.03	176	-	…	-	11.5
59	Uzbekistan	6.70	144	0.15	141	0.01	94	0.16	2.2
60	Viet Nam	5.41	149	1.13	101	0.01	96	0.16	20.8
61	Yemen	2.78	168	0.07	161	-	…	-	2.8
62	Zambia	2.15	176	0.11	151	-	…	-	13.6
63	Zimbabwe	3.22	165	0.71	116	0.04	77	1.53	27.8
	Low Income	**3.77**		**0.28**		**0.01**		**0.201**	**10.6**

8. Network penetration

		Effective Teledensity 2003	*Rank 2003*	*Internet subs per 100 inhabitants 2003*	*Rank 2003*	*Broadband subscribers per 100 inhabitants 2003*	*Rank 2003*	*Broadband as % of total Internet subscribers 2003*	*Internet subscribers as % of telephone 2003*
64	Albania	35.80	73	0.65	117	-	…	-	7.8
65	Algeria	6.93	143	0.19	137	-	…	-	2.7
66	Armenia	14.80	119	1.84	85	0.00	111	0.00	12.4
67	Belarus	31.11	81	0.23	134	0.00	107	0.00	0.7
68	Bolivia	16.67	115	0.62	118	-	…	-	8.8
69	Bosnia	27.40	87	2.27	77	0.01	102	0.02	9.3
70	Brazil	26.36	91	4.49	62	0.42	57	1.73	18.7
71	Bulgaria	36.77	71	0.11	150	0.58	52	1.52	0.3
72	Cape Verde	15.63	117	1.09	104	-	…	-	7.0
73	China	21.40	107	5.39	56	0.84	46	4.00	25.8
74	Colombia	20.03	109	1.63	92	0.10	69	0.51	8.1
75	Cuba	0.16	205	…	…	-	…	-	…
76	Djibouti	3.44	163	0.31	130	0.00	108	0.06	22.2
77	Dominican Rep.	27.14	88	1.23	100	-	…	-	10.7
78	Ecuador	18.41	112	0.83	111	0.07	73	0.56	6.9
79	Egypt	12.73	126	…	…	0.01	100	0.06	…
80	El Salvador	17.65	114	1.73	90	1.43	38	12.41	15.0
81	Fiji	13.31	121	1.09	105	-	…	-	8.8
82	Guatemala	13.15	124	…	…	-	…	-	…
83	Guyana	9.93	133	2.25	78	-	…	-	24.9
84	Honduras	4.87	153	1.09	103	-	…	-	23.3
85	Iran (I.R.)	22.03	103	1.23	99	0.02	85	0.11	5.6
86	Iraq	2.78	167	…	…	-	…	-	…
87	Jamaica	53.30	53	3.59	70	-	…	-	21.4
88	Jordan	24.18	99	1.75	88	0.09	70	0.80	15.4
89	Kazakhstan	13.04	125	…	…	-	…	-	…
90	Kiribati	5.11	150	0.85	110	-	…	-	16.9
91	Maldives	14.91	118	0.37	127	0.07	74	0.66	3.7
92	Marshall Islands	8.27	137	1.29	98	-	…	-	15.6
93	Micronesia	1.48	186	1.77	87	-	…	-	17.2
94	Morocco	24.34	97	0.20	136	0.01	95	0.22	4.9
95	Namibia	11.63	128	0.81	112	-	…	-	12.2
96	Palestine	13.27	123	1.11	102	-	…	-	12.7
97	Paraguay	29.85	84	0.59	119	0.01	98	0.18	12.8
98	Peru	10.61	132	1.49	93	0.30	63	4.45	22.2
99	Philippines	19.13	111	0.99	107	0.03	83	0.63	24.2
100	Romania	32.87	76	4.10	67	0.68	49	3.33	20.0
101	Russia	24.22	98	1.29	97	-	…	-	5.3
102	Samoa	6.53	146	0.72	114	-	…	-	11.2
103	Serbia and Montenegro	33.78	75	3.11	72	-	…	-	12.8
104	South Africa	36.36	72	2.16	79	0.01	101	0.06	20.6
105	Sri Lanka	4.92	152	0.45	122	0.00	103	0.09	9.1
106	St. Vincent	23.35	100	5.03	59	0.91	45	3.97	21.9
107	Suriname	31.95	79	1.05	106	0.03	79	0.21	6.9
108	Swaziland	8.43	136	1.82	86	-	…	-	41.1
109	Syria	12.32	127	0.42	123	-	…	-	3.5
110	TFYR Macedonia	27.13	89	1.44	94	-	…	-	5.4
111	Thailand	26.04	92	2.40	75	0.03	84	0.24	22.7
112	Tonga	11.29	130	1.90	82	0.01	93	0.10	16.9
113	Tunisia	19.21	110	0.93	108	0.03	82	0.22	7.9
114	Turkey	40.84	66	5.13	58	0.08	72	0.30	18.5
115	Turkmenistan	7.71	139	0.04	169	-	…	-	0.6
116	Ukraine	21.61	105	…	…	-	…	-	…
117	Vanuatu	3.76	159	0.72	115	0.01	99	0.23	22.9
	Lower Middle Income	**21.88**		**3.70**		**0.49**		**2.40**	**20.54**

8. Network penetration

		Effective Teledensity 2003	Rank 2003	Internet subs per 100 inhabitants 2003	Rank 2003	Broadband subscribers per 100 inhabitants 2003	Rank 2003	Broadband as % of total Internet subscribers 2003	Internet subscribers as % of telephone 2003
118	Argentina	21.88	104	3.87	68	0.30	62	1.38	17.9
119	Belize	20.46	108	1.74	89	0.20	65	1.76	15.4
120	Botswana	25.29	95	0.85	109	-	…	-	11.4
121	Chile	42.83	65	5.72	54	2.37	33	10.73	25.9
122	Costa Rica	25.05	96	2.31	76	0.01	97	0.03	9.3
123	Croatia	58.37	51	12.30	34	0.27	64	0.66	29.5
124	Czech Republic	96.46	7	20.99	20	0.15	66	0.42	58.3
125	Dominica	30.39	83	5.72	53	0.41	58	1.35	18.9
126	Estonia	65.02	42	9.42	40	3.62	28	9.79	25.5
127	Gabon	22.44	102	0.58	120	0.00	104	0.13	20.3
128	Grenada	31.65	80	4.18	64	1.07	42	3.68	14.4
129	Guadeloupe	74.32	30	5.69	55	-	…	-	11.9
130	Hungary	67.60	40	6.52	50	2.21	34	6.34	18.7
131	Latvia	52.86	54	1.63	91	0.83	47	2.94	5.8
132	Lebanon	22.70	101	3.71	69	1.00	44	5.16	19.2
133	Libya	13.56	120	…	…	-	…	-	…
134	Lithuania	66.62	41	4.95	60	1.45	37	5.73	19.6
135	Malaysia	44.20	64	11.95	36	0.44	56	2.41	65.8
136	Mauritius	37.87	69	4.75	61	0.02	86	0.08	16.7
137	Mayotte	21.56	106	…	…	-	…	-	…
138	Mexico	25.45	94	1.98	81	0.08	71	0.53	12.5
139	Northern Marianas	30.87	82	…	…	-	…	-	…
140	Oman	18.32	113	1.86	84	-	…	-	20.6
141	Panama	26.76	90	2.12	80	-	…	-	17.0
142	Poland	45.09	62	4.16	66	0.34	60	1.07	13.1
143	Saudi Arabia	32.11	77	2.66	74	0.04	78	0.23	17.1
144	Seychelles	68.18	38	4.17	65	0.15	67	0.55	15.3
145	Slovak Republic	68.42	37	3.39	71	0.14	68	0.60	14.1
146	St. Kitts and Nevis	50.00	57	9.60	39	1.04	43	2.13	19.6
147	St. Lucia	31.95	78	…	…	-	…	-	…
148	Trinidad & Tobago	27.81	86	2.84	73	0.01	91	0.05	11.4
149	Uruguay	27.96	85	…	…	-	…	-	…
150	Venezuela	25.64	93	1.31	96	0.44	54	4.02	11.9
	Upper Middle Income	**35.16**		**4.26**		**0.40**		**1.82**	**20.33**

8. Network penetration

		Effective Teledensity	*Rank*	*Internet subs per 100 inhabitants*	*Rank*	*Broadband subscribers per 100 inhabitants*	*Rank*	*Broadband as % of total Internet subscribers*	*Internet subscribers as % of telephone*
		2003	*2003*	*2003*	*2003*	*2003*	*2003*	*2003*	*2003*
151	Andorra	61.63	49	7.49	45	*4.28*	26	*7.99*	14.0
152	Antigua & Barbuda	*48.98*	*60*	…	…	-	…	-	…
153	Aruba	*50.00*	*57*	*7.01*	*46*	-	…	-	*21.5*
154	Australia	71.95	33	25.45	14	2.99	31	5.52	46.9
155	Austria	87.88	15	16.10	28	7.44	18	15.49	33.5
156	Bahamas	*40.56*	*67*	8.75	42	*7.23*	19	*17.42*	21.1
157	Bahrain	63.84	45	*7.62*	*44*	*1.40*	*39*	*5.24*	*28.5*
158	Barbados	51.91	55	…	…	10.13	*11*	*20.39*	…
159	Belgium	*78.56*	*25*	*16.34*	*27*	*8.41*	*17*	*17.04*	*33.1*
160	Bermuda	*86.15*	*17*	…	…	-	…	-	…
161	Brunei Darussalam	*40.06*	*68*	*6.35*	*51*	-	…	-	*25.6*
162	Canada	62.90	47	*17.73*	*23*	14.67	*3*	*23.32*	*28.2*
163	Cyprus	*68.80*	*36*	*10.65*	*37*	1.35	*40*	*2.00*	*15.8*
164	Denmark	88.72	14	50.35	3	13.30	6	19.86	75.2
165	Faroe Islands	*64.37*	*44*	*17.11*	*26*	-	…	-	*37.6*
166	Finland	90.06	12	25.27	15	9.41	14	19.27	51.8
167	France	69.59	34	17.57	24	5.61	22	9.91	31.0
168	French Guiana	*49.94*	*59*	*6.63*	*48*	-	…	-	*23.5*
169	French Polynesia	*37.49*	*70*	5.34	57	0.39	59	1.77	24.3
170	Germany	78.54	26	27.88	11	5.53	23	8.39	42.3
171	Greece	78.00	27	6.86	47	0.00	105	0.01	15.1
172	Greenland	*44.69*	*63*	*15.83*	*29*	-	…	-	*35.8*
173	Guam	*50.89*	*56*	…	…	*1.08*	*41*	*2.19*	…
174	Guernsey	*97.74*	*5*	*1.36*	*95*	-	…	-	*1.4*
175	Hong Kong, China	105.75	3	33.89	6	17.97	2	32.37	61.1
176	Iceland	96.56	6	*17.30*	*25*	13.99	*4*	*21.19*	*26.2*
177	Ireland	84.47	19	*27.53*	*12*	0.75	*48*	*1.54*	*56.7*
178	Israel	*95.45*	*8*	*14.13*	*30*	9.61	*13*	*21.62*	*31.8*
179	Italy	101.76	4	30.94	8	4.00	27	8.27	63.9
180	Japan	67.96	39	26.59	13	11.70	7	20.97	*47.7*
181	Jersey	*84.79*	*18*	…	…	-	…	-	…
182	Korea (Rep.)	69.37	35	23.32	18	23.33	1	43.33	43.3
183	Kuwait	57.81	52	9.24	41	0.53	53	2.67	46.6
184	Luxembourg	*106.05*	*2*	23.83	17	3.40	29	6.27	43.9
185	Macao, China	81.51	23	13.28	31	6.19	20	15.89	34.1
186	Malta	72.50	32	19.20	22	5.68	21	10.92	36.9
187	Martinique	*82.13*	*22*	10.20	38	*1.53*	36	*3.49*	*23.3*
188	Neth. Antilles	*0.00*	…	…	…	-	…	-	…
189	Netherlands	76.76	28	30.70	9	11.36	9	18.49	50.0
190	New Caledonia	*35.71*	*74*	13.10	32	*0.31*	61	*1.35*	*57.7*
191	New Zealand	64.82	43	19.51	21	2.07	35	4.62	43.5
192	Norway	90.89	10	27.90	10	8.43	16	11.81	39.1
193	Portugal	90.38	11	69.77	1	4.84	25	11.68	168.5
194	Puerto Rico	*46.65*	*61*	*6.60*	*49*	*0.59*	*51*	*1.78*	*20.1*
195	Qatar	58.99	50	4.40	63	0.44	55	1.52	15.2
196	Réunion	74.74	29	*6.31*	*52*	-	…	-	*15.9*
197	Singapore	*79.56*	*24*	52.49	2	10.05	12	22.32	116.6
198	Slovenia	87.09	16	12.04	35	2.90	32	7.14	29.6
199	Spain	91.61	9	12.74	33	5.21	24	12.15	29.7
200	Sweden	*88.89*	*13*	*35.50*	*4*	10.78	*10*	*14.70*	*48.4*
201	Switzerland	84.34	20	*31.09*	*7*	11.44	*8*	*15.69*	*42.6*
202	Taiwan, China	110.84	1	34.56	5	13.35	5	22.63	58.6
203	United Arab Emirates	73.57	31	7.85	43	0.63	50	2.23	27.9
204	United Kingdom	*84.07*	*21*	*22.54*	*19*	*3.13*	*30*	*5.22*	*37.5*
205	United States	62.13	48	*23.95*	*16*	9.29	*15*	*14.95*	*38.5*
206	Virgin Islands (US)	*63.49*	*46*	…	…	-	…	-	…
	High Income	**73.99**		**24.51**		**8.80**		**15.24**	**43.08**
	WORLD	**23.43**		**5.60**		**1.59**		**3.49**	**20.01**
	Africa	**6.73**		**0.23**		**0.00**		**0.10**	**14.73**
	Americas	**37.89**		**10.52**		**3.89**		**7.02**	**24.25**
	Asia	**15.95**		**3.81**		**1.15**		**3.08**	**18.04**
	Europe	**58.83**		**13.77**		**2.79**		**5.11**	**29.30**
	Oceania	**53.94**		**18.38**		**2.11**		**4.06**	**43.69**

Note: For data comparability and coverage, see the technical notes.
Data in italics refer to 2001.

Source: ITU.

9. International Internet bandwidth

		Total (Mbit/s)	Bits per Inhabitant		Bits per Internet user		Bits per Internet subscriber		Simultaneous intl. 256 kbit/s links	
		2003	2003	Rank	2003	Rank	2003	Rank	2003	Rank
1	Afghanistan	30.0	1.57	141	1'572.9	38	44'939.0	3	120.0	105
2	Angola	*7.0*	*0.51*	*160*	*179.0*	*128*	*815.6*	*113*	*28.0*	*139*
3	Azerbaijan	*2.1*	*0.26*	*175*	*7.2*	*188*	*180.0*	*167*	*8.2*	*158*
4	Bangladesh	50.0	0.39	167	215.8	118	647.3	128	200.0	94
5	Benin	*2.1*	*0.31*	*171*	*31.5*	*182*	*325.3*	*154*	*8.4*	*157*
6	Bhutan	6.6	9.83	109	464.2	80	3'481.3	53	26.6	140
7	Burkina Faso	*8.0*	*0.68*	*154*	*174.8*	*129*	*790.0*	*115*	*32.0*	*137*
8	Burundi	*4.0*	*0.59*	*156*	*299.6*	*101*	*4'993.2*	*43*	*16.0*	*151*
9	Cambodia	21.0	1.56	142	629.1	63	3'078.9	60	84.0	112
10	Cameroon	*9.0*	*0.58*	*157*	*157.3*	*133*	*1'715.9*	*84*	*36.0*	*134*
11	Central African Rep.	*0.5*	*0.11*	*181*	*78.6*	*160*	*235.9*	*161*	*1.8*	*184*
12	Chad	*0.5*	*0.07*	*185*	*35.8*	*179*	*297.9*	*157*	*2.0*	*179*
13	Comoros	*0.3*	*0.34*	*169*	*53.7*	*172*	*268.4*	*160*	*1.0*	*185*
14	Congo	*0.1*	*0.04*	*189*	*8.9*	*187*	*206.5*	*165*	*0.5*	*188*
15	Côte d'Ivoire	*11.0*	*0.69*	*153*	*128.2*	*144*	*757.6*	*118*	*44.0*	*123*
16	D.P.R. Korea	…	…	…	…	…	…	…	…	…
17	D.R. Congo	*10.2*	*0.20*	*178*	*214.7*	*119*	*1'777.7*	*81*	*41.0*	*125*
18	Equatorial Guinea	*1.0*	*1.93*	*138*	*582.5*	*68*	*1'048.6*	*101*	*4.0*	*177*
19	Eritrea	*2.0*	*0.51*	*161*	*220.8*	*116*	*699.1*	*122*	*8.0*	*161*
20	Ethiopia	*10.0*	*0.15*	*180*	*139.8*	*138*	*918.4*	*109*	*40.0*	*126*
21	Gambia	*2.0*	*1.57*	*140*	*85.9*	*153*	*536.9*	*139*	*8.2*	*159*
22	Georgia	…	…	…	…	…	…	…	…	…
23	Ghana	*12.0*	*0.56*	*159*	*74.0*	*163*	*625.4*	*133*	*48.0*	*118*
24	Guinea	*2.0*	*0.27*	*174*	*52.4*	*173*	*190.7*	*166*	*8.0*	*161*
25	GuineaoBissau	*0.1*	*0.05*	*187*	*3.5*	*189*	*303.7*	*155*	*0.3*	*189*
26	Haiti	…	…	…	…	…	…	…	…	…
27	India	3'000.0	2.98	132	170.2	130	759.8	117	12'000.0	34
28	Indonesia	*573.0*	*2.79*	*133*	*74.4*	*162*	*694.0*	*124*	*2'292.0*	*56*
29	Kenya	*56.0*	*1.85*	*139*	*146.8*	*137*	*1'304.9*	*93*	*224.0*	*91*
30	Kyrgyzstan	*15.0*	*3.02*	*131*	*103.5*	*149*	*3'444.7*	*56*	*60.0*	*116*
31	Lao P.D.R.	*1.7*	*0.31*	*173*	*116.3*	*147*	*682.9*	*126*	*6.7*	*173*
32	Lesotho	*1.0*	*0.49*	*162*	*51.1*	*175*	*633.8*	*130*	*4.1*	*175*
33	Liberia	*0.3*	*0.08*	*184*	*268.4*	*105*	…	…	*1.0*	*185*
34	Madagascar	*6.0*	*0.39*	*168*	*89.2*	*152*	*273.5*	*159*	*24.0*	*141*
35	Malawi	*2.0*	*0.20*	*179*	*58.3*	*171*	*166.4*	*169*	*8.0*	*161*
36	Mali	*6.0*	*0.58*	*158*	*251.7*	*109*	*419.4*	*147*	*24.0*	*141*
37	Mauritania	*9.5*	*3.62*	*128*	*996.1*	*53*	*10'376.5*	*26*	*38.0*	*132*
38	Moldova	79.2	18.83	89	288.4	103	5'206.1	42	316.8	83
39	Mongolia	22.0	9.39	110	161.5	131	501.5	142	88.0	111
40	Mozambique	*4.5*	*0.25*	*176*	*94.0*	*151*	*770.1*	*116*	*17.9*	*150*
41	Myanmar	10.0	0.21	177	374.5	90	647.2	129	40.0	126
42	Nepal	*10.0*	*0.44*	*165*	*131.1*	*142*	*524.3*	*141*	*40.0*	*126*
43	Nicaragua	*32.0*	*6.07*	*118*	*372.8*	*91*	*1'597.8*	*85*	*128.0*	*103*
44	Niger	*0.5*	*0.04*	*188*	*35.8*	*179*	*223.8*	*164*	*2.0*	*179*
45	Nigeria	*72.0*	*0.61*	*155*	*100.7*	*150*	*1'418.1*	*89*	*288.0*	*87*
46	Pakistan	567.0	3.97	127	*396.4*	*89*	*2'313.8*	*72*	2'268.0	57
47	Papua New Guinea	*6.0*	*1.12*	*148*	*83.9*	*154*	*233.0*	*162*	*24.0*	*141*
48	Rwanda	*10.3*	*1.28*	*145*	*430.8*	*84*	*4'661.9*	*47*	*41.1*	*124*
49	S. Tomé & Principe	*2.0*	*13.80*	*100*	*139.8*	*138*	*1'884.2*	*79*	*8.0*	*161*
50	Senegal	*79.0*	*8.00*	*111*	*368.2*	*92*	*8'640.6*	*32*	*316.0*	*84*
51	Sierra Leone	*0.5*	*0.11*	*182*	*67.1*	*166*	*715.8*	*119*	*2.0*	*179*
52	Solomon Islands	0.5	1.13	147	214.7	119	536.9	139	2.0	179
53	Somalia	*0.8*	*0.08*	*183*	*9.1*	*186*	*161.5*	*170*	*3.1*	*178*
54	Sudan	*24.0*	*0.76*	*152*	*83.9*	*154*	*419.4*	*147*	*96.0*	*109*
55	Tajikistan	2.0	0.32	170	509.0	75	4'639.7	48	8.0	161
56	Tanzania	*16.0*	*0.48*	*164*	*67.1*	*166*	*335.5*	*153*	*64.0*	*114*
57	Togo	*12.0*	*2.52*	*136*	*59.9*	*170*	*1'006.6*	*104*	*48.0*	*118*
58	Uganda	*9.5*	*0.39*	*166*	*79.7*	*158*	*1'418.2*	*88*	*38.0*	*132*
59	Uzbekistan	32.0	1.31	144	68.2	165	896.7	110	128.0	103
60	Viet Nam	1'038.0	13.38	101	311.0	100	1'186.8	96	4'152.0	49
61	Yemen	*6.0*	*0.31*	*172*	*62.9*	*168*	*419.4*	*147*	*24.0*	*141*
62	Zambia	*5.1*	*0.48*	*163*	*78.8*	*159*	*447.4*	*146*	*20.5*	*148*
63	Zimbabwe	1'445.0	128.79	51	*3'030.4*	*27*	*18'097.9*	*13*	5'780.0	42
	Low Income	**7'347.8**	**3.11**		**202.3**		**1'444.5**		**29'391.3**	

9. International Internet bandwidth

		Total (Mbit/s)	Bits per Inhabitant		Bits per Internet user		Bits per Internet subscriber		Simultaneous intl. 256 kbit/s links	
		2003	2003	Rank	2003	Rank	2003	Rank	2003	Rank
64	Albania	12.0	4.09	126	419.4	85	629.1	131	48.0	118
65	Algeria	*156.3*	*5.16*	*121*	*327.8*	*99*	*2'731.5*	*67*	*625.2*	*77*
66	Armenia	10.0	2.76	135	52.4	173	149.8	171	40.0	126
67	Belarus	200.0	21.24	86	150.7	136	9'232.9	30	800.0	73
68	Bolivia	*18.0*	*2.24*	*137*	*69.9*	*164*	*359.2*	*151*	*72.0*	*113*
69	Bosnia	*25.0*	*6.84*	*116*	*262.1*	*108*	*301.3*	*156*	*100.0*	*108*
70	Brazil	*9'340.5*	*55.66*	*66*	*684.9*	*62*	*1'239.8*	*95*	*37'362.0*	*26*
71	Bulgaria	189.0	26.40	82	128.3	143	23'315.4	10	756.0	74
72	Cape Verde	*3.0*	*6.86*	*115*	*154.4*	*135*	*627.8*	*132*	*12.0*	*154*
73	China	*9'380.0*	*7.82*	*112*	*123.7*	*146*	*145.2*	*172*	*37'520.0*	*25*
74	Colombia	3'620.0	86.70	58	1'389.3	42	5'324.8	41	14'480.0	33
75	Cuba	*52.0*	*4.82*	*122*	*454.4*	*81*	…	…	*208.0*	*92*
76	Djibouti	*2.0*	*3.21*	*129*	*330.4*	*98*	*1'022.6*	*103*	*8.2*	*159*
77	Dominican Rep.	*51.8*	*6.95*	*114*	*108.6*	*148*	*563.5*	*138*	*207.2*	*93*
78	Ecuador	500.0	40.32	71	920.2	54	4'883.9	45	2'000.0	60
79	Egypt	1'148.0	17.54	93	445.8	83	…	…	4'592.0	47
80	El Salvador	*43.4*	*6.98*	*113*	*82.7*	*157*	*404.2*	*150*	*173.6*	*99*
81	Fiji	12.0	15.24	99	228.8	114	1'398.1	91	48.0	118
82	Guatemala	*874.0*	*74.42*	*61*	*2'291.1*	*32*	…	…	*3'496.0*	*52*
83	Guyana	…	…	…	…	…	…	…	…	…
84	Honduras	*10.0*	*1.53*	*143*	*62.2*	*169*	*139.8*	*173*	*40.0*	*126*
85	Iran (I.R.)	1'000.0	15.85	96	243.9	112	1'284.8	94	4'000.0	50
86	Iraq	…	…	…	…	…	…	…	…	…
87	Jamaica	*73.2*	*29.02*	*80*	*127.9*	*145*	*808.0*	*114*	*292.8*	*86*
88	Jordan	*90.0*	*17.22*	*95*	*206.5*	*123*	*984.6*	*106*	*360.0*	*82*
89	Kazakhstan	*48.0*	*3.18*	*130*	*201.3*	*125*	…	…	*192.0*	*96*
90	Kiribati	*0.5*	*6.03*	*119*	*268.4*	*105*	*708.3*	*120*	*2.0*	*179*
91	Maldives	*9.0*	*32.91*	*77*	*629.1*	*63*	*8'844.6*	*31*	*36.0*	*134*
92	Marshall Islands	1.5	30.00	78	1'156.4	48	2'329.5	71	6.2	174
93	Micronesia	2.0	19.44	88	209.7	121	1'096.3	100	8.0	161
94	Morocco	*310.0*	*10.79*	*108*	*406.3*	*88*	*5'417.6*	*40*	*1'240.0*	*67*
95	Namibia	*8.5*	*4.63*	*124*	*137.1*	*141*	*575.0*	*137*	*34.0*	*136*
96	Palestine	40.0	11.59	105	289.3	102	1'048.6	101	160.0	100
97	Paraguay	100.0	17.68	92	873.8	55	2'995.9	61	400.0	80
98	Peru	*1'356.0*	*51.85*	*68*	*498.9*	*76*	*3'474.8*	*55*	*5'424.0*	*45*
99	Philippines	*890.5*	*11.51*	*107*	*266.8*	*107*	*1'167.2*	*98*	*3'562.0*	*51*
100	Romania	2'320.0	115.87	53	608.2	66	2'828.7	64	9'280.0	37
101	Russia	*8'967.3*	*64.22*	*64*	*1'567.1*	*39*	*4'973.8*	*44*	*35'869.2*	*27*
102	Samoa	*3.0*	*17.26*	*94*	*786.4*	*56*	*2'383.1*	*70*	*12.0*	*154*
103	Serbia and Montenegro	*10.0*	*0.97*	*150*	*12.4*	*184*	*31.3*	*179*	*40.0*	*126*
104	South Africa	*564.5*	*12.77*	*103*	*190.9*	*126*	*591.9*	*135*	*2'258.0*	*58*
105	Sri Lanka	75.0	4.10	125	349.5	96	919.8	108	300.0	85
106	St. Vincent	*4.0*	*35.25*	*75*	*599.2*	*67*	*701.2*	*121*	*16.0*	*151*
107	Suriname	12.0	23.92	85	*629.1*	*63*	*2'275.8*	*73*	48.0	118
108	Swaziland	*1.0*	*1.03*	*149*	*39.8*	*177*	*56.5*	*176*	*4.1*	*175*
109	Syria	*16.0*	*0.96*	*151*	*76.3*	*161*	*229.8*	*163*	*64.0*	*114*
110	TFYR Macedonia	*50.0*	*25.16*	*83*	*524.3*	*73*	*1'747.6*	*82*	*200.0*	*94*
111	Thailand	1'437.7	24.11	84	249.9	111	1'005.0	105	5'750.7	43
112	Tonga	*2.0*	*21.08*	*87*	*723.2*	*60*	*1'107.8*	*99*	*8.0*	*161*
113	Tunisia	*124.0*	*13.15*	*102*	*206.4*	*124*	*1'416.4*	*90*	*496.0*	*79*
114	Turkey	2'200.0	33.78	76	419.4	85	659.1	127	8'800.0	39
115	Turkmenistan	*0.3*	*0.06*	*186*	*33.6*	*181*	*123.5*	*174*	*1.0*	*185*
116	Ukraine	*314.1*	*6.59*	*117*	*366.0*	*93*	…	…	*1'256.4*	*66*
117	Vanuatu	2.5	12.62	104	349.5	96	1'747.6	82	10.0	156
	Lower Middle Income	**45'679.7**	**20.17**		**350.3**		**1'129.2**		**222'364.4**	

9. International Internet bandwidth

		Total (Mbit/s)	Bits per Inhabitant		Bits per Internet user		Bits per Internet subscriber		Simultaneous intl. 256 kbit/s links	
		2003	2003	Rank	2003	Rank	2003	Rank	2003	Rank
118	Argentina	5'476.2	155.28	48	1'400.5	41	4'015.5	51	21'904.8	31
119	Belize	46.0	163.40	47	1'607.8	37	9'396.9	28	184.0	97
120	Botswana	26.0	15.49	97	454.4	81	1'817.5	80	104.0	107
121	Chile	1'981.0	141.24	49	519.3	74	2'468.8	69	7'924.0	40
122	Costa Rica	275.0	69.10	62	360.4	95	2'991.8	62	1'100.0	71
123	Croatia	180.0	43.15	70	186.1	127	350.8	152	720.0	76
124	Czech Republic	22'206.0	2'313.52	17	8'624.0	12	11'021.6	23	88'824.0	18
125	Dominica	5.0	67.04	63	419.4	85	1'171.9	97	20.0	149
126	Estonia	555.0	453.27	34	1'310.7	45	4'809.6	46	2'220.0	59
127	Gabon	45.0	35.29	74	1'348.2	43	6'049.5	36	180.0	98
128	Grenada	4.0	37.32	72	220.8	116	892.4	111	16.0	151
129	Guadeloupe	2.0	4.77	123	41.9	176	83.9	175	8.0	161
130	Hungary	10'000.0	1'014.67	26	4'369.1	24	15'563.7	16	40'000.0	23
131	Latvia	423.0	192.24	44	473.9	79	11'767.4	22	1'692.0	63
132	Lebanon	60.0	17.98	91	157.3	133	484.0	143	240.0	89
133	Libya	6.0	1.14	146	39.3	178	…	…	24.0	141
134	Lithuania	328.0	105.60	55	494.4	78	2'131.6	76	1'312.0	65
135	Malaysia	1'320.5	55.01	67	159.3	132	460.4	144	5'282.0	46
136	Mauritius	34.0	29.20	79	237.7	113	614.7	134	136.0	102
137	Mayotte	…	…	…	…	…	…	…	…	…
138	Mexico	5'825.0	59.07	65	498.6	77	2'988.2	63	23'300.0	30
139	Northern Marianas	…	…	…	…	…	…	…	…	…
140	Oman	38.0	15.33	98	221.4	115	826.1	112	152.0	101
141	Panama	621.5	209.07	43	5'430.7	21	9'879.9	27	2'486.0	55
142	Poland	6'316.0	171.62	46	738.3	58	4'124.2	50	25'264.0	28
143	Saudi Arabia	400.0	18.61	90	279.6	104	699.1	122	1'600.0	64
144	Seychelles	6.0	78.64	59	536.1	71	1'888.2	78	24.0	141
145	Slovak Republic	9'931.0	1'936.66	20	7'568.9	13	57'171.6	1	39'724.0	24
146	St. Kitts and Nevis	2.0	43.43	69	208.0	122	452.3	145	7.9	172
147	St. Lucia	15.0	96.91	57	1'209.9	46	…	…	60.0	116
148	Trinidad & Tobago	96.0	77.26	60	729.4	59	2'720.6	68	384.0	81
149	Uruguay	436.2	134.16	50	1'143.5	50	…	…	1'744.8	62
150	Venezuela	690.0	28.16	81	567.7	69	2'146.9	75	2'760.0	53
	Upper Middle Income	**67'349.4**	**211.91**		**1'111.9**		**4'387.8**		**269'397.5**	

9. International Internet bandwidth

		Total (Mbit/s)	Bits per Inhabitant		Bits per Internet user		Bits per Internet subscriber		Simultaneous intl. 256 kbit/s links	
		2003	2003	Rank	2003	Rank	2003	Rank	2003	Rank
151	Andorra	188.0	2'341.24	16	19'617.1	4	31'251.2	5	752.0	75
152	Antigua & Barbuda	28.0	373.54	36	2'936.0	28	…	…	112.0	106
153	Aruba	…	…	…	…	…	…	…	…	…
154	Australia	10'497.9	552.01	31	1'162.1	47	2'168.6	74	41'991.6	22
155	Austria	36'076.0	4'685.80	7	10'141.7	9	29'098.8	8	144'304.0	15
156	Bahamas	145.0	479.48	32	1'810.0	34	5'480.6	39	580.0	78
157	Bahrain	309.0	466.81	33	1'655.6	36	6'129.0	35	1'236.0	69
158	Barbados	…	…	…	…	…	…	…	…	…
159	Belgium	84'024.1	8'494.18	4	25'913.4	3	51'998.6	2	336'096.4	9
160	Bermuda	…	…	…	…	…	…	…	…	…
161	Brunei Darussalam	60.0	173.65	45	1'797.6	35	2'735.4	66	240.0	89
162	Canada	89'273.0	2'951.08	14	5'810.6	20	16'644.7	15	357'092.0	8
163	Cyprus	245.0	346.41	37	1'027.6	51	3'251.9	58	980.0	72
164	Denmark	109'204.0	21'230.87	1	41'548.9	1	42'162.8	4	436'816.0	6
165	Faroe Islands	…	…	…	…	…	…	…	…	…
166	Finland	16'587.0	3'332.58	11	6'563.3	16	13'185.3	18	66'348.0	20
167	France	200'000.0	3'501.07	9	9'576.0	10	19'926.0	11	800'000.0	4
168	French Guiana	2.0	11.58	106	83.9	154	174.8	168	8.0	161
169	French Polynesia	24.0	103.31	56	719.0	61	1'935.8	77	96.0	109
170	Germany	260'667.8	3'312.69	12	7'008.5	14	11'883.9	21	1'042'671.2	3
171	Greece	2'446.2	223.89	41	1'492.7	40	3'264.2	57	9'784.8	36
172	Greenland	6.0	109.80	54	251.7	109	693.6	125	24.0	141
173	Guam	…	…	…	…	…	…	…	…	…
174	Guernsey	…	…	…	…	…	…	…	…	…
175	Hong Kong, China	18'780.0	2'875.66	15	6'129.3	18	8'484.3	33	75'120.0	19
176	Iceland	68.0	246.72	40	365.7	94	1'426.1	87	272.0	88
177	Ireland	13'501.0	3'516.96	8	11'235.6	8	12'776.9	19	54'004.0	21
178	Israel	1'418.0	219.77	42	743.4	57	1'555.3	86	5'672.0	44
179	Italy	119'794.0	2'285.89	18	6'789.9	15	7'389.0	34	479'176.0	5
180	Japan	30'285.6	249.03	39	555.2	70	936.6	107	121'142.4	16
181	Jersey	…	…	…	…	…	…	…	…	…
182	Korea (Rep.)	37'069.0	811.05	28	1'330.2	44	3'477.2	54	148'276.0	14
183	Kuwait	287.0	122.51	52	530.8	72	1'325.7	92	1'148.0	70
184	Luxembourg	1'469.0	3'411.65	10	9'060.9	11	14'315.5	17	5'876.0	41
185	Macao, China	690.0	1'613.19	21	6'029.3	19	12'149.3	20	2'760.0	53
186	Malta	310.0	812.65	27	2'708.8	29	4'231.8	49	1'240.0	67
187	Martinique	2.0	5.35	120	26.2	183	52.4	177	8.0	161
188	Neth. Antilles	…	…	…	…	…	…	…	…	…
189	Netherlands	50'000.0	3'219.41	13	6'168.1	17	10'485.8	25	200'000.0	11
190	New Caledonia	8.0	36.63	73	139.8	138	279.6	158	32.0	137
191	New Zealand	2'303.0	602.33	30	1'144.5	49	3'088.1	59	9'212.0	38
192	Norway	22'696.1	5'195.52	6	15'031.0	6	18'620.5	12	90'784.4	17
193	Portugal	4'019.0	407.74	35	2'107.1	33	584.4	136	16'076.0	32
194	Puerto Rico	…	…	…	…	…	…	…	…	…
195	Qatar	465.0	763.89	29	3'869.7	25	17'375.4	14	1'860.0	61
196	Réunion	2.0	2.77	134	11.7	185	43.9	178	8.0	161
197	Singapore	5'898.2	1'473.78	22	2'689.0	30	2'807.7	65	23'592.8	29
198	Slovenia	2'510.0	1'317.94	24	3'509.2	26	10'944.5	24	10'040.0	35
199	Spain	46'554.0	1'192.38	25	4'986.8	23	9'356.2	29	186'216.0	12
200	Sweden	94'896.0	11'085.62	2	19'415.7	5	31'222.8	6	379'584.0	7
201	Switzerland	65'827.3	9'432.63	3	27'005.1	2	30'340.6	7	263'309.2	10
202	Taiwan, China	44'923.0	2'080.93	19	5'334.7	22	6'022.0	37	179'692.0	13
203	United Arab Emirates	1'085.0	281.59	38	1'024.8	52	3'586.7	52	4'340.0	48
204	United Kingdom	319'663.3	5'767.51	5	13'407.7	7	25'587.1	9	1'278'653.2	2
205	United States	381'692.5	1'369.26	23	2'517.2	31	5'717.6	38	1'526'770.0	1
206	Virgin Islands (US)	…	…	…	…	…	…	…	…	…
	High Income	**2'075'999.0**	**2'250.72**		**5'203.1**		**9'522.3**		**8'303'996.0**	
	WORLD	**2'196'375.9**	**374.50**		**1'095.2**		**2'793.7**		**8'825'149.2**	
	Africa	**4'280.1**	**5.35**		**219.8**		**1'681.0**		**17'120.5**	
	Americas	**502'704.3**	**622.30**		**1'559.8**		**4'209.6**		**2'010'817.1**	
	Asia	**161'471.1**	**46.57**		**258.6**		**992.7**		**645'884.4**	
	Europe	**1'515'057.4**	**1'997.63**		**5'356.8**		**11'161.3**		**6'060'229.6**	
	Oceania	**12'863.0**	**420.11**		**907.4**		**1'872.0**		**51'451.9**	

Source; TeleGeography Inc., ITU research, and other sources

10. Main telephone lines

		Main telephone lines (k) 1998	Main telephone lines (k) 2003	Main telephone lines CAGR (%) 1998-03	Main telephone lines per 100 inhabitants 1998	Main telephone lines per 100 inhabitants 2003	Main telephone lines per 100 inhabitants CAGR (%) 1998-03
1	Afghanistan	29.0	36.7	4.8	0.14	0.18	6.1
2	Angola	65.1	96.3	8.1	0.54	0.67	4.5
3	Azerbaijan	680.2	*923.8*	*8.0*	8.87	*11.35*	*6.4*
4	Bangladesh	412.6	742.0	12.5	0.33	0.55	10.8
5	Benin	38.4	66.5	11.6	0.64	0.95	8.1
6	Bhutan	10.4	25.2	19.3	1.64	3.56	16.8
7	Burkina Faso	41.2	65.4	9.7	0.38	0.53	7.0
8	Burundi	17.8	23.9	6.0	0.28	0.34	4.0
9	Cambodia	24.3	36.4	8.4	0.21	0.26	3.9
10	Cameroon	93.9	*110.9*	*4.2*	0.66	*0.70*	*1.6*
11	Central African Rep.	9.6	*9.0*	*-1.5*	0.27	*0.23*	*-4.6*
12	Chad	8.6	*11.8*	*8.2*	0.12	*0.15*	*5.4*
13	Comoros	6.2	13.2	16.3	0.95	1.66	11.9
14	Congo	22.0	7.0	-20.5	0.79	0.20	-24.0
15	Côte d'Ivoire	170.0	328.0	14.0	1.19	1.97	10.6
16	D.P.R. Korea	500.0	980.0	14.4	2.20	4.10	13.3
17	D.R. Congo	9.3	*10.0*	*1.7*	0.02	*0.02*	-
18	Equatorial Guinea	5.6	9.6	11.5	1.29	1.77	6.4
19	Eritrea	24.3	38.1	9.4	0.68	0.92	6.2
20	Ethiopia	164.1	435.0	21.5	0.28	0.63	17.9
21	Gambia	25.6	*38.4*	*10.6*	2.15	*2.89*	*7.6*
22	Georgia	628.8	650.5	0.7	12.16	13.30	1.8
23	Ghana	133.4	302.3	17.8	0.70	1.35	14.1
24	Guinea	15.2	26.2	11.5	0.21	0.34	10.2
25	Guinea-Bissau	8.1	10.6	5.5	0.70	0.82	3.2
26	Haiti	65.0	*130.0*	*18.9*	0.83	*1.57*	*17.1*
27	India	21'593.7	48'917.0	17.8	2.20	4.63	16.1
28	Indonesia	5'571.6	8'477.0	8.8	2.73	3.94	7.7
29	Kenya	288.3	328.4	2.6	1.03	1.04	-
30	Kyrgyzstan	368.4	*394.8*	*1.7*	7.84	*7.75*	*-0.3*
31	Lao P.D.R.	28.5	*61.9*	*21.4*	0.57	*1.12*	*18.3*
32	Lesotho	21.0	*28.6*	*8.0*	1.02	*1.32*	*6.7*
33	Liberia	6.5	*6.9*	*1.5*	0.24	*0.21*	*-3.3*
34	Madagascar	47.2	59.6	4.8	0.33	0.36	1.9
35	Malawi	37.4	85.0	17.9	0.38	0.81	16.6
36	Mali	27.1	*56.6*	*20.3*	0.28	*0.53*	*17.8*
37	Mauritania	15.0	*31.5*	*20.3*	0.62	*1.18*	*17.3*
38	Moldova	657.5	791.1	3.8	15.02	17.94	3.6
39	Mongolia	103.4	138.1	6.0	4.47	5.62	4.7
40	Mozambique	75.4	*83.7*	*2.7*	0.47	*0.46*	*-0.4*
41	Myanmar	229.3	363.0	9.6	0.52	0.68	5.8
42	Nepal	208.4	371.8	12.3	0.98	1.57	10.0
43	Nicaragua	141.2	*171.6*	*5.0*	3.01	*3.20*	*1.5*
44	Niger	18.1	*22.4*	*5.4*	0.18	*0.19*	*1.5*
45	Nigeria	438.6	853.1	14.2	0.41	0.69	10.9
46	Pakistan	2'756.1	3'982.8	7.6	2.08	2.66	5.0
47	Papua New Guinea	56.9	*62.0*	*2.2*	1.18	*1.13*	*-1.0*
48	Rwanda	10.8	*23.2*	*21.0*	0.16	*0.28*	*14.7*
49	S. Tomé & Principe	4.3	7.0	10.2	3.05	4.59	8.5
50	Senegal	139.5	228.8	10.4	1.55	2.21	7.3
51	Sierra Leone	17.4	*24.0*	*8.4*	0.37	*0.48*	*6.9*
52	Solomon Islands	7.9	6.2	-4.6	1.99	1.31	-8.0
53	Somalia	20.0	*100.0*	*49.5*	0.21	*1.01*	*49.0*
54	Sudan	162.2	900.0	40.9	0.55	2.70	37.4
55	Tajikistan	221.3	242.1	1.8	3.68	3.70	0.1
56	Tanzania	121.8	149.1	4.1	0.39	0.42	1.3
57	Togo	31.4	60.6	14.1	0.71	1.21	11.2
58	Uganda	56.9	61.0	1.4	0.27	0.24	-2.2
59	Uzbekistan	1'536.7	1'717.1	2.2	6.42	6.70	0.9
60	Viet Nam	1'743.6	4'402.0	20.3	2.25	5.41	19.2
61	Yemen	249.5	*542.2*	*21.4*	1.48	*2.78*	*17.1*
62	Zambia	77.7	88.4	2.6	0.80	0.79	-0.2
63	Zimbabwe	236.5	300.9	4.9	2.13	2.56	3.8
	Low Income	**40'536.0**	**79'266.3**	**14.4**	**1.77**	**3.16**	**12.3**

10. Main telephone lines

		Main telephone lines (k) 1998	Main telephone lines (k) 2003	CAGR (%) 1998-03	Main telephone lines per 100 inhabitants 1998	2003	CAGR (%) 1998-03
64	Albania	115.7	255.0	17.1	3.72	8.30	17.4
65	Algeria	1'477.0	2'199.6	8.3	5.01	6.93	6.7
66	Armenia	556.6	562.6	0.2	14.66	14.80	0.2
67	Belarus	2'489.9	3'071.3	4.3	24.79	31.11	4.6
68	Bolivia	452.4	600.1	5.8	5.69	7.14	4.7
69	Bosnia	333.2	938.0	23.0	9.07	24.48	22.0
70	Brazil	19'986.6	42'317.0	16.2	12.05	24.05	14.8
71	Bulgaria	2'758.0	2'856.1	0.7	33.09	38.05	2.8
72	Cape Verde	40.0	71.7	12.4	9.58	15.63	10.3
73	China	87'420.9	262'747.0	24.6	6.96	20.90	24.6
74	Colombia	6'366.9	8'768.1	6.6	15.59	20.03	5.1
75	Cuba	387.6	*574.4*	*14.0*	3.49	*5.11*	*13.6*
76	Djibouti	7.9	9.5	3.6	1.30	1.42	1.7
77	Dominican Rep.	772.2	901.8	3.2	9.45	11.54	4.1
78	Ecuador	990.8	1'549.0	9.3	8.14	11.91	7.9
79	Egypt	3'971.5	8'735.7	17.1	6.47	12.73	14.5
80	El Salvador	386.7	752.6	14.2	6.41	11.55	12.5
81	Fiji	76.9	102.0	5.8	9.66	12.35	5.1
82	Guatemala	517.0	*846.0*	*13.1*	4.79	*7.05*	*10.2*
83	Guyana	59.9	*80.4*	*7.6*	7.05	*9.15*	*6.7*
84	Honduras	249.5	*322.5*	*6.6*	3.99	*4.81*	*4.8*
85	Iran (I.R.)	7'355.0	14'571.1	14.7	11.89	22.03	13.1
86	Iraq	650.0	*675.0*	*0.9*	2.98	*2.78*	*-1.7*
87	Jamaica	462.8	*444.4*	*-1.0*	18.26	*16.92*	*-1.9*
88	Jordan	510.9	622.6	4.0	10.74	11.36	1.1
89	Kazakhstan	1'775.4	*2'081.9*	*4.1*	10.86	*13.04*	*4.7*
90	Kiribati	2.8	*4.5*	*12.4*	3.43	*5.11*	*10.5*
91	Maldives	20.0	*28.7*	*9.4*	7.72	*10.20*	*7.2*
92	Marshall Islands	3.7	4.5	3.6	7.47	8.27	2.0
93	Micronesia	9.1	11.1	4.1	8.54	10.33	3.9
94	Morocco	1'393.4	1'219.2	-2.6	5.03	4.05	-4.3
95	Namibia	105.9	127.4	3.8	6.26	6.62	1.1
96	Palestine	167.3	315.8	13.6	5.77	8.73	8.6
97	Paraguay	260.7	273.2	0.9	4.99	4.61	-1.6
98	Peru	1'555.1	1'839.2	3.4	6.27	6.71	1.4
99	Philippines	2'491.6	3'340.0	6.0	3.42	4.12	3.8
100	Romania	3'599.0	4'300.0	3.6	16.01	20.48	5.0
101	Russia	29'246.0	*35'500.0*	*5.0*	19.86	*24.22*	*5.1*
102	Samoa	8.5	13.3	9.4	4.89	7.29	8.3
103	Serbia and Montenegro	2'319.4	2'611.7	2.4	21.81	24.27	2.2
104	South Africa	5'075.4	*4'844.0*	*-1.2*	12.05	*10.66*	*-3.0*
105	Sri Lanka	523.5	939.0	12.4	2.92	4.90	10.9
106	St. Vincent	21.0	*27.3*	*6.7*	18.79	*23.35*	*5.6*
107	Suriname	67.3	79.8	3.5	15.80	15.17	-0.8
108	Swaziland	29.0	46.2	9.8	3.05	4.43	7.8
109	Syria	1'477.0	*2'099.3*	*9.2*	9.47	*12.32*	*6.8*
110	TFYR Macedonia	439.2	*560.0*	*6.3*	21.94	*27.13*	*5.5*
111	Thailand	5'037.5	6'600.0	5.6	8.49	10.55	4.5
112	Tonga	8.5	*11.2*	*7.1*	8.67	*11.29*	*6.8*
113	Tunisia	752.2	1'163.8	9.1	8.06	11.77	7.9
114	Turkey	16'959.5	18'916.7	2.2	26.73	27.70	0.7
115	Turkmenistan	354.0	*374.0*	*1.4*	8.22	*7.71*	*-1.6*
116	Ukraine	9'698.2	*10'833.3*	*2.8*	19.07	*21.61*	*3.2*
117	Vanuatu	5.2	6.5	4.8	2.85	3.15	2.0
	Lower Middle Income	**221'801.3**	**452'745.3**	**15.3**	**9.49**	**18.87**	**14.7**

10. Main telephone lines

		Main telephone lines			Main telephone lines per 100 inhabitants		
		(k)		CAGR (%)			CAGR (%)
		1998	2003	1998-03	1998	2003	1998-03
118	Argentina	7'323.1	*8'009.4*	*2.3*	20.86	*21.88*	*1.2*
119	Belize	32.5	33.3	0.5	14.26	11.27	-4.6
120	Botswana	102.0	131.8	5.3	6.51	7.49	2.8
121	Chile	3'046.7	3'250.9	1.3	20.56	22.10	1.5
122	Costa Rica	742.4	*1'038.0*	*8.7*	19.33	*25.05*	*6.7*
123	Croatia	1'558.0	*1'825.0*	*4.0*	34.77	*41.72*	*4.7*
124	Czech Republic	3'741.5	3'626.0	-0.6	36.34	36.03	-0.2
125	Dominica	20.1	*23.7*	*4.3*	26.50	*30.39*	*3.5*
126	Estonia	498.6	*475.0*	*-1.2*	34.39	*35.06*	*0.5*
127	Gabon	38.7	38.4	-0.1	3.32	2.87	-2.8
128	Grenada	27.5	32.6	3.5	29.78	29.04	-0.5
129	Guadeloupe	197.1	*210.0*	*2.1*	47.13	*48.73*	*1.1*
130	Hungary	3'423.0	3'602.9	1.0	33.59	34.86	0.8
131	Latvia	742.3	653.9	-2.5	30.19	28.34	-1.3
132	Lebanon	566.0	*678.8*	*4.6*	17.74	*19.88*	*2.9*
133	Libya	500.0	750.0	8.4	9.07	13.56	8.4
134	Lithuania	1'112.9	824.2	-5.8	30.07	25.31	-3.4
135	Malaysia	4'384.1	4'571.6	0.8	20.16	18.16	-2.1
136	Mauritius	245.4	348.2	7.3	21.16	28.52	6.2
137	Mayotte	12.2	*10.0*	*-4.8*	8.92	*6.24*	*-8.6*
138	Mexico	9'926.9	16'311.1	10.4	10.36	15.77	8.8
139	Northern Marianas	20.6	*21.0*	*0.8*	32.76	*30.87*	*-2.9*
140	Oman	220.0	*233.9*	*1.5*	9.62	*9.22*	*-1.1*
141	Panama	418.8	*386.9*	*-2.0*	15.13	*12.87*	*-4.0*
142	Poland	8'812.3	12'300.0	6.9	22.76	31.87	7.0
143	Saudi Arabia	2'167.0	3'502.6	10.1	10.95	15.54	7.3
144	Seychelles	18.8	*21.7*	*3.8*	23.78	*26.91*	*3.1*
145	Slovak Republic	1'539.3	1'294.7	-3.4	28.54	24.08	-3.3
146	St. Kitts and Nevis	18.4	*23.5*	*6.4*	41.65	*50.00*	*4.7*
147	St. Lucia	40.4	*51.1*	*6.1*	26.92	*31.95*	*4.4*
148	Trinidad & Tobago	264.1	*325.1*	*5.3*	20.58	*24.98*	*5.0*
149	Uruguay	823.5	*946.5*	*3.5*	25.04	*27.96*	*2.8*
150	Venezuela	2'592.3	*2'841.8*	*2.3*	11.15	*11.27*	*0.3*
	Upper Middle Income	**55'176.2**	**68'393.7**	**4.4**	**17.54**	**20.58**	**3.2**

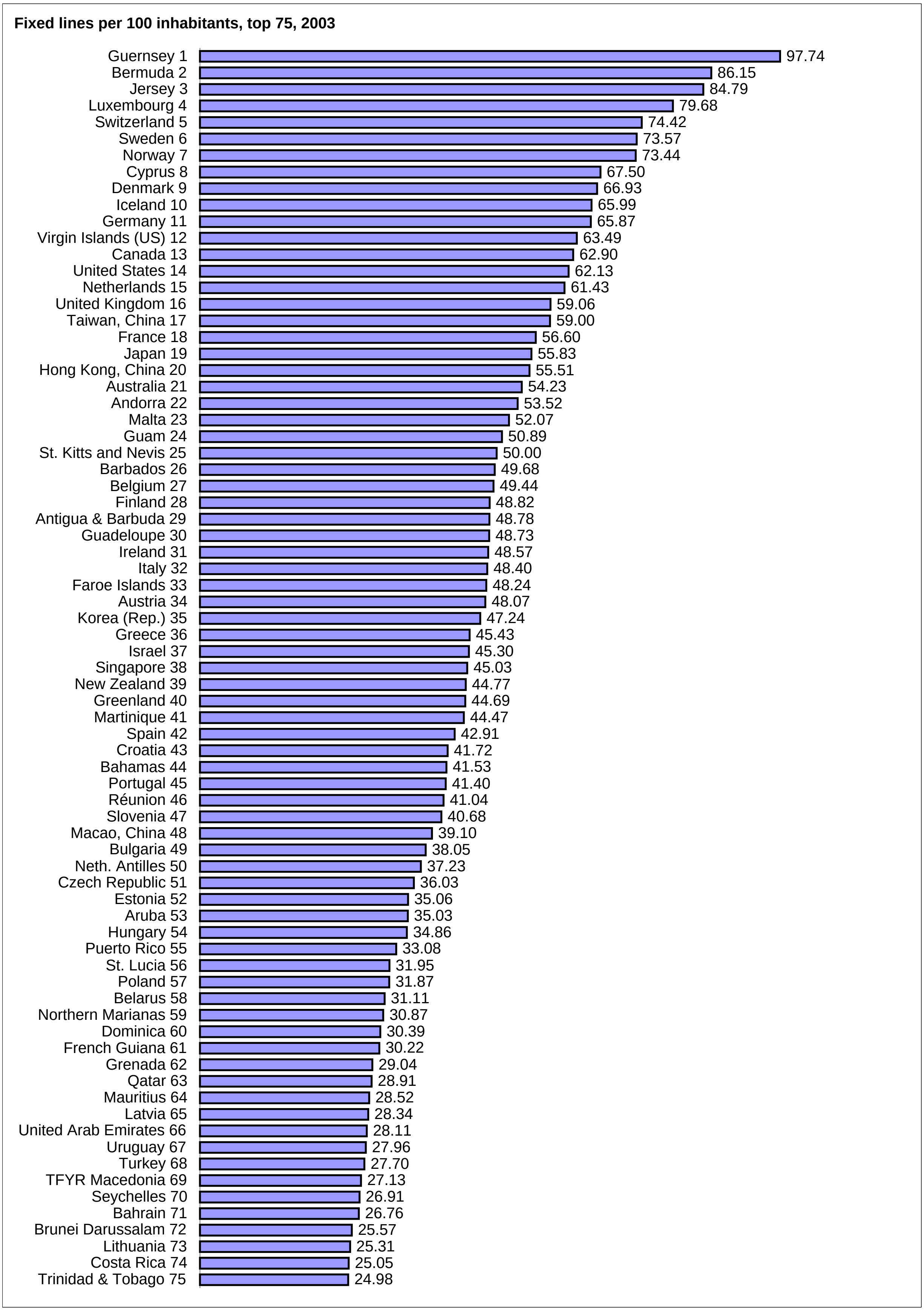
10. Main telephone lines

		Main telephone lines (k)			Main telephone lines per 100 inhabitants		
		1998	2003	CAGR (%) 1998-03	1998	2003	CAGR (%) 1998-03
151	Andorra	32.9	45.1	6.5	43.93	53.52	4.0
152	Antigua & Barbuda	34.0	*38.0*	*2.9*	46.80	*48.78*	*1.0*
153	Aruba	35.1	*37.1*	*1.9*	37.30	*35.03*	*-2.1*
154	Australia	9'540.0	10'815.0	2.5	50.93	54.23	1.3
155	Austria	3'996.6	3'881.0	-0.6	50.10	48.07	-0.8
156	Bahamas	105.9	131.7	4.5	35.77	41.53	3.0
157	Bahrain	157.6	185.8	3.3	26.09	26.76	0.5
158	Barbados	113.0	134.0	3.5	42.37	49.68	3.2
159	Belgium	5'056.4	*5'120.4*	*0.3*	49.51	*49.44*	-
160	Bermuda	53.7	*56.0*	*1.0*	83.95	*86.15*	*0.6*
161	Brunei Darussalam	77.7	*90.0*	*3.7*	24.68	*25.57*	*0.9*
162	Canada	19'293.7	19'950.9	0.7	65.84	62.90	-0.9
163	Cyprus	404.7	500.6	4.3	61.41	67.50	1.9
164	Denmark	3'495.9	3'610.1	0.6	65.97	66.93	0.3
165	Faroe Islands	24.0	*23.0*	*-1.1*	54.38	*48.24*	*-3.0*
166	Finland	2'841.5	2'548.0	-2.2	55.07	48.82	-2.4
167	France	34'098.8	33'905.4	-0.1	58.39	56.60	-0.6
168	French Guiana	46.3	*51.0*	*3.3*	30.54	*30.22*	*-0.3*
169	French Polynesia	53.1	53.5	0.2	23.31	21.41	-1.7
170	Germany	46'530.0	54'350.0	3.2	56.72	65.87	3.0
171	Greece	5'535.5	5'205.1	-1.2	52.22	45.43	-2.7
172	Greenland	25.0	*25.3*	*0.4*	44.56	*44.69*	*0.1*
173	Guam	75.1	*80.0*	*2.2*	49.97	*50.89*	*0.6*
174	Guernsey	48.1	*55.0*	*4.5*	77.58	*97.74*	*8.0*
175	Hong Kong, China	3'729.2	3'806.4	0.4	56.98	55.89	-0.4
176	Iceland	178.4	190.7	1.3	64.82	65.99	0.4
177	Ireland	1'633.0	1'955.0	3.7	44.08	48.57	2.0
178	Israel	2'807.0	*3'006.0*	*1.7*	46.91	*45.30*	*-0.9*
179	Italy	25'986.1	26'596.0	0.5	45.31	48.40	1.3
180	Japan	62'413.3	60'218.5	-0.7	49.39	47.19	-0.9
181	Jersey	68.7	*73.9*	*2.5*	79.94	*84.79*	*2.0*
182	Korea (Rep.)	20'088.5	25'800.4	5.1	44.24	53.83	4.0
183	Kuwait	427.3	486.9	2.6	21.08	19.82	-1.2
184	Luxembourg	293.1	245.0	-3.5	68.73	54.26	-4.6
185	Macao, China	173.9	174.6	0.1	40.39	38.93	-0.7
186	Malta	191.5	208.3	1.7	49.88	52.07	0.9
187	Martinique	172.2	*172.0*	-	45.45	*44.47*	*-0.7*
188	Neth. Antilles	78.0	*81.0*	*1.3*	36.65	*37.23*	*0.5*
189	Netherlands	9'337.0	10'004.0	1.4	59.24	61.43	0.7
190	New Caledonia	49.3	*52.0*	*1.4*	23.97	*23.21*	*-0.8*
191	New Zealand	1'809.0	1'798.0	-0.1	47.42	44.85	-1.1
192	Norway	2'934.5	3'268.1	2.2	66.01	71.35	1.6
193	Portugal	4'116.9	4'278.8	0.8	41.25	41.40	0.1
194	Puerto Rico	1'261.7	*1'276.5*	*0.3*	33.65	*33.08*	*-0.4*
195	Qatar	150.5	184.5	4.2	27.87	28.91	0.7
196	Réunion	242.7	*300.0*	*7.3*	35.58	*41.04*	*4.9*
197	Singapore	1'777.9	1'889.5	1.2	45.33	45.03	-0.1
198	Slovenia	723.2	812.3	2.4	36.29	40.68	2.3
199	Spain	16'288.6	17'567.5	1.5	41.37	42.91	0.7
200	Sweden	6'389.0	*6'579.2*	*0.7*	72.16	*73.57*	*0.5*
201	Switzerland	4'884.0	*5'335.0*	*2.2*	68.40	*73.27*	*1.7*
202	Taiwan, China	11'500.4	13'355.0	3.0	52.44	59.08	2.4
203	United Arab Emirates	915.2	1'135.8	4.4	32.29	28.11	-2.7
204	United Kingdom	32'829.0	*34'898.0*	*1.5*	55.42	*59.06*	*1.6*
205	United States	179'822.1	181'599.9	0.2	65.50	62.13	-1.1
206	Virgin Islands (US)	64.9	*69.4*	*2.3*	60.33	*63.49*	*1.7*
	High Income	**525'010.9**	**548'310.2**	**0.9**	**55.88**	**56.36**	**0.2**
	WORLD	**842'524.5**	**1'148'715.5**	**6.4**	**14.31**	**18.48**	**5.3**
	Africa	**16'442.3**	**24'701.3**	**8.5**	**2.26**	**3.01**	**5.9**
	Americas	**257'388.1**	**294'806.0**	**2.8**	**32.14**	**34.53**	**1.4**
	Asia	**255'612.3**	**485'589.9**	**13.7**	**7.41**	**13.40**	**12.6**
	Europe	**297'787.1**	**326'293.5**	**1.8**	**37.59**	**40.97**	**1.7**
	Oceania	**11'619.0**	**12'924.3**	**2.2**	**39.39**	**40.73**	**0.7**

Note: For data comparability and coverage, see the technical notes.
Figures in italics are estimates or refer to years other than those specified.

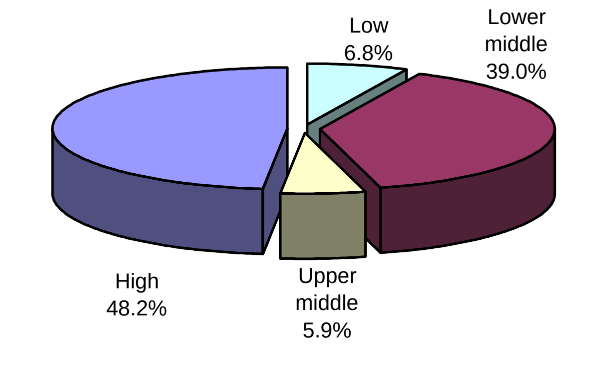
Source: ITU.

10. Main telephone lines

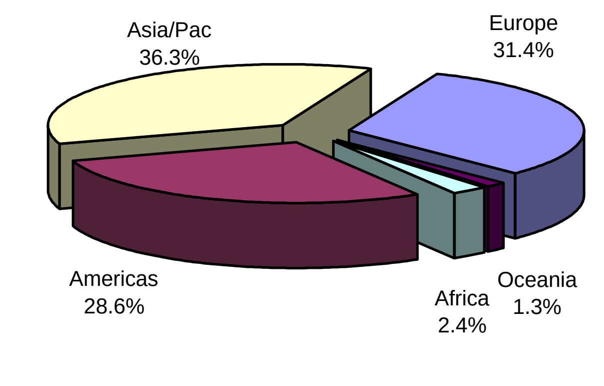


10. Main telephone lines

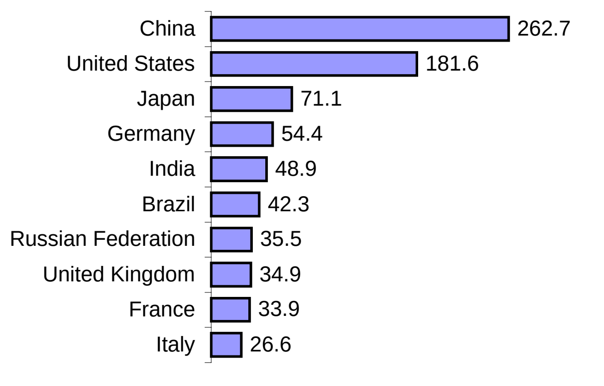
Fixed lines, by income, 2003



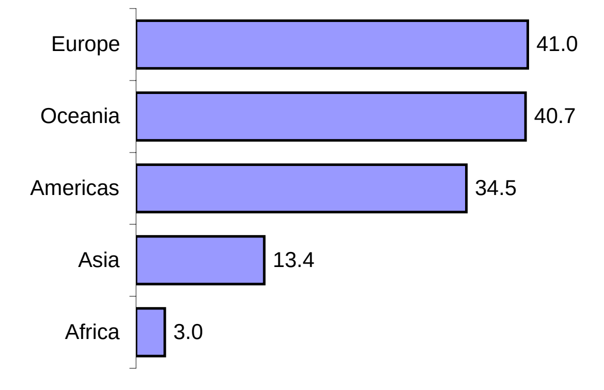
Fixed lines, by region, 2003



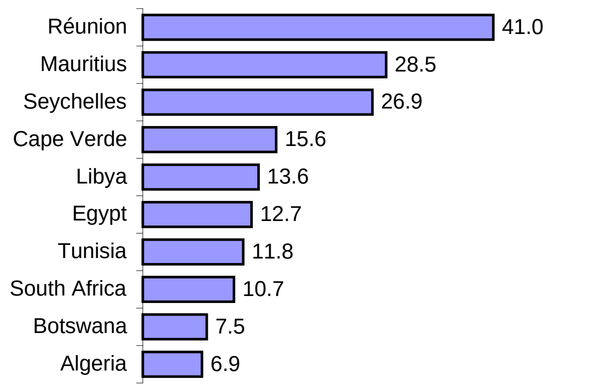
Total fixed lines, top 10, 2003, millions



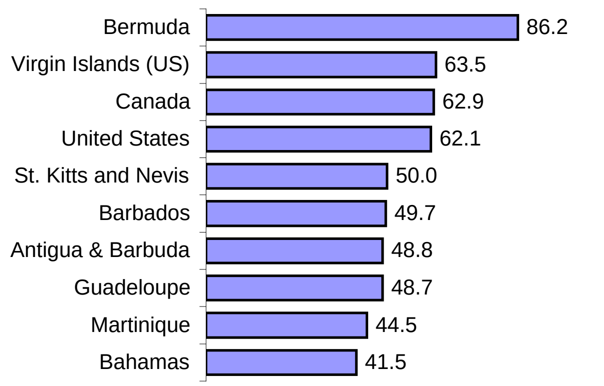
Fixed lines penetration, by region, 2003



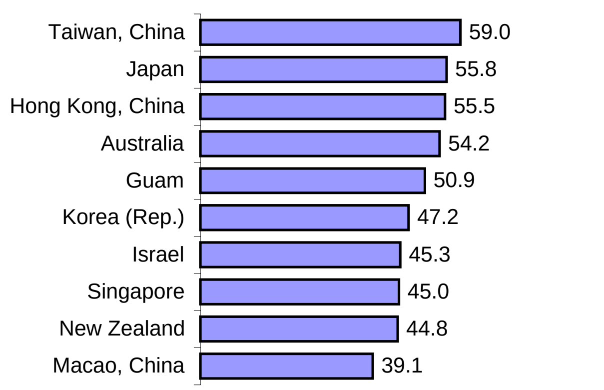
Africa: Fixed line penetration, top 10, 2003



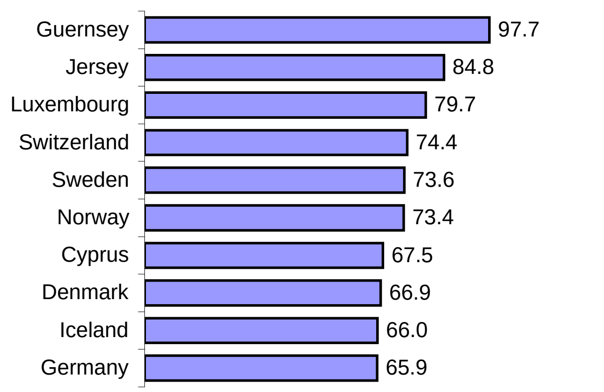
Americas: Fixed line penetration, top 10, 2003



Asia/Pacific: Fixed line penetration, top 10, 2003



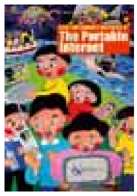
Europe: Fixed line penetration, top 10, 2003



* Penetration = subscribers per 100 inhabitants

ITU Internet Reports 2004: The Portable Internet

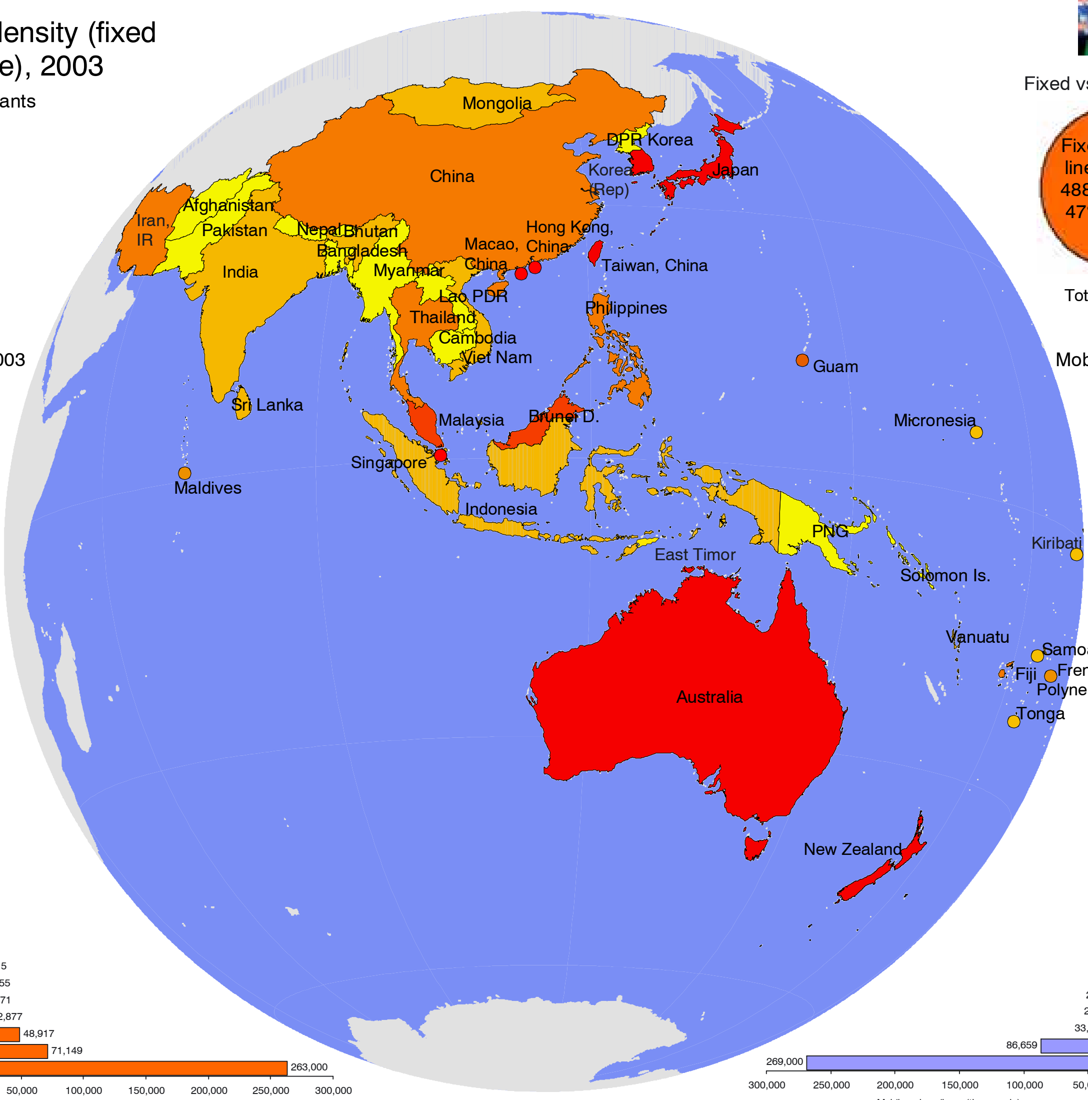
www.itu.int/portableinternet



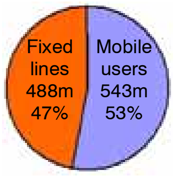
Total teledensity (fixed plus mobile), 2003

Per 100 inhabitants

- 1 - 5
- 6 - 20
- 21 - 50
- 51 - 100
- 101 - 170

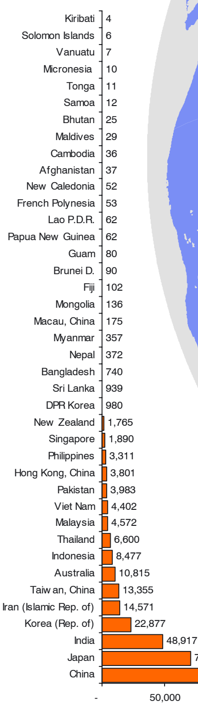


Fixed vs Mobile, 2003

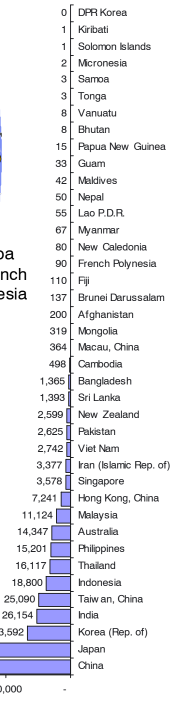


Total Asia-Pacific: 1.031 billion

Fixed Lines, 2003 in thousands

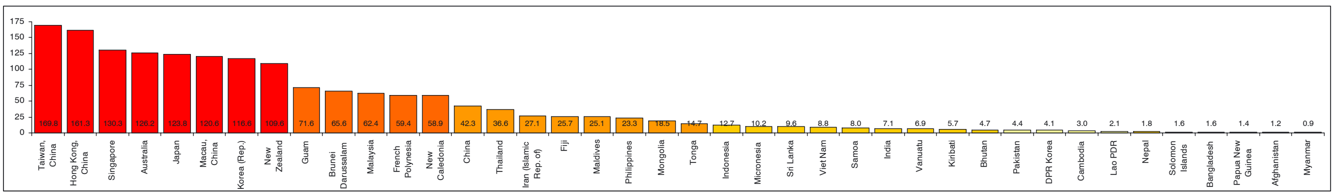


Mobile users, 2003 in thousands

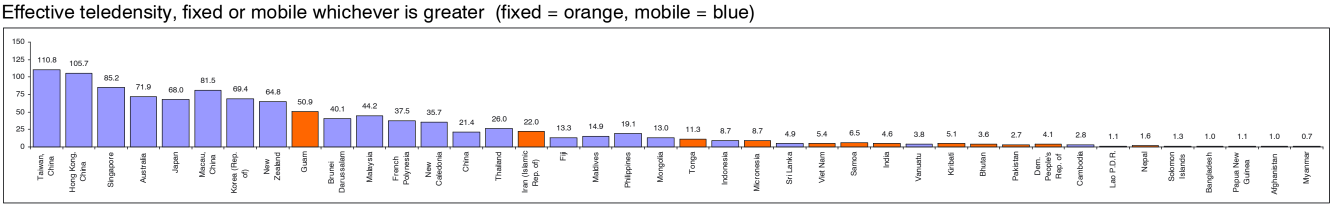


Denominations and classifications employed in these maps do not imply any opinion on the part of the ITU concerning the legal or other status of any territory or any endorsement or acceptance of any boundary.

Total teledensity (fixed plus mobile)

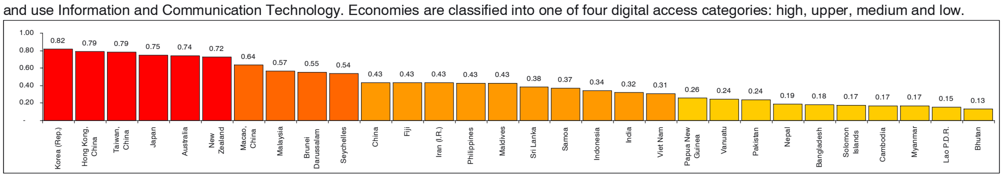


Effective teledensity, fixed or mobile whichever is greater (fixed = orange, mobile = blue)



Digital Access Index 2003

The Digital Access Index (DAI) consists of eight variables organized into five categories. It measures the overall ability of individuals in an economy to access and use Information and Communication Technology. Economies are classified into one of four digital access categories: high, upper, medium and low.

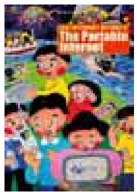


Source: ITU World Telecommunication Indicators Database

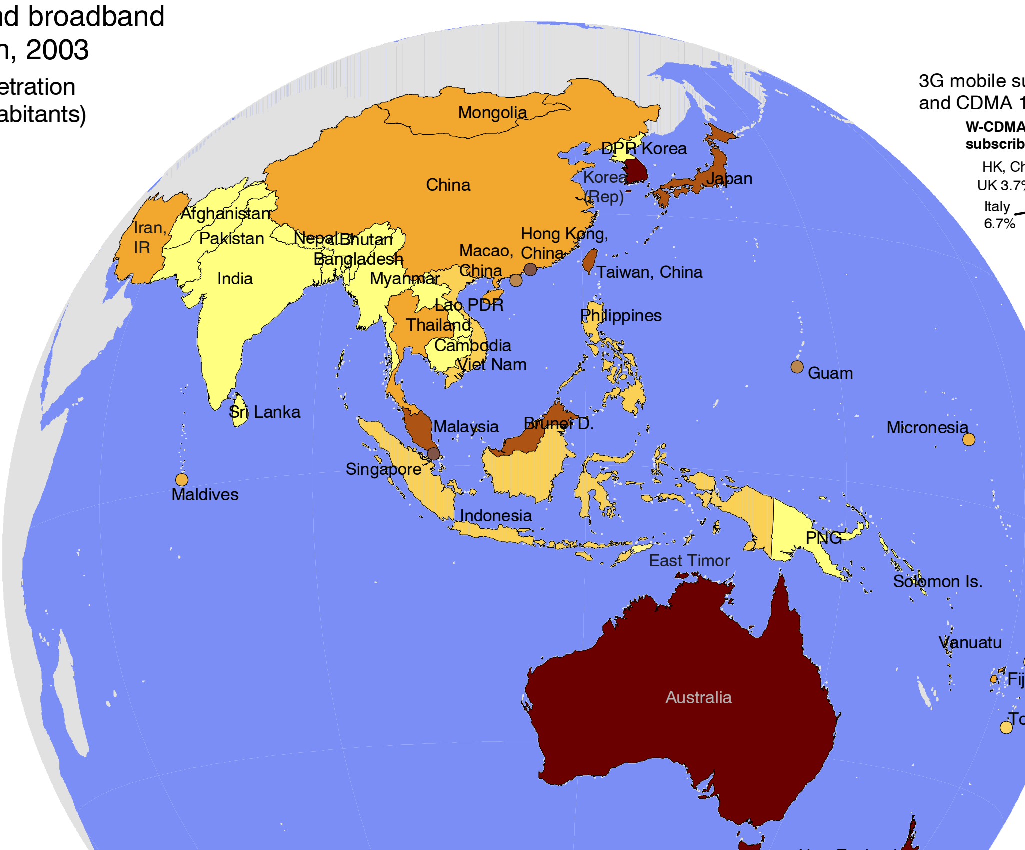
ITU TELECOM ASIA 2004

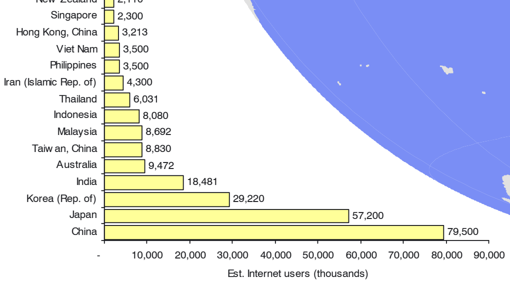
ITU Internet Reports 2004: The Portable Internet

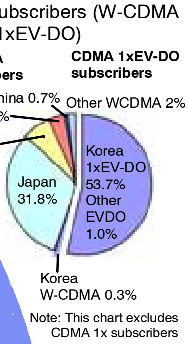
www.itu.int/portableinternet

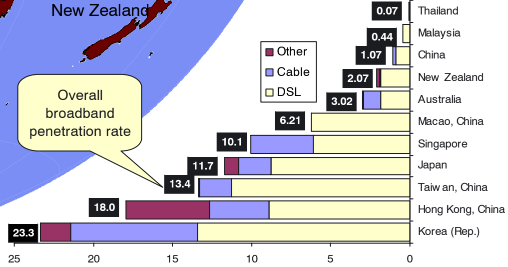


Internet and broadband penetration, 2003



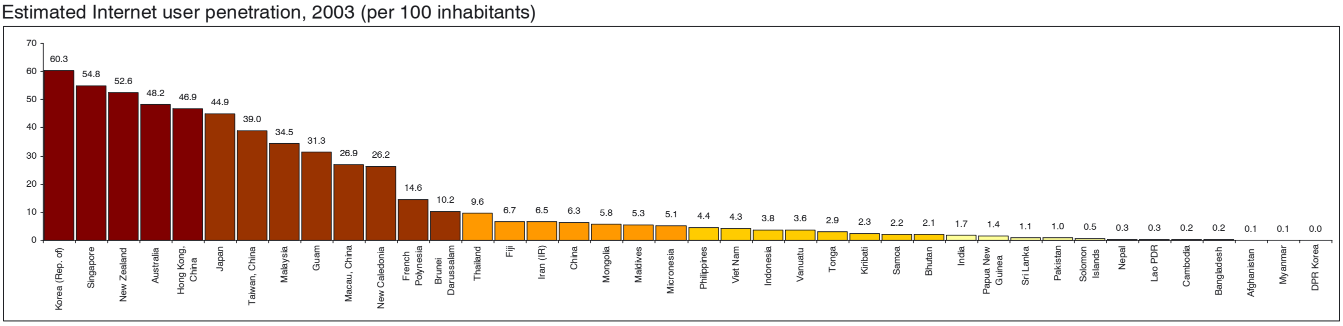




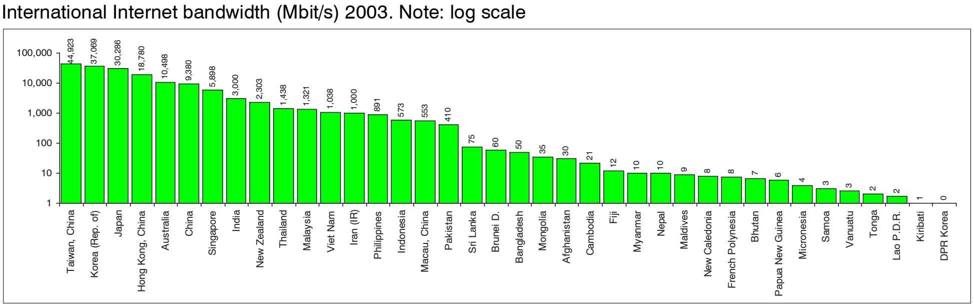


Denominations and classifications employed in these maps do not imply any opinion on the part of the ITU concerning the legal or other status of any territory or any endorsement or acceptance of any boundary.

Estimated Internet user penetration, 2003 (per 100 inhabitants)



International Internet bandwidth (Mbit/s) 2003. Note: log scale



Source: ITU World Telecommunication Indicators Database

ITU TELECOM ASIA 2004

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 unless otherwise noted. For economies 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 economies where neither the IMF nor World Bank rates are available, a United Nations end-of-period rate is used.

Group figures are either *totals* or weighted *averages* depending on the indicator. For example, for main telephone lines, the total number of *main telephone lines* for each grouping is shown, while for *main 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 to economies for which data is available for both years. Data was collected and updated on an ongoing basis up to the date of publication; different collection times and dates may account for slight discrepancies between individual entries.

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. Mobile subscribers
Cellular mobile telephone 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 cellular subscribers by the population and multiplying by 100. *% digital* is the number of mobile cellular subscribers who use a digital cellular service (e.g. GSM, CDMA, DAMPS, PCS, PHS) by the total number of mobile subscribers. *As a % of total telephone subscribers* is obtained by dividing the number of cellular subscribers by the total number of telephone subscribers (sum of the main telephone lines and the cellular subscribers) and multiplying by 100.

3. Mobile prices
The table shows the costs associated with cellular mobile telephone service. *Connection charge* refers to connection charges for basic telephone service. In each economy, the price of the lowest offer on the market for 100 minutes of monthly use is quoted, or of the incumbent if other market prices are not known. This indicator is not always comparable since some countries include a number of free local calls in the connection price. *Per-minute local call* refers to the cost of a one-minute call in same exchange area. Any taxes involved in these three charges are included to improve comparability. *Peak* and *Off-peak* give the cost of a one-minute call during peak and off-peak hours respectively. *Cost of a local SMS* is the charge to the consumer of sending a single short message service text within the same local exchange area.

4. Internet subscribers
Internet subscribers refers to the sum of dial-up, leased lines and broadband subscribers. *Internet subscribers per 100 inhabitants* is calculated by dividing Internet subscribers by population and multiplying by 100. *Dial-up subscribers* refer to those who use the public switched telephone network to access the Internet. *As % of total subscribers* is calculated by dividing dial-up subscribers by total Internet subscribers and multiplying by 100. Where this statistic is low, it can be assumed that broadband subscriptions are high. *Broadband subscribers* is the total number of broadband subscribers and includes DSL, cable modem and other access technologies.

5. Information technology
Internet hosts refers 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 or a three digit top-level domain generally reflecting the nature of the organization using the Internet computer. The numbers 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 (e.g. generic top-level domains such as .edu or .com) 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 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) in use, both in absolute numbers and in terms of PC ownership per 100 inhabitants. These numbers are derived from the annual questionnaire supplemented by other sources.

6. Broadband subscribers

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. The statistics here exclude services offering a throughput of less than 256 kbit/s. *Broadband subscribers* refer to the sum of DSL, cable modem and other broadband subscribers. *Broadband subscribers per 100 inhabitants* is calculated by dividing the total number of broadband subscribers by the population and multiplying by 100. *DSL* refers to the total number of digital subscriber lines. *As a % of residential telephone* is calculated by dividing the number of DSL subscribers by the number of residential telephone lines and multiplying by 100. *Cable modem Internet subscribers* refers to Internet subscribers via a cable TV network. *Other* refers to other broadband access technologies that are not related to DSL or cable modem. Examples may include fixed wireless or satellite connections. Note that *Total broadband subscribers* sums the last known values for DSL, cable modem, and other technologies. As a result, the *Total broadband subscribers* figure may combine data from different years.

7. Broadband prices

The prices gathered for the Broadband prices table are meant only as a broad representation of typical broadband offers available in an economy. Broadband is considered any dedicated connection to the Internet of 256 kbit/s or faster. They do not necessarily represent the least expensive, fastest or most cost-effective connections. Rather, they give a small sample of the offers available to consumers in July 2004. All prices were gathered during July 2004 with exchange rates valid as of 30 July 2004. Broadband offers are usually residential offerings unless only business connections are available from the ISP. Since ADSL technologies are increasingly used to replace leased lines in businesses, the costs shown in the table may be very high in some developing economies and markets since they represent replacements for leased lines rather than residential offers. In general, ISP choices do not necessarily reflect the dominant ISP in the market. Some ISPs place download limits on broadband connections and where applicable, the service offering closest to 1 Gigabyte of data per month is used. Other ISPs may put time restrictions on broadband usage. The service offering closest to 100 hours per month is selected. The prices included are those advertised and may or may not include ISP charges. Where ISP charges are known to be separate, they are included. Taxes may or may not be included in the advertised prices. All costs are gathered in local currency and converted to nominal US$ at the exchange rate on July 30, 2004. Most prices in the table are for DSL services. Cable modem prices are given if they are found to be lower or more prevalent. The prices shown do not include installation charges or telephone line rentals that are often required for DSL service. The prices are gathered by looking for the most "common" or cost-efficient broadband offer. In most cases, two prices are gathered for each economy. *Lower speed monthly charge* refers to a lower-speed connection, typically between 256 and 1024 kbit/s download speed and is meant to show an example of a typical "entry-level" broadband offer in the economy. The monthly charge reflects the ISP charge for one month of service. It does not include installation fees or modem rental charges if they are charged separately. *Speed (kbit/s) down* represents the advertised maximum theoretical download speed and not speeds guaranteed to users. *Higher speed monthly charge* refers to a faster, and typically more expensive offer available in the economy. It is not necessarily from the same provider as the *Lower speed* offering. Again, charges do not include installation fees or modem rentals. Download speeds are theoretical maximums. *Lowest sampled cost US$ per 100 kbit/s* gives the most cost-effective subscription based on criteria of least cost per 100 kbit/s. This is calculated by dividing the monthly subscription charge in US$ by the theoretical download speed, and then multiplying by 100. This figure is calculated for each recorded sample and the lowest cost per 100 kbit/s is given. *Lowest sampled cost as a % of monthly income (GNI)* is *Lowest sampled cost US$ per 100 kbit/s* divided by per capita monthly income (World Bank, Atlas method, no PPP). The figure is then reported as a percentage (multiplied by 100). *ISP* lists the name of the Internet service provider whose sampled price was the lowest per 100 kbit/s over all the country samples.

8. Network penetration

Network penetration looks at density of information and communication technologies in an economy, namely fixed/mobile telephony and Internet connectivity. *Effective teledensity* shows either *cellular mobile subscribers per 100 inhabitants* or *main telephone lines per 100 inhabitants,* whichever is higher in a particular economy. *Rank* shows the relative position of each economy in terms of each respective density on a scale of 1 to 206, with 1 being the highest. *Internet subscribers per 100 inhabitants* is calculated by dividing total Internet subscribers by the population and multiplying by 100. *Broadband subscribers per 100 inhabitants* is calculated by dividing total broadband subscribers by population and multiplying by 100. *Broadband as a % of total Internet subscribers* is the number of *broadband subscribers* divided by *Internet subscribers* and multiplying by 100. *Internet subscribers as % of telephone* is calculated by dividing *Internet subscribers* by *total main lines* and multiplying by 100.

9. International Internet bandwidth

Bandwidth refers to the width of the range of frequencies that an electronic signal occupies on a given transmission medium. It is a measure of how fast data flows on a given transmission path, and determines the quantity and the speed of information transmitted. *Rank* shows the relative position of each economy in terms of each respective indicator of bit capacity, on a scale of 1 to 206, where 1 represents the highest bit capacity. *Total international Internet bandwidth* shows the total capacity of Internet bandwidth expressed in Megabits per second (Mbit/s). *Bits per inhabitant* divides *Total international Internet bandwidth* by the population. *Bits per Internet user* divides *Total international Internet bandwidth* by *estimated Internet users. Bits per Internet subscriber* refers to international Internet bandwidth divided by the number of Internet subscribers in the economy. *Simultaneous international 256 kbit/s links* examines how many international 256 kbit/s connections (the lowest speed defined as broadband) can be created using the total international Internet bandwidth of the economy. This number is calculated first by multiplying *Total international Internet bandwidth* by 1000 to convert it to kbit/s. Next, *Total international Internet bandwidth* is divided by 256. While it is likely that many broadband connections will access local or national content, the figure should give an idea of the maximum number of international, dedicated broadband connections the economy can support. International Internet bandwidth data are provided from various sources including: TeleGeography Inc. (http://www.telegeography.com), ITU research, and other sources.

10. Main telephone lines

This table shows the number of *Main telephone lines* (or fixed lines) and *Main telephone lines per 100 inhabitants* (or teledensity) for the years indicated and corresponding annual growth rates. *Main telephone 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. It includes ISDN subscribers but not broadband lines, even though these may be used for voice, to avoid double counting. Note that for most countries, main lines also include public payphones. *Main telephone lines per 100 inhabitants* is calculated by dividing the number of main lines by the population and multiplying by 100.

11. Special focus: Asia-Pacific

The two pages of maps and accompanying charts highlight the development of the ICT market in the Asia-Pacific region. They were specially prepared for ITU TELECOM Asia 2004, in Busan, Republic of Korea, 7-11 September 2004 and the ITU/MIC Korea Digital Bridges Symposium, 10-11 September 2004, also in Busan. For more information see http://www.itu.int/ASIA2004/index.html and http://www.itu.int/digitalbridges.

Box 1: Other economies

Population, main telephone lines, cellular subscribers and total telephone density (fixed plus mobile cellular subscribers per 100 inhabitants) for economies not shown in the main tables, 2003.

Economy	Population	Mainlines	Mobile subs	Total teledensity
American Samoa	60'798	*14'700*	...	*24.2*
Anguilla	11'600	*6'201*	*1'773*	*68.7*
Ascension	1'300	*642*	*0*	*49.4*
British Virgin Islands	23'400	*11'705*	*8'000*	*84.2*
Cayman Islands	49'300	*38'000*	*17'000*	*111.6*
Cook Islands	19'300	*6'170*	*1'499*	*39.7*
Falkland (Malvinas) Is.	2'500	2'592	0	103.7
Gibraltar	28'500	*24'552*	*12'167*	*128.8*
Liechtenstein	34'294	*19'923*	*11'402*	*91.3*
Monaco	32'600	33'499	15'081	149.0
Montserrat	4'000	*2'811*	*489*	*82.5*
Nauru	11'650	*1'850*	*1'500*	*28.8*
Niue	1'982	*1'050*	*400*	*73.2*
San Marino	27'000	20'689	16'900	139.2
St. Helena	4'186	2'193	0	52.4
St. Pierre & Miquelon	6'600	*4'770*	...	*72.3*
Tokelau	2'000	*300*	*0*	*15.0*
Turks & Caicos Is.	18'800	*5'740*	...	*30.5*
Tuvalu	9'600	*650*	0	*6.8*
Wallis and Futuna	14'700	1'890	*0*	*12.9*

Note : Figures in italics are estimates or refer to earlier years.
Source: ITU World Telecommunication Indicators Database.

SOURCES

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.

Telecommunications

The telecommunications data are obtained via an annual questionnaire. Depending on the country, the questionnaire is sent to the government ministry responsible for telecommunications, to the telecommunications 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 mission reports prepared by ITU staff. In some instances, estimates, generally based on extrapolation or interpolation techniques, are made by ITU staff.