International Telecommunication Union

Birth of Broadband

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Birth of Broadband

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FOREWORD

"Birth of Broadband" is the fifth in the series of "ITU Internet Reports", originally launched in 1997. This edition has been specially prepared for the ITU TELECOM World 2003 Exhibition and Forum, to be held in Geneva from 12 to 18 October 2003. As one of the "hot topics" of the telecommunication industry in 2003, broadband is expected to be one of the highlights of this year's show. This new report examines the emergence of high-speed, dedicated Internet connections that will greatly expand the world's access to information. Broadband will also facilitate the long-expected convergence of three previously distinct technologies: computing, communications and broadcasting.

The introductory chapter of this report, *Broadband dreams*, explains what broadband can do for users, society and industry. Chapter two, *Technologies for broadband*, explains the different broadband technologies and how each can provide broadband access under different economic and network conditions. Chapter three, *Supplying broadband*, looks at how broadband has been successfully provided in certain economies and how certain policies can help expand the network. Chapter four, *Using broadband*, discusses the current and emerging applications that are driving broadband take-up along with applications and content models that show the most promise for the future. Chapter five, *Regulatory and policy aspects*, examines regulatory and policy frameworks in successful broadband markets. Chapter six, *Promoting broadband*, looks at the broadband experiences of several countries characterized by high penetration rates and extensive networks, including conclusions drawn from ITU country case studies on broadband, and examines why and how broadband should be actively promoted. Chapter seven, *Broadband and the information society*, looks at broadband as a component of a society built around ubiquitous access to information, including some of the benefits and pitfalls of total connectivity. The *Statistical annex* contains data and charts covering 206 economies worldwide, with original data on broadband and comparative information measured against a selection of variables.

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 broadband, to all the world's inhabitants. This is in line with the Resolution of the highest administrative organ of ITU (Resolution 101 of the Plenipotentiary Conference (Minneapolis, 1998), which calls upon ITU to "fully embrace the opportunities for telecommunication development that arise from the growth of IP-based services", and subsequent ongoing calls from ITU Member States to continue to actively pursue this objective. The ITU Internet Reports are hopefully a significant contribution to that commitment.

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The report has benefited from the input and comments of many people to whom we owe our thanks. In particular, we would like to thank Lucy Firth, Paolo Rosa, Susan Schorr and Robert Shaw. In addition, this work would not have been possible without help from the following people from the ITU membership: Ian MacInnes (Canada), Don MacLean (Canada), Craig McTaggart (Canada), Ari Johansson (Iceland), Bjarni Sigurdsson (Iceland), Richard Horton (Ireland), Chong Chinyong (Republic of Korea), Lee SangHak (Republic of Korea), Lee YongSeok (Republic of Korea), M.H. Au (Hong Kong, China) Sara Lam (Hong Kong, China), Fion Fung (Hong Kong, China), Yui-choi Siu (Hong Kong, China) and Benjamin Tong (Hong Kong, China). 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 broadband developments in their countries. Without their assistance, a report of this nature would be impossible. In particular, we would like to thank the Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT), Japan, for its generous voluntary contribution, which has enabled the case study programme to be expanded.

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.

The views expressed in this report are those of the authors and do not necessarily reflect the opinions of ITU or its membership.

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GLOSSARY

3G: *Third-generation mobile network or service*. Generic name for mobile network/service based on the IMT-2000 family of global standards.

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

ADSL2: *Asymmetric Digital Subscriber Line 2* (ITU-T G.992.3 and ITU-T G.992.4). A sequel to the original ITU Recommendation. It allows increased line speeds, new power-saving elements, and extends the reach of the original ADSL specification.

ADSL2+: *Asymmetric digital subscriber line 2 plus* (ITU-T G.992.5). This revised version of ADSL2 enables increased speeds by increasing the frequencies used on the copper line.

ASP: *Application service provider*. Provider of a service that allows users to run applications remotely from a server rather than having the actual programs installed on their computers. This allows for higher power applications to run on small or basic terminals.

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

Bandwidth: The range of frequencies available to be occupied by signals. In analogue systems it is measured in terms of Hertz (Hz) and in digital systems in bits 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.

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.

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).

Burstiness: Technical jargon used to describe a high peak-to-average rate of packets as they are received over the network. There is no unique mathematical definition of "burstiness", but a traffic stream is considered to be more "bursty" than another if its packets are more clumped together.

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 based on Qualcomm technology. Includes CDMA2000 1x, 1xEV-DO (Evolution, Data Optimized) and 1xEV-DV (Evolution, Data and Voice). One of the IMT-2000 "family" of standards.

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*.

Condominium Fibre Build: A network model where a group of end-users band together to install strands of fibre optic cable to an ISP at the same time. At completion, the end-users are each given separate strands of fibre for their own usage.

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

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.

DOCSIS: *Data over cable systems interface specifications* (ITU-T J.112). An ITU Recommendation for cable modems. It specifies modulation schemes and the protocol for exchanging bi-directional signals over cable.

DOCSIS2: *Data over cable systems interface specifications 2* (ITU-T J.122). The newest, revised version of DOCSIS, approved at the end of 2002.

DSL: *Digital subscriber line*. See also *ADSL, ADSL2, ADSL2+, SHDSL, SDSL, VDSL* and *xDSL*.

DSLAM: *Digital subscriber line access multiplexer.* A device, located at the central office of a DSL provider, that separates and routes the voice-frequency signals and data traffic on a DSL line.

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

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).

Endrun: A fibre optic infrastructure that provides a dedicated fibre optic cable directly to each user's premise rather than several premises optically splitting off one line. See *PON*.

EPOP: *Expanding point of profitability*. A network topography where the network expands incrementally to unserved areas as they become profitable to operators. Newly connected areas can then be used as backbones to more remote areas as they eventually become profitable to providers.

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.

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

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

FTTH: *Fibre to the home*. A high-speed fibre optic, Internet connection that terminates at a residence. See *FTTx*.

FTTx: *Fibre to the x,* where x is a home (FTTH), building (FTTB), curb (FTTC), or neighbourhood (FTTN). These terms are used to describe the reach of an optical fibre network.

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.

FSO: *Free space optics*. A system of lasers used to transmit data optically through the atmosphere at very high speeds. Similar to optical fibre without the physical cable.

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

GEO: *Geostationary earth orbit*. A satellite in orbit 35'650 km above the Earth in a rotation that mimics that of the Earth, thus appearing stationary in the sky.

GMPCS: *Global mobile personal communications by satellite*. Non-geostationary satellite systems that are intended to provide global communication coverage to small handheld devices.

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

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.

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.

Half duplex: Half duplex refers to a communication channel that can only handle one-way traffic at a time. In essence, each side of the communication must wait until the other is finished transmitting to start sending information. By contrast, full duplex communication allows for both parties to broadcast and receive at the same time.

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.

HAPS: *High altitude platform station*. A term referring to balloons and high altitude aircraft that can be used to provide communication services. See *LAPS*.

HDTV: *High-definition television*. A new format for television that offers far superior quality to current NTSC, PAL, or SECAM systems. The resolution of the picture is roughly double previous television signals and the pictures are displayed with a screen ratio of 16:9 as compared with most of today's TV screens, which have a screen ratio of 4:3.

HFC: *Hybrid fibre copper*. A broadband network that utilizes fibre optic cabling to the vicinity and then copper lines to individual users.

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.

HIPERMAN: *High performance radio metropolitan area network*. This is a European standard aimed at providing a broadband wireless solution for Metropolitan Area Networks.

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 major network provider in a particular country, often a former State-owned monopoly.

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.

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.

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

IP telephony: *Internet protocol telephony*. IP telephony is used as a generic term for the conveyance of voice, fax and related services, partially or wholly over packet-based, IP-based networks. See also *VoIP* and *Voice over broadband*.

IPR: *Intellectual property rights*. Copyrights, patents and trademarks giving creators the right to prevent others from using their inventions, designs or other creations. The ultimate aim is to act as an incentive to encourage the development of new technology and creations which will eventually be available to all. The main international agreements are the World Intellectual Property Organization's (WIPO) *Paris Convention for the Protection of Industrial Property* (patents, industrial designs, etc.), the *Berne Convention for the Protection of Literary and Artistic Works* (copyright), and the World Trade Organization's (WTO) *Agreement on Trade-Related Aspects of Intellectual Property Rights* (TRIPS).

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

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

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

JPEG: *Joint photographic expert group compression standard.* Standard for the compression and coding of still images.

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

LAPS: *Low altitude platform station.* A system usually consisting of balloons that provides wireless communication services over a wide area. Similar to HAPS but the altitudes are lower.

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*.

LEO: *Low Earth orbit*. A term that refers to satellite orbits between 650 km and 2'600 km above the Earth. A LEO satellite is only in view for a few minutes and rotates the Earth every few hours. See *GEO*.

LLU: *Local loop unbundling*. The process of requiring incumbent operators to open the last mile of their legacy networks to competitors. Similar reference to *ULL* (*unbundled local loop*).

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

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

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

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

OFDM: *Orthogonal frequency division multiplexing*. A method of digital modulation in which a signal is split into several narrowband channels at different frequencies in order to minimize interference among channels that are close in frequency. OFDM is used in European digital audio broadcast services, and also in wireless LANs.

P2P: *Peer to peer*. P2P refers to networks that facilitate direct connections among individual nodes rather than through a centralized server. However, many famous P2P networks, such as "Napster", actually relied on a central server to connect users. Other networks (such as "Gnutella") offer true peer-to-peer, decentralized connections.

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

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

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

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

PLC: *Power line communications*. A communication network that uses existing power lines to send a receive data by using electrical signals as the carrier. Power flows on the line at 50-60 Hz while data is sent in the 1 MHz range.

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

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

PON: *Passive optical network.* A type of full passive wave division multiplexing (WDM) network that allows multiple locations to connect to one optical fibre strand (or wavelength) by using optical splitters break up the wavelength of light into allocated time slots for each user. See *Endrun* and *WDM*.

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.

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 telecommunications infrastructure and services to the general public ("public" refers to the customer base). Also referred to as a n operator, service provider, carrier or "telco".

QoS: *Quality of service*. A measure of network performance that reflects the quality and reliability of a connection. QoS can indicate a data traffic policy that guarantees certain amounts of bandwidth at any given time, or can involve traffic shaping that assigns varying bandwidth to different applications.

RLAN: *Radio local area network*. See *WLAN*.

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.

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.

SDSL: *Symmetrical DSL*. A proprietary North American DSL standard. However, the term SDSL is often also used to describe SHDSL.

SHDSL: *Single pair high-speed DSL*. The informal name for ITU-T Recommendation G.991.2 that offers high-speed, symmetrical connectivity over a twisted copper pair.

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.

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.

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

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

Ubiquitous computing: A term that reflects the view that future communication networks will allow seamless access to data, regardless of where the user is. See *Pervasive computing*.

ULL: *Unbundled local loop*. See *LLU*.

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

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

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

UTP: *Unshielded twisted pair*. A cable with one or more twisted copper wires bound in a plastic sheath. It is used extensively for high-speed connections because it allows the release of radiation that would interfere if kept in the line with a shielded cable.

VDSL: *Very-high-data-rate digital subscriber line*. (ITU-T G.993.1). The fastest version of DSL that can handle speeds up to 52 Mbit/s over very short distances. Often used to branch out from fibre connections inside apartment buildings.

Voice over broadband: A method of making voice calls over a broadband connection. The calls can be either made via a computer or through traditional phones connected to voice over broadband equipment. See also *IP telephony* and *VoIP*.

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

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*.

WDM: *Wave division multiplexing.* Technology that allows multiple data streams to travel simultaneously over the same fibre optic cable by separating each stream into its own wavelength of light.

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*. 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.

Worm: A self-contained program (usually malicious) that can automatically propagate throughout a network. In addition to damage caused by the program on a user's machine, the programs can slow down network traffic as all infected machines scan simultaneously to find new hosts.

WSIS: *The United Nations World Summit on the Information Society*. The first phase of WSIS will take 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, SHDSL, and VDSL. See *ADSL*, *SHDSL*, *VDSL*.

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.

AM	Amplitude modulation
ARPU	Average revenue per user
ATM	Asynchronous transfer mode
B2B	Business-to-business
B2C	Business-to-consumer
CO	Central office
CRM	Customer relationship management
DVR	Digital video recorder
ETSI	European Telecommunications Standards Institute
EU	European Union
GHz	Gigahertz
ICT	Information and communication technologies
ID	Identity
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IRC	Internet relay chat
ISO	International Organization for Standardization
ITU	International Telecommunication Union
ITU-D	ITU Development Sector
ITU-R	ITU Radiocommunication Sector
ITU-T	ITU Standardization Sector
iTV	Interactive television
LDC	Least developed countries
LED	Light-emitting diode
LMDS	Local multipoint distribution system
MDF	Main distribution frame
MHz	Megahertz
MMDS	Multipoint microwave distribution system
MPEG	Motion Pictures Experts Group
MPLS	Multi-protocol label switching
OECD	Organisation for Economic Co-operation and Development
OLT	Optical line termination
ONU	Optical network unit
PBX	Private branch exchange
POTS	Plain old telephone system

PPTP	Point-to-point tunneling protocol
PVR	Personal video recorder
QoS	Quality of service
RADIUS	Remote authentication dial-in user service
SMP	Significant market power
SPU	ITU Strategy and Policy Unit
STB	Set-top box
UN	United Nations
VOD	Video on demand
WAN	Wide area network
WAS	Wireless access system
WBA	Wireless broadband access
WEP	Wired equivalence privacy
WRC	World Radiocommunication Conference

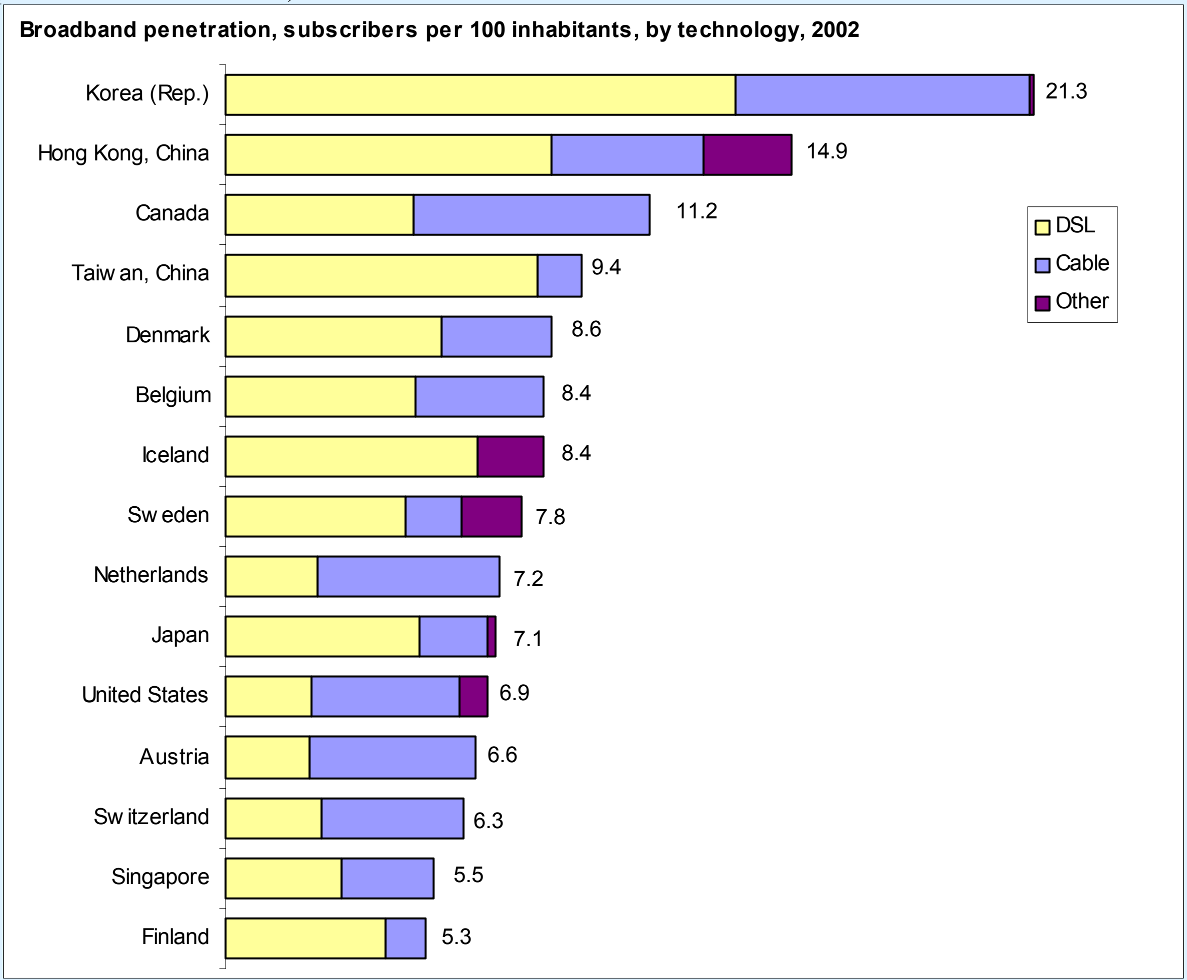
1 CHAPTER ONE: BROADBAND DREAMS

Like most technology-driven industries, telecommunications are historically characterized by steady growth punctuated by an occasional leap forward, usually when a new technology is introduced. We are by now familiar with the historical succession of the telegraph, telex, fax and e-mail, each one of which revolutionized human communications. In the last part of the twentieth century, the almost simultaneous arrival of two major innovations—mobile phones and the Internet—not only changed the face of communications, but also gave the impetus for dramatic economic growth. However, as they reach saturation in the developed world in particular, the industry is searching for the "next big thing" to drive a new wave of innovation and growth.

In the 2002 edition of ITU Internet Reports, *Internet for a Mobile Generation*[1], we examined the likelihood that the coming together of the Internet and mobile communications will provide a major future driver for growth. This convergence of mobile and Internet technologies still seems likely to come to fruition, though the indications are that it will take longer than expected. But in the meantime, a new technology is emerging that promises to provide a unifying platform for three converging industrial sectors: computing, communications and broadcasting. That technology is "broadband", and it is the subject of this report. The title "Birth of Broadband" reflects the view that broadband is still just at the start of its growth cycle, with the main phase of market expansion still to come.[2]

Figure 1.1: Broadband penetration rates around the world

Top 15 broadband economies, worldwide



Note: "DSL" refers to the range of technologies using digital subscriber line technology. "Cable" refers to the use of cable modems on Cable TV networks. "Other" broadband technologies includes fibre to the home (FTTH), satellite, wireless LAN, etc.

Source: ITU.

Around the world, there were around 63 million "broadband" subscribers at the start of 2003 compared with 1.13 billion fixed-line users and 1.16 billion mobile phone users. Broadband users enjoy a range of service speeds from 256 kbit/s up to 100 Mbit/s. The number of subscribers is growing rapidly, with a 72 per cent increase during 2002. Digital subscriber line (DSL) is currently the most commonly deployed platform, followed by cable modems, Ethernet local area networks (LAN), fixed-wireless access, wireless LANs (WLAN), satellite and other technologies. The vast majority of today's users are in the developed world. But even among member countries of the Organisation for Economic Co-operation and Development (OECD), there are large disparities, not only in service availability but also in terms of quality of access and price per Mbit/s.

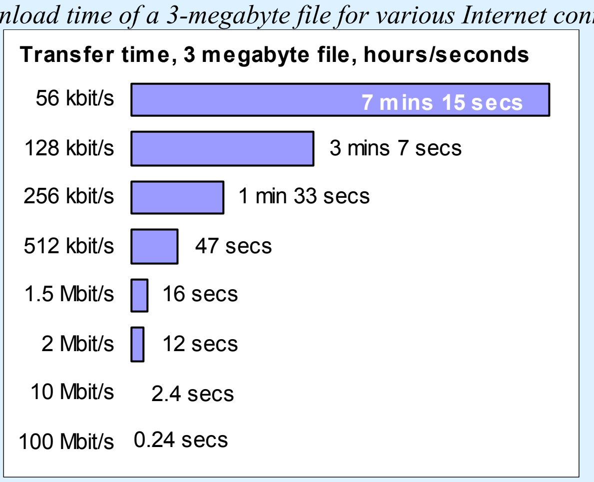
1.1 What will broadband do for me?

A broadband connection typically comprises an unobtrusive device that sits between a PC and a cable in a wall. Or it might take the form of a wireless LAN transmitter and network card. Unlike a telephone, a television (TV) or a computer, it is not at all obvious by looking at this hardware what broadband can do, and why one would need it. Broadband fits into the gap between being a service market and a hardware market. It is generally not worth signing up for a broadband service without first buying a computer and a network connection (like a DSL transceiver, a cable modem or a WLAN card). But equally, it is not possible to buy broadband off-the-shelf without first signing up for a network service. So service providers and manufacturers have to work together to sell the service.

Compared with other major innovations, broadband can be a hard sell. The fact that most broadband services are partly substitutable by other services, for instance by narrowband dial-up Internet access, means that it is even harder to convince users that have not yet experienced broadband to buy it. It is important therefore, that broadband providers focus clearly in their marketing on what consumers *really need*. The temptation is to focus just on speed of transmission, which is the one undeniable advantage of broadband over narrowband alternatives (see Figure 1.2). But while measures of transmission speed may be meaningful to engineers, they may mean little to the average consumer. To communicate this advantage to potential customers, it is vital to be able to explain this in terms of shorter waiting times for downloads or access to specific applications or content.

Figure 1.2: Speed matters

Download time of a 3-megabyte file for various Internet connections



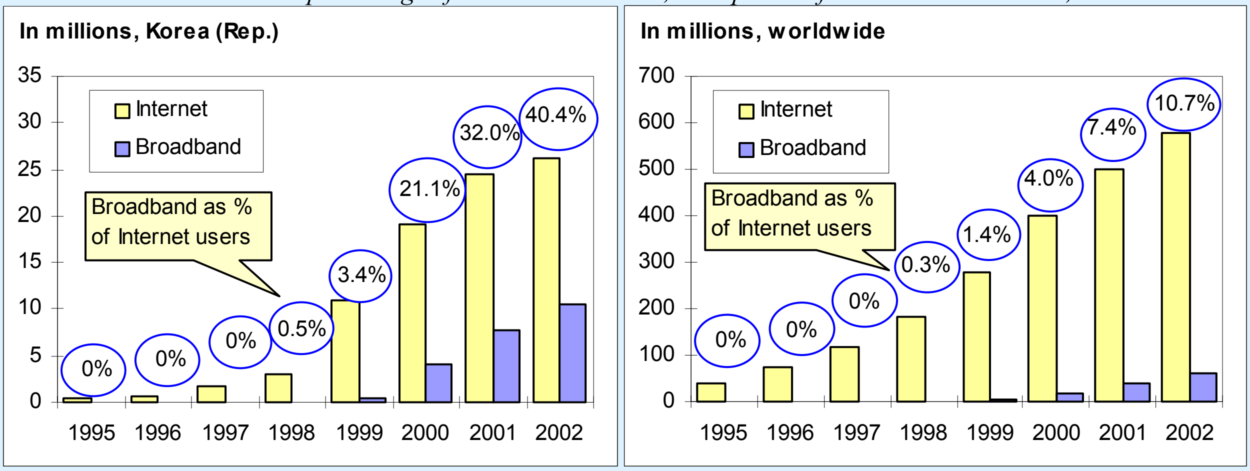
File type	Megabytes
Movie (1.5 hour - DVD)	4'000
Movie (1.5 hour - DivX)	650
3 minute music file (Wav file, raw)	35
Digital photograph (4 megapixels, uncompressed)	11
ITU Internet for a Mobile Generation (PDF, 240 pages)	4
3 minute music file (MP3 - 128 kbit encoding)	3
Digital photograph (4 megapixels, JPEG 10:1)	1

Note: (Left) The times listed use the theoretical maximum line speeds and do not take into account any transmission control overhead. As a rule of thumb, overhead will decrease transfer rates by around 13 per cent. Network congestion will also slow transfer speeds further still.
(Right) The digital file sizes are only approximations as issues like video resolution and sound quality have an enormous impact on overall file sizes.
Source: ITU.

Around one in every ten Internet subscribers worldwide has a dedicated broadband connection (see Figure 1.3, right chart), though many more share the benefits of high-speed Internet access, for instance through a local area network (LAN), at work or at school. Because of the nature of broadband (you have to use it to understand the benefits it offers), it is apparent that market take-off will require a certain "critical mass" of users. The best form of marketing for a service like broadband is word of mouth, as users describe the service to their friends. In the case of the Republic of Korea, which is an estimated three years ahead of the global average in terms of converting Internet users to broadband, the critical mass was attained as early as 2000 and since then take-off has been rapid.

Figure 1.3: Slowly catching up

Broadband subscribers as a percentage of total Internet users, in Republic of Korea and worldwide, 1995-2002



Source: MIC Korea and ITU World Telecommunication Indicators Database.

Household penetration currently stands at around two-thirds of the Korean population. One of the interesting features of the Korean experience is how many of the new broadband users had not previously experienced narrowband (dial-up) Internet access, but instead subscribed to Internet services for the first time as broadband users.

1.2 What will broadband do for society?

Although it is mainly home consumers that have been driving demand for broadband services to date, in the longer term, it could be business or government applications that prove just as important. Generally speaking, network providers already have profitable businesses in providing high-speed Internet access to the corporate sector, for instance through leased line services or integrated services digital network (ISDN). These services are now under price pressure from new broadband technologies. For instance, consider the relative prices of leased lines and broadband in a selection of developed economies (Table 1.1). Among the selected developed economies shown in the Table, the price of a 2 Mbit/s leased line is highest in Japan, but the price of a consumer broadband connection is actually lowest in that country. The price advantage that broadband holds over alternative private network options in Japan is of the order of 111 times, suggesting a major incentive for business and government users to shift to other broadband technologies when possible. Although the price incentive is far less pronounced in economies like the United Kingdom or the United States, it is still significant.

For example, even in the United States, where the price advantage of broadband is only four times that of establishing a private network, the incentive of shifting is still huge, and the same is true of many other economies. Consider these examples:

- A telemedicine application in the UK for transmitting high-quality medical images between locations (say between a hospital and doctor's surgery). Using broadband would mean that fifteen times more locations could be served for the same price, bringing other economies of scale.
- A remote education application in Australia. The cost of maintaining a broadband link between a central university and remote users is 21 times cheaper than with a leased line, assuming the basic infrastructure is available. This means the network can be larger and a higher percentage of project costs can be spent on teaching time rather than connection costs.

Table 1.1: Comparative monthly prices of broadband and leased lines

For selected developed economies, in US dollars (excluding tax), 2003

Economy	Price of a 2Mbit/s leased line, US$	Price of broadband connection, US$	Speed of broadband connection (down/up), kbit/s	Price advantage of broadband over leased lines
Australia	1'071	51	512/128	21
Japan	2'688	24	26000/1000	111
Netherlands	664	52	1536/256	13
UK	484	33	512/256	15
USA	230	53	1500/256	4

Note: The leased line prices are for a 2.0 Mbit/s leased line (1.5 Mbit/s for US), rented per month in US$ for a 2 kilometre distance. The "price advantage" of broadband over leased lines is calculated by dividing the monthly rental price of a leased line by the monthly rental price of a DSL broadband connection, having corrected for the difference in speeds.
Source: ITU, adapted from data from ITU and Teligen (http://www.teligen.co.uk).

- A project to send digital photographs from tulip farmers in rural Netherlands to purchasing agents for flower sellers in Amsterdam. An thirteen-fold reduction in costs could mean the difference between a business cost and a business opportunity.

Suddenly, the availability of affordable high-speed Internet access means that business plans that were once shelved as being "too expensive" can now be dusted off and implemented with broadband.

But at the same time, the fact that broadband is changing the economics of Internet access has significant implications for those outside the range of service. Whereas we take for granted the almost universal availability of the fixed-line telephone network in most developed countries, and a similarly high level of penetration of cellular mobile service too, broadband is not nearly so widely available—at least not yet. Broadband provided by DSL has significant limitations on distance from the central exchange. These can be overcome, but only at a cost. Similarly, cable modem service is only available where there is a modern cable TV network, usually only in urban areas. Thus, although the distance-defeating effects of telecommunication technologies have become a rallying call for technophiles in recent years, the reality is that broadband may actually *increase* the digital divide *within* countries, especially between urban and rural areas.

Broadband is also having an effect on the digital divide *between* countries: as developed countries adopt broadband, the current trend is for them to pull even further ahead of developing ones, thus increasing the digital divide. However, as the unit costs of providing broadband become cheaper, some developing countries may be able to use the technology to leapfrog ahead, providing an integrated voice, video and data network using the same infrastructure. The technology of wireless LANs, in particular, can be used successfully to extend access. As discussed in later chapters of this report, broadband may well hold out longer-term promise for helping to overcome the digital divide.

1.3 What will broadband do for the industry?

For the information and communication technologies (ICT) sector, and for the telecommunication industry in particular, broadband comes at an ideal time. The initial optimism surrounding the arrival of the World Wide Web, in the mid-1990s, prompted a boom in the share prices of so-called dot.com companies, which in turn inflated the share prices of telecommunication companies. The collapse in dot.com share prices had a profound effect on the outlook for the telecommunication sector, especially after mid-2000. A combination of over-capacity, accounting scandals and inflated bidding for third-generation mobile licences led to a crisis of investor confidence, notably in North America and Western Europe. Although the market reaction is probably overstated, there is still a desperate need for some good news in the sector.

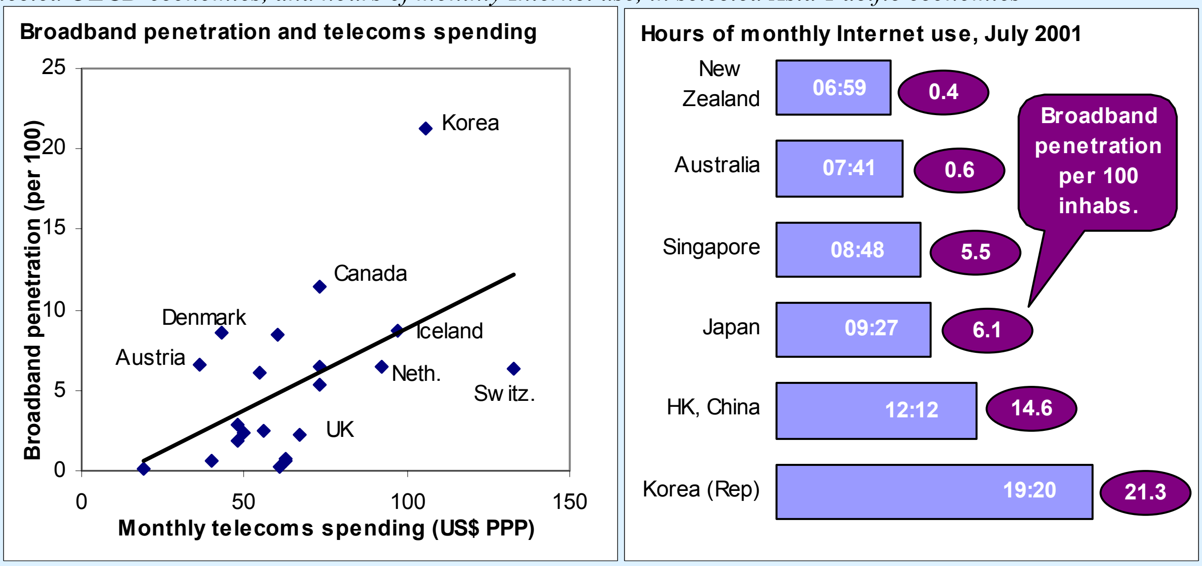
Whatever the grounds for optimism, it would probably be unrealistic to herald broadband as a market driver on the same scale as mobile phones and the Internet. Rather, broadband is an *incremental* improvement, offering Internet access that is faster, more convenient and (per Megabyte downloaded) much cheaper than ever before. But broadband does provide a platform for the development of content services, which is where the real money lies. The dot.com boom was driven by the expectation that the Internet would create huge new markets for electronic commerce, on-demand content (music, movies, newspapers, sports events etc), online applications and much more. But the narrowband Internet access networks of the 1990s just weren't up to the task of delivering this dream. Finally, with broadband, the reality can perhaps catch up with the marketing hype.

Even better news is that early evidence suggests that broadband access can help drive user spending. This is in part because even though Internet access becomes cheaper, consumers make more use of it. There is, for instance, quite a positive relationship between broadband penetration and monthly spending on communication services (Figure 1.4, left chart). The country with the highest level of broadband penetration worldwide (the Republic of Korea) also has the second highest level of monthly telecommunication spending (after Switzerland). Other high broadband economies, such as Canada and Iceland, also have above average levels of consumer telecommunication spending.

Even stronger evidence of a link between broadband and more intensive use of the Internet comes from the Asia-Pacific region, which currently leads the world in broadband. There is a direct correlation between higher levels of broadband penetration and longer periods of average monthly Internet use (see Figure 1.4, right chart). Korea and Hong Kong, China which lead the region in broadband penetration also report much longer average monthly Internet use than other low broadband economies, such as Australia and New Zealand, although the latter two have a comparable living standard and a supposed advantage in terms of the English language, which is still the dominant language for content on the Internet. The evidence seems to suggest that, although it is quicker to download information on a higher-speed connection (see Figure 1.2), the rich experience of using broadband makes users want to stay on for longer, and to spend more money on content and applications.

Figure 1.4: How broadband promotes higher consumer telecommunication spending

Broadband penetration (2002) and average monthly consumer telecommunication spending (in US$, PPP), in selected OECD economies, and hours of monthly Internet use, in selected Asia-Pacific economies



Note: Consumer spending is the latest available data from national surveys (between 2000 and 2002).
Source: ITU World Telecommunication Indicators Database, OECD and Nielsen/Net Ratings.

For the industry as a whole, especially on the content and applications side, the advent of broadband therefore offers a platform to create new business models. But for individual operators, especially those in developing countries that may lack the resources or the know-how to develop broadband networks, there are also challenges. Foremost among these are the threats posed by broadband to existing business models:

- For instance, as indicated in Table 1.1, broadband represents a threat to existing, and usually quite profitable, markets for leased lines, virtual private networks and other business services. Service providers may try to segment their market by charging higher prices for broadband access to business users than to consumers, as the Philippines Long Distance Telephone Company (PLDT) in the Philippines, and Comcast in the United States do, but this is unlikely to be acceptable to regulators or corporate users.

- Similarly, broadband provides a pretty effective means for carrying voice over IP, which allows users to pay much lower bills for their telephone service. As explained further in Chapter four, voice over IP tariffs usually represent a considerable saving over conventional, switched voice telephony, especially for long-distance and international calls. Although public telecommunication operators that offer broadband may not advertise the VoIP capacity of broadband, customers may quickly discover it, especially if there are carriers in the market—such as Vonage in the United States or Yahoo BB! in Japan—that do not have an existing market share in voice telephony to defend.
- Where there is regulatory pressure on incumbent operators to unbundle their local loops, the barriers to entry for competitors are reduced. Although incumbent operators currently have majority market shares for DSL broadband in most developed countries, this may not continue as competitors gain ground. Incumbent operators may also find they are facing direct competition from new sources, such as cable TV providers, wireless LAN operators and even local authorities that may build their networks.

These and other challenges will be explored in the report.

1.4 Structure of the report

This report aims to explore the aspects of broadband mentioned here in greater depth, taking a variety of different angles. In doing so, we hope to reflect an international, global perspective, that also offers detailed close-ups of broadband in practice in people's lives everywhere. Every effort has been made to describe specialized, technical details in simple terms, so that readers from all backgrounds will be able to understand more easily areas that are not of their particular specialization. We also hope that the different policy and strategy aspects of promoting broadband, developing infrastructure and content, and supplying them to the user, offer useful insights to all interested parties. To that end, the chapters have been broken down to cover different areas as follows:

- **Chapter Two: Technologies for Broadband**
  Several technology platforms are using the tag "broadband", but what does it mean and what does it imply for differences in service quality? There are a variety of broadband platforms, including ADSL and cable modem as well as between more recent arrivals, such as wireless LANs, fixed wireless or fibre in the access network. Will these different technologies continue to coexist? Is the absence of a cable television network a barrier to broadband take-up?
- **Chapter Three: Supplying Broadband**
  Many different companies have entered the broadband arena, but in the majority of ITU Member States, it is the incumbent fixed-line operator that has emerged as the dominant provider. What are the dynamics of the broadband market and what corporate strategies have been most successful in winning market share? What pricing strategies have been most effective and how do prices vary between countries? Is broadband relevant for developing nations? Can broadband be supplied effectively on a community access model?
- **Chapter Four: Using Broadband**
  Broadband users tend to be young and highly educated, and the most popular applications at present are games and file sharing. If broadband is to become a mass-market, the user profile will need to broaden and services will need to be marketed also to business users. This chapter examines which applications are currently driving broadband demand, how content fits into the picture—including intellectual property issues—and how usage is likely to evolve in the future.
- **Chapter Five: Regulatory and Policy Aspects**
  Fair-competition among market players is necessary to promote broadband telecommunication. The creation of a fair-competitive environment is the most important role for government to play. For broadband, the market environment covers several different sectors, including cable TV as well as telephony. What policies / regulations are helpful to promote fair, inter-modal competition in the broadband market? What level of cross-ownership and cross-sectoral service provision should be allowed?

- **Chapter Six: Promoting Broadband**
  As local and national governments prepare for the challenges of the information society, there is much interest in who is doing well, and who is doing poorly, in broadband Internet access. Broadband access is being touted as a way for governments to attract investment, ensure future economic prosperity and provide enhanced social welfare. How can broadband be successfully promoted? What are the lessons to date from successful broadband economies? Is the case for broadband different in developing nations?
- **Chapter Seven: Broadband and the Information Society**
  Broadband changes user habits, for instance by encouraging "always-on" use and positioning the home computer as a multimedia entertainment device. Coupled with the growth in high-speed mobile Internet access, and the development of pervasive communications, broadband will also change attitudes towards the information society. What new challenges will this pose, for instance for social ethics and welfare, and information security?

The report draws throughout on ITU country case studies on broadband development and promotion, including Canada, Iceland, Republic of Korea, Japan, Malaysia and Hong Kong, China, as well as further case studies on Internet diffusion.[3] The Statistical Tables at the end of the report provide the latest available data on the state of broadband and telecommunications worldwide, extracted from the ITU World Telecommunication Indicators Database.

[1] See: *ITU Internet Reports 2002: Internet for a Mobile Generation*, ITU, at: http://www.itu.int/osg/spu/publications/sales/mobileinternet/index.html.

[2] The analysis contained in the Report is drawn in part from an ITU New Initiatives workshop on the topic "Promoting Broadband", held in Geneva from 9 to 11 April 2003. An earlier workshop on the " Regulatory Implications of Broadband" was held in Geneva in May 2001. The documents, presentations and background resources from these events are available from the ITU website at: http://www.itu.int/broadband.

[3] These and other ITU case studies are available on the ITU website at: http://www.itu.int/casestudies.

2 Chapter Two: Technologies For Broadband

2.1 What is broadband?

Although most people have heard of broadband, few know exactly how they could begin to define it. Many would probably associate broadband with a particular speed or set of services, but in reality the term "broadband" is like a moving target. Internet speeds are increasing all the time, and at each new advance, marketeers eagerly emphasize just how blazingly fast the latest connection speeds are. It is revealing to look back at advertisements for 14.4 and 28.8 kbit/s modems, for example, just to see how every step is considered "blazing" at the time. It is also important to acknowledge that broadband technologies are always changing, and that a report like this necessarily reflects just a "slice in time". One can therefore only really talk about the "current" state of broadband, and make tentative extrapolations, based on planned or incipient developments, that may or may not come to fruition in the future.

The term broadband is commonly used to describe recent Internet connections that are significantly faster than earlier dial-up technologies, but it does not refer to a certain speed or specific service. For instance, what was termed as a "fast" Internet connection two years ago is now designated as "narrowband". While the term broadband is used to describe many different Internet connection speeds, Recommendation I.113 of the ITU Standardization Sector (ITU-T) defines broadband as a transmission capacity that is faster than primary rate ISDN, at 1.5 or 2.0 Mbit/s. However, this definition is not strictly followed. The Organisation for Economic Co-operation and Development (OECD) considers broadband to correspond to transmission speeds equal to or greater than 256 kbit/s. For the purposes of this report however, ISDN technologies are considered *not* to constitute broadband, despite the fact that some operators label ISDN as a "type of broadband". While 256 kbit/s satisfies the current definition for "broadband," it is clear that as technology improves, we will soon reach a day when even ITU's recommended speeds are considered too slow.

In this report, we define broadband as the last-mile connection to the end-user, although some of these last-mile technologies may also be used for back-end infrastructure. Indeed, wireless technologies such as Wi-Fi have been used to form backbone Internet connections in countries such as Bhutan that do not have a developed wireline infrastructure. It is also important to bear in mind that broadband speeds are only as fast as the slowest portion of the network connecting them to the Internet. Therefore, the speeds referred to here are considered to be maximum speeds that will in fact vary according to type of infrastructure and level of network congestion.

Having attempted briefly to define what broadband is, this chapter will set out an analysis of the types of broadband infrastructure, broken down into two categories: fixed-line and wireless technologies. Finally, technological trends are discussed in order to make educated predictions of where broadband is heading.

For all that broadband may enable in terms of applications and services, the availability of broadband depends primarily on infrastructure. Around the world there does not appear to be a universally optimal broadband technology. Rather, different broadband technologies seem suited to different environments, with relative benefits depending largely on what they are used for. This is corroborated by the fact that a technology that proves successful in some countries may not work well in others, due to economic, cultural, political, geographical, or other factors. Indeed, the medium of choice may depend upon the legacy medium (where existent), the regulatory framework, and the supporting institutional arrangements.

Although most of the marketing literature differentiates broadband according to transmission speed (bandwidth), there are in fact a number of different characteristics that help determine the appropriateness of a particular broadband platform for a particular application. These include latency (very important in on-line gaming); burstiness (important for file-sharing applications); mobility and the ability to interwork with other platforms.

While there is no one-size-fits-all broadband technology, broadband can be said to fall into two basic categories: wired (fixed-line) and wireless. This section describes the most popular broadband technologies, highlighting some of their benefits and drawbacks.

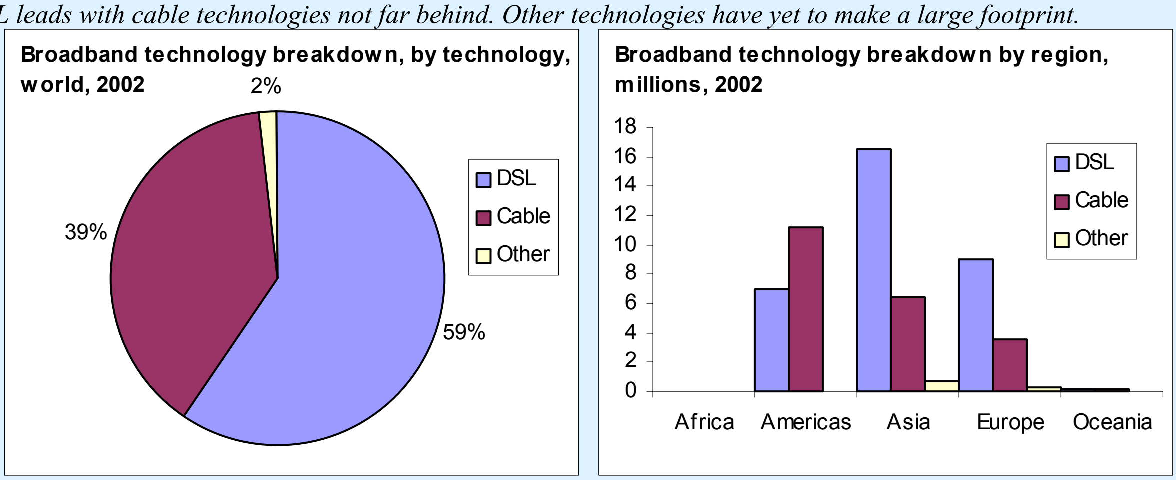
2.2 Fixed-line infrastructure

Broadband has tended to follow the evolutionary pattern pioneered by traditional phone service; in other words, connections are initially established over fixed lines and eventually become available over wireless networks as technology develops. Where broadband is concerned, wired connections account for the vast majority (over 98 per cent) of current connections—although wireless technologies are starting to grow quickly.

For fixed-line connections, digital subscriber line (DSL) technologies are the most popular worldwide, followed closely by cable. By region, DSL is more common than cable in Asia and Europe but the opposite is true in the Americas. While DSL and cable modem technologies have largely been built on top of existing networks, some new transmission technologies, such as fibre optic cables, have been gaining in popularity as well (see Figure 2.1). These are explained in greater depth in the sections that follow.

Figure 2.1: Distribution of broadband connections, by technology, 2002

DSL leads with cable technologies not far behind. Other technologies have yet to make a large footprint.



Source: ITU World Telecommunication Indicators Database.

2.2.1 Digital Subscriber Line (DSL) technologies

Building upon the traditional analogue system that formed the basic telephone network, the integrated services digital network (ISDN) was the digital switched network technology that first enabled improved quality and speed, not only for the transmission of voice, but also of data and images. While ISDN offered a significant upgrade to traditional copper phone lines, digital subscriber lines (DSL) have advanced the technology and increased the speeds further still. A key advantage of DSL technologies is that they use existing copper twisted pair wiring and do not require new cabling as would say, fibre optics. DSL utilizes different frequencies to split voice and data services over the same standard phone line. Previously, phone networks only used a small portion of the available bandwidth for voice traffic. However, DSL has taken advantage of the unused space on the copper pair to include data traffic (see Figure 2.2). DSL speeds are influenced by the distance between the subscriber and the local exchange, the gauge of the phone wire, and the type of DSL technology.

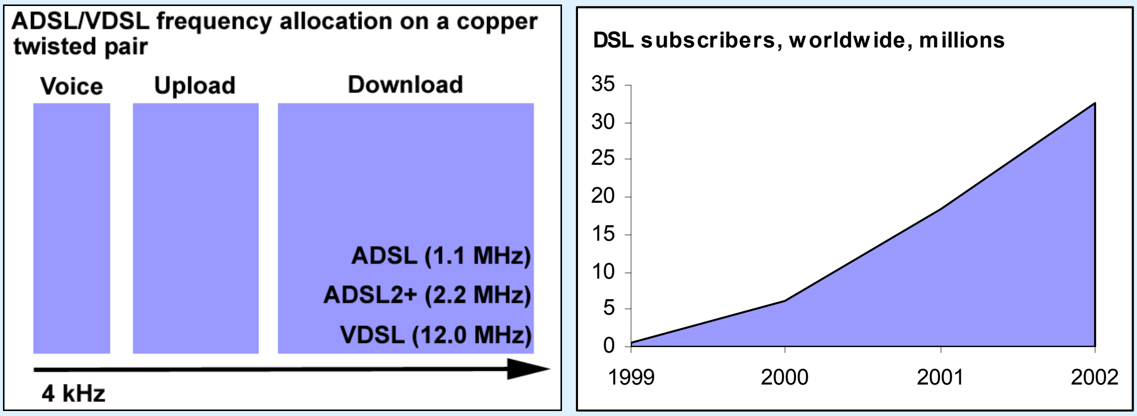
A main benefit of DSL technologies is that they offer a dedicated amount of bandwidth that does not vary with the number of subscribers in an area. This is because each line functions like a complete circuit to the central office of the operator. Cable and wireless technologies can suffer from congestion when more and more users start using the allotted bandwidth for an area. This makes DSL technologies ideal for home and business use that need a certain amount of bandwidth available at any given time.

In its various forms, DSL is the most popular broadband technology in the world. In 2002, 64 per cent of broadband countries had more DSL lines than cable connections. The Republic of Korea led the world in DSL penetration in 2002 with 13.4 subscribers per 100 inhabitants followed by Iceland (8.4), Hong Kong, China (8.3), Taiwan, China (8.1), and Japan (5.5).

Importantly, the rate of DSL deployment often hinges on whether the incumbent operator is willing or not to open the local loop to competitors. This process is known as local loop unbundling (LLU).

Figure 2.2: DSL making full use of copper lines

DSL technologies make more efficient use of copper lines by separating voice and data channels into different frequencies



Source: ITU, ITU World Telecommunication Indicators Database.

ADSL(G.dmt) – (ITU-T G.992.1)[1]

DSL comes in several different "flavours" that offer different benefits. Some are more suited for residential use and others for business. Asymmetric DSL (ADSL), for instance, is a form of DSL where more bandwidth is allocated to download than to upload. This makes it ideal for web browsing and typical Internet usage, where downloading of large files is more important than uploading, because it enables maximum speeds of 8-10 Mbit/s downstream and a maximum of 1 Mbit/s upstream. ADSL is available at a maximum distance of 3 km from the local exchange. It is well suited to residential use because it shares a single twisted copper pair with voice, allowing users to use the telephone and surf the Internet simultaneously on the same line. ADSL is the most popular form of DSL offered around the world and the transceivers falling in this category are described in the ITU-T Recommendations of the G.99x-series.

ADSL(G.lite) – (ITU-T G.992.2)[2]

Originally, ADSL installations required a physical splitter to separate out voice and data traffic. These installations had to be performed by technicians and significantly increased the cost of installing an ADSL line. However, G.lite allows for a splitter-free connection that simply requires the modem to be plugged in, thus drastically reducing the expense and difficulty of rolling out ADSL service.[3] In addition, this ITU Recommendation extends the reach of ADSL by sacrificing speed; G.lite can reach 5.4 km but its maximum download speed is limited to 1.5 Mbit/s whole upload speeds are limited to 512 kbit/s. G.lite has been used to connect areas that were previously inaccessible via standard ADSL. It has also facilitated so-called "plug and play" installations, by users themselves.

SHDSL – Single pair high-speed DSL (ITU-T G.991.2)[4]

Single pair high-speed DSL (SHDSL) is covered by a recent ITU Recommendation (ITU-T G.991.2)[5] for symmetric, high-speed DSL. SHDSL connections are best suited for servers (web, FTP, file) and other business uses such as video conferencing that require high speeds in both directions. SHDSL uses a copper pair to send and receive data through two bands, which allow for speeds up to 2.3 Mbit/s in both directions. By including a second copper pair, SHDSL speeds can reach 4.6 Mbit/s in each direction. These speeds are possible over a 3 km range with data rates attenuating for longer distances. The two SHDSL bands send data over the low frequencies to extend the reach of the loop, making it impossible for SHDSL to carry a voice channel (POTS or ISDN) like ADSL.[6] This lack of voice capability imposes significant installation costs in the local loop—a cost that is passed on to the consumer through higher subscription costs. Therefore, SHDSL is more suitable as a replacement for traditional leased lines for business (businesses can usually absorb higher subscription rates than private users) rather than for the consumer market.

In some parts of Europe, SHDSL is referred to simply as SDSL, not to be confused with a different standard of the same name used in North America, which is described below.

Symmetrical DSL (SDSL)

SDSL is a proprietary standard mainly used in North America, but which even there is losing popularity to SHDSL. SDSL offers equivalent traffic flow in each direction but, like SHDSL, it cannot share the line with analogue signals, thus posing significant installation/modification costs in the local loop. SDSL is best suited to sites that require significant upload speeds such as web/FTP servers and business applications. The capacity of SDSL is adjusted according to signal quality and speeds and distance combinations ranging from 160 kbit/s over 7 km to 1.5 Mbit/s over 3 km are offered. Higher speeds are possible by combining multiple twisted pair wires.

ADSL2, ADSL2plus (ITU-T G.992.3/G.992.4) [7]

ITU-T G992.3 (ADSL2) is the sequel to the original ITU-T ADSL Recommendation, which is to date the most successful broadband technology in the world, and enables improved speed, reach, power consumption and other technical elements over the original version. When developing the two new Recommendations, ITU-T was able to incorporate feedback from service providers and end-users. ADSL2 can deliver 8-12 Mbit/s while extending the reach of the original ADSL by 300 metres.

The main improvements over the original ADSL standard can be summarized as follows. The speed and reach increases in ADSL2 are largely owed to improved performance on long lines in the presence of interference.[8] Other improvements include addressing several technical issues that appeared with original ADSL standards. The new Recommendations allow for the use of filters, rather than splitters, at both ends of the connection. This offers cost savings, obviating the need for a technician to install splitters at the home or office. ADSL2 also introduces power management features into ADSL modems, allowing for more cost-effective operation on both sides of the connection. Original ADSL equipment remains in an always-on state, using the same amount of energy regardless of whether data is being transferred or not. ADSL2 introduces three power states for the equipment, each corresponding to need. The highest power levels are used during large downloads as they allow for more bandwidth. Lower power levels are used during periods of inactivity, allowing for energy savings both at the central office and at the customer premises, all while maintaining an always-on connection.

The new ADSL2 Recommendation also realigns the voice channels and offers providers the ability to combine multiple ADSL2 lines for faster bandwidth to certain customers. In addition, ADSL2 systems can enter an "all-digital" mode where voice channels are reassigned to data, similar to SHDSL. This is especially important for business lines that may not need voice services over the ADSL2 line.

ITU-T Recommendation G.992.5 (ADSL2plus or ADSL2+) builds further on ADSL2, increasing the bandwidth by extending the usable frequencies on the line. While both technologies use the same frequencies for telephone calls, and uploading data, the download channel is extended from a maximum of 1.1 MHz with ADSL2 to 2.2 MHz with ADSL2plus. This increases download bandwidth from 8 Mbit/s with ADSL2 to 16 Mbit/s with ADSL2plus.[9] These speeds are possible over 1.5 km and higher speeds may even be possible.

VDSL – Very-high-data-rate digital subscriber line (ITU-T G.993.1)[10]

VDSL (ITU-T G.993.1) is the latest form of DSL and offers the fastest DSL speeds over short distances to date, at 52 Mbit/s of bandwidth over a standard twisted pair cable. While the speed is much higher than other DSL technologies, it comes at a price: decreased reach of the network. This makes VDSL the optimal choice for branching out short distances from fibre connections, rather than, for example, providing longer-range broadband to rural communities.

VDSL was originally named VADSL but the "A" (for asymmetric) was dropped because VDSL can support both symmetric and asymmetric transport. These connections can be very fast because the physical distances are kept very short, allowing for maximum throughput. As fibre optic networks continue to move closer to communities around the globe, VDSL will become increasingly important as a way to bridge the last-kilometre gap. The Republic of Korea has made extensive use of VDSL technologies in apartment buildings around the country as a way to share fibre connections arriving in the basement of apartments. Fibre connections are difficult to install in places that require twists and turns, such as apartment buildings. By using VDSL, which involves a twisted copper pair rather than fibre, the short distances to each apartment can be covered.

2.2.2 Cable modem technologies

While DSL is the most prevalent broadband technology in the world, cable modem technology is not far behind. Coaxial cable has several different benefits over DSL that have allowed it to flourish in economies with developed cable television networks.

Cable networks were originally designed for one-way video transmission. Cable companies provided video that was sent, or broadcast, over lines to subscribers' homes. However, as the networks have evolved, new equipment has made it possible to send data in both directions on a cable network, (i.e. downloading and uploading from the household), thus making Internet access over cable a viable solution. The physical cable network sends different "channels" on separate blocks of 6 MHz frequencies along the same cable. Originally, these channels each carried different television channels until a method was developed to reserve unused channels and dedicate them to Internet traffic. One channel sends data from the Internet to users (6 MHz of frequency corresponds to roughly 30 Mbit/s) and another channel is used to send data back on the Internet from households (see Figure 2.3).

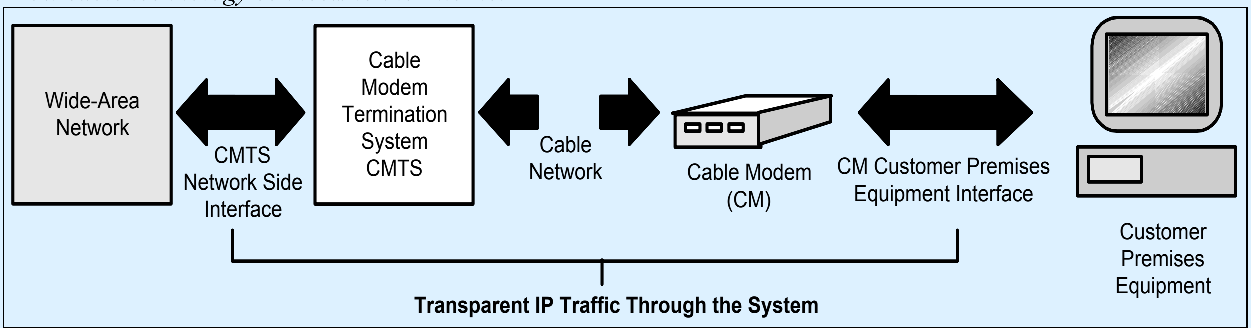
These reserved channels are "broadcast" around the network to all subscribers in a certain area. Each cable modem can recognize which parts of the broadcast are destined for it and pull them off the network. Cable modems are then able to send information back to the Internet by waiting for their "turn to talk" on the response channel and essentially broadcasting their request in quick bursts back to the central office of the cable company.

All cable subscribers in a small area share the same channels to send and receive data, and the amount of bandwidth users receive is directly tied to how much bandwidth their neighbours are using. This is in contrast to DSL networks that offer an unshared dedicated line. If no other users are using a cable node at a given time, cable subscribers may theoretically have disposal of all of the combined bandwidth allotted to their own and their neighbours' homes. Conversely though, during heavy usage, cable modem subscribers can see significant reductions in their bandwidth. Typically, 1.5 Mbit/s download speeds or higher can be expected over cable modems during normal usage times. In order to protect against abuse, many cable companies have restricted the upload bandwidth to 128 kbit/s in order to stop high-bandwidth users who use more than their share from running server or peer-to-peer applications on their home computers. Cable companies have also found another way to increase the bandwidth of users in an area by simply dedicating additional channels to data and dividing the number of users on a particular node.

The cable modem technology, called DOCSIS, is a product of ITU-T Study Group 9. The first generations of cable modems were built on ITU-T Recommendation J.112[11], however a new ITU-T Recommendation J.122 (DOCSIS2)[12] was approved at the end of 2002 and offers improvements to the existing standard while maintaining backwards compatibility. The new DOCSIS2 standard improves the way the cable modem broadcasts data back to the central office, allowing for more economical use of existing bandwidth.[13]

Figure 2.3: Cable modem connections

How cable technology connects to the Internet



Source: ITU-T Recommendation J.122, ITU-T Study Group 9.

Cable broadband access may not be as prevalent in the world as DSL, but it dominates in some markets with a fully developed cable television network. In 2002, the Republic of Korea led the world in cable broadband connections with 7.7 subscribers per 100 inhabitants, while Canada (5.2), the Netherlands (4.9), Switzerland (3.6) and Belgium (3.5) round out the top five economies.

2.2.3 Fibre optic cable

While DSL and cable technologies are based on copper wire, a newer technology, fibre optic cable, is drastically increasing bandwidth and steadily replacing copper networks, especially in the trunk and middle-mile segments. Unlike copper, fibre optic cable uses lasers or light emitting diodes (LED) to transmit pulses of light down extremely fine strands of silicon. Fibre optic cable can carry thousands of times more data than either electric signals or radio waves, because light uses higher frequencies. In brief, the higher the frequency, the faster the waves can be switched on and off, forming the 0's and 1's that comprise digital data. This faster speed allows more data to be sent in the same amount of time. The infrared laser light that is used in telecommunications has a frequency of roughly 100 MHz, 100 million times higher than an AM radio signal and 100 billion times higher than an electric telephone signal.[14]

Fibre optics can therefore theoretically provide nearly unlimited bandwidth potential, and maximum bandwidth is actually limited by current technology. Most fibre optic cables transmit light at one frequency, but the cables should be able to handle a wide range of frequencies, just as DSL uses several frequencies to split voice and data traffic over copper. As the technology improves, the bandwidth on fibre optic lines can be increased by simply adding more frequencies on the line.

Currently, fibre optic technology can provide transmission rates of 10 Gbit/s per wavelength on a strand, with even higher rates in development. This has made fibre the technology of choice for backbone connections (e.g. high bandwidth connections between cities) and heavy bandwidth areas within cities. Strands of fibre optic cables also make up the majority of lines crossing the oceans of the world. Since the costly aspect of fibre optics is the laying of cable, fibre is typically installed in bundled strands to accommodate future bandwidth needs over and above current needs.

While fibre has long been cost-efficient as a backbone technology over long distances, the cost of the termination equipment at each end of the fibre strand has however made connecting small communities or homes prohibitive. But as the technologies have improved, the price of the equipment has dropped and currently the cost of fibre rollout is approaching the cost of other wired networks. It seems that for new developments at least, it is most sensible from a long-term perspective to lay fibre rather than copper. Even DSL and cable networks often use fibre to connect to the central offices and then break out to copper from there.

In addition to the cost of termination equipment, fibre is also less attractive owing to its lack of flexibility in comparison, for example, to copper wire. Fibre optic cable can only withstand a limited amount of curves and bends, which makes installations in apartment buildings very difficult due to the additional attenuation loss. As mentioned above in the section on VDSL, one solution adopted in the Republic of Korea overcomes this by using VDSL for the final section to individual apartments.

Several governments are laying fibre infrastructure to have it ready when it finally becomes cost effective to install the connections and "light up" the fibre to the home. Countries such as Iceland, Japan, Korea, Singapore and Sweden have been most progressive—already installing extensive fibre connections to neighbourhoods or homes. Japan and Singapore are in the process of a nationwide rollout of fibre optic cables. On a smaller scale, the village of Måtgränd in Sweden decided to build its own fibre network among residents, including a fibre link out to the Internet backbone. The network provides 100 Mbit/s links to residents, who may otherwise have had to wait years for the fast network to expand out to them.[15] In Iceland, Lina.Net (a subsidiary of the Reykjavik Energy Company), together with Ericsson, has established a residential fibre network capable of delivering speeds of up to 100 Mbit/s.

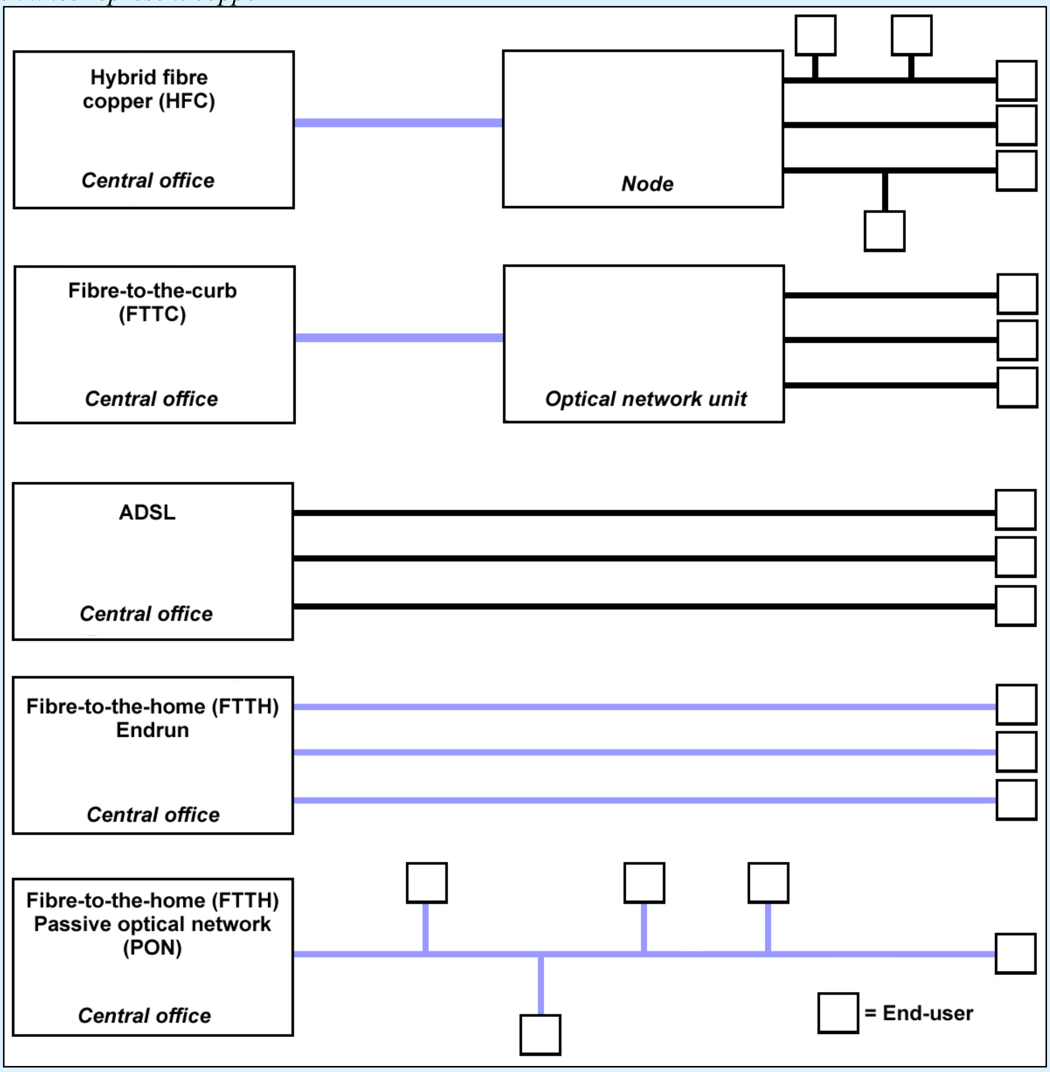
Interestingly, while most fibre optic cable is laid in the ground, Japanese companies such as NTT have started using aerial cables to connect homes. This decreases the costs of installation and makes use of existing power poles as anchors (see Figure 3.6 in Chapter three). Overall, as old, legacy infrastructure is retired, fibre optic cables seem to be on the way to making up more and more of telecommunication networks around the world.

Last-kilometre solutions

Most current broadband networks employ a mixture of copper wire and fibre optic cabling. These networks rely on the faster speeds of fibre for backbone connections spanning a country or encircling a metropolitan area while the last kilometre is predominantly copper cabling (e.g. DSL). However, fibre is starting to replace the copper much closer to end-users. Hybrid fibre copper (HFC), and fibre-to-the-curb (FTTC) networks make use of fibre cabling into the last kilometre and only span out over copper for short distances into households. ADSL networks rely on copper for further distances while fibre-to-the-home (FTTH) networks bring fibre connections directly to end-users. There are many different network architectures for the last kilometre and several main topographies are given below in Figure 2.4.

Figure 2.4: Last-kilometre wired networks

Various uses of fibre and copper technologies to reach end-users. The lighter blue lines represent fibre optic cables while black lines represent copper



Source: ITU, adapted from Paul E. Green, Jr., Fibre-to-the-Home White Paper, 2003.

Ethernet in the first mile

While copper (DSL, cable) and fibre technologies provide physical broadband links, Ethernet in the first mile is providing a platform on top of these technologies to transport data more cost-effectively.

Ethernet over unshielded twisted pair (UTP) has become the default standard in LANs with some estimates suggesting that 85 per cent of all local area networks use the technology.[16] Correspondingly, and due to Ethernet's longevity and popularity, equipment prices are very low.

Despite being the default standard for moving data in small network environments, Ethernet's success outside LANs has been stunted by network size and distance restrictions. Ethernet's maximum cable length is roughly 100 metres, significantly short of last mile demands unless extensive repeating equipment is used. Ethernet's broadcast-type architecture is also incompatible for long-distance transport for several reasons.

First, Ethernet lets any device on the network send data as fast as it can, essentially leaving all bandwidth on the network up for grabs. Second, there are no provisions to ensure quality of service (QoS), something vital for long-haul networks delivering time-sensitive data. Ethernet's design is therefore very efficient for small networks but could bring long-range networks to a grinding halt.

In some instances however, technologies such as multi-protocol label switching (MPLS) are now enabling Ethernet to be used on longer distance networks by introducing QoS and bandwidth control to an IP network.[17] This has extended Ethernet's reach for long-distance transportation and makes it an inexpensive alternative for middle- or last-mile, fast connections. Gigabit Ethernet also now allows connections up to 1 Gbit/s and does not require multiple conversions in and out of protocols *en route*. These advances have made Ethernet in the first mile a good way to send data cheaply over fibre networks.

2.3 Wireless

Copper and fibre technologies are rapidly evolving to send data more quickly and efficiently. However, many areas of the world have struggled to build out traditional copper telephone lines, let alone upgraded lines capable of higher data speeds. As a result, wireless technologies are becoming an attractive option for rural areas and developing economies that have limited existing infrastructure. Even in the developed world, wireless broadband technologies have been successful because of their low-cost installations and wide reach. This section examines the major wireless broadband technologies that are in use or currently under development.

Table 2.1: Wireless networking technologies

Name	Speed	Range	Frequency	Notes
802.11b (Wi-Fi)	11 Mbit/s	100 m	2.4 GHz	Most popular and widespread[18]
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
802.11e	54 Mbit/s	NA	5 GHz	Adds QoS not present in a,b,or g.
802.16 (WiMAX)	70 Mbit/s	50 km	2-11 GHz	QoS, Very long distance, Metro net
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	Personal area network [not WLAN]
Infrared LAN	4 Mbit/s	~20 m	350'000 GHz	Same room only, no negative health effects

Source: ITU, updated from "Internet for a Mobile Generation", ITU, 2002.

2.3.1 Fixed wireless technologies

"Fixed wireless" technologies go by many names, including terrestrial wireless broadband, fixed wireless access (FWA) for broadband services, wireless broadband access (WBA) or broadband wireless access (BWA). While the names may all be different, they are all stationary mobile technologies, that is, Internet access provided between fixed points.

Fixed wireless technology is not new. Microwaves and other backbone technologies have already been deployed extensively in telecommunications. Recently though, rapid technological advances in wireless technologies and the release of large portions of spectrum have boosted wireless access, adding to its faster deployment, greater flexibility and (arguably) lower cost. Fixed wireless broadband providers have found particular success in rural communities that are far out of reach of fixed lines.

Fixed wireless systems are constrained by their allotted radio spectrum, which is a finite resource.[19] Typically, 1 Hz of spectrum can yield 1-4 bit/s of throughput, depending on various factors (such as modulation technique and environmental factors).[20] Fixed wireless systems use frequencies between 900 MHz to 40 GHz. 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.

The biggest disadvantage of fixed wireless is the fact that very few standards exist for fixed wireless equipment. There is also a strong variation in fixed wireless spectrum allocation, with blocks of frequencies allocated for different uses, some licensed and some not. Even when frequencies are licensed for certain uses, they are not uniform across different countries. This makes large-scale equipment production difficult, and increases costs.

The following distribution systems give an introduction to the types of fixed wireless solutions that are available today. The future looks more encouraging in this regard: as countries begin to better coordinate spectrum allocation one can expect to see fixed wireless technologies gaining more ground.

MMDS

Multipoint microwave distribution system (MMDS) was traditionally used to provide one-way, analogue wireless cable TV broadcast service and was widely known as "wireless cable". The initial service had difficulty competing with traditional terrestrial and cable broadcasters but now the MMDS frequencies (2.1 GHz to 2.7 GHz) are being used for providing broadband services. This frequency range does not require straight line of sight.

With MMDS, a transmitting tower must be placed at a high elevation and can provide high-speed data rates of up to 10 Mbit/s over a 48-56 km radius. Users must then have a unidirectional dish that can be connected directly to the tower or to repeaters that extend the range of the signal. MMDS is most effective in difficult-to-wire areas where rivers and highways preclude the feasible installation of cabling. However, despite early optimism, the lack of a uniform standard for MMDS equipment and other economic problems have forced many operators to curtail services.

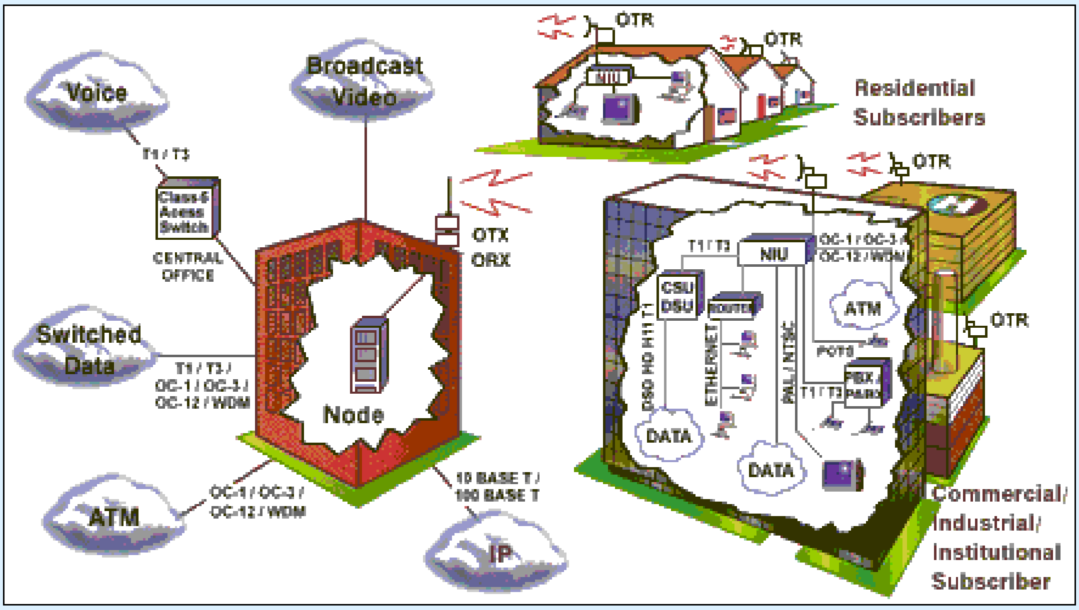
LMDS

Local multipoint distribution system (LMDS) (see Figure 2.5) was originally designed for wireless digital television transmission. It occupies a very large amount of spectrum above 20 GHz and can provide two-way broadband service including video, telephony and high-speed Internet access. However, the lack of a uniform standard for LMDS has kept costs very high and resulted in interoperability problems. Also, the high frequencies of LMDS require line of sight. Notwithstanding these drawbacks, the technology is promising, with fast data rates over long distances to multiple users.

802.16 (WiMAX)

The IEEE recently standardized 802.16, commonly known as WiMAX, as a new fixed-wireless standard using point-to-multipoint architecture. The initial version (802.16) was developed to meet the requirements for broadband wireless access systems operating between 10 and 66 GHz. A recent amendment (802.16a) does the same for systems operating between 2 and 11 GHz. WiMAX equipment should be able to transmit between 32-56 km with maximum data rates close to 70 Mbit/s. The higher frequencies in the range require line of sight. This requirement eases the effect of multipath, allowing for wide channels, typically greater than 10 MHz in bandwidth, thus providing very high capacity links on both the uplink and the downlink. At the lower frequencies, line of sight is not required but speeds are lower.[21]

Figure 2.5: Local multipoint distribution system (LMDS)



Source: Wireless Communications Association International at: http://www.wcai.com/lmds.htm.

While other fixed wireless technologies have had great difficulty with interoperability, the WiMAX technical working group sought to replicate the success of Wi-Fi by following its development and certification processes. First, the WiMAX working group included leading companies in many industries whose clout in their individual markets would help promote a common standard.[22] Second, the WiMAX Forum is similar to the very successful Wi-Fi forum which offers a "stamp of approval" that equipment will interoperate with other certified products, further helping to create a single common standard.

Unlike wireless LAN technologies such as 802.11a, 802.11b, or 802.11g (all discussed below), WiMAX is seen as a high-speed wireless backbone, or middle-mile technology, linking distant ISPs to the Internet. Wireless LAN technologies can then disseminate the connections over the last leg of the network to users (see Figure 2.6).

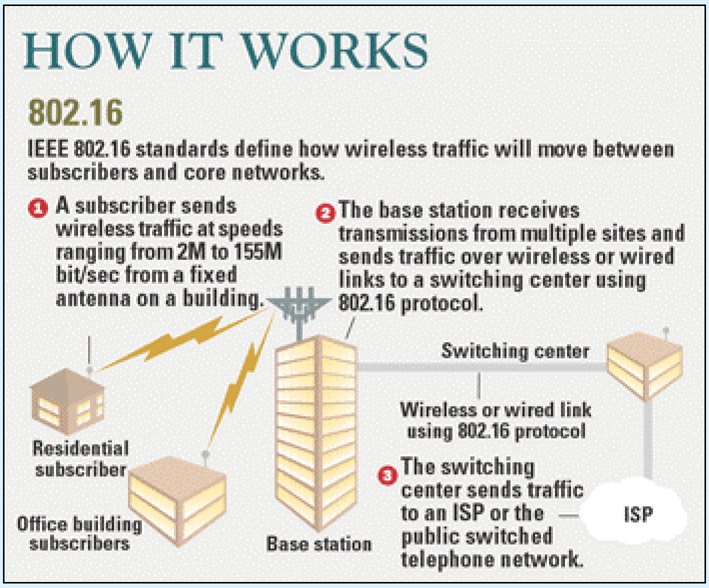
Fujitsu Microelectronics hopes to have a system-on-chip solution for 802.16a by mid-2004. The WiMAX group will also work with the European Telecommunications Standards Institute (ETSI) to develop test plans for HIPERMAN, the European broadband wireless metropolitan area access standard.

2.3.2 Satellite technologies

Satellite technologies are being used to deliver Internet access to very remote regions of the world. While the connections are more expensive than other methods of delivery, they provide a viable option to rural and remote areas of the world that have no other real broadband options. However, while they offer worldwide coverage, they also suffer from latency problems (the delay between a signal being sent and received).[23]

Satellites are basically radio relay stations in orbit above the Earth that receive, amplify and redirect analogue and digital signals. Since the launch of the first satellite by the Russian Federation (then the Soviet Union) in the late 1950s, satellites have grown in complexity and power.

Figure 2.6: Long-range connections over IEEE 802.16



Source: Network World Fusion at: http://www.nwfusion.com/news/tech/2001/0903tech.html.

Communication satellites[24] provide a worldwide linkup of radio, telephone, and television and have traditionally been launched in a geostationary orbit. Geostationary (GEO) satellites are in orbit 35’650 km above the Earth and rotate with the Earth, thus appearing stationary. A fleet of three GEOs can provide complete global coverage. In addition to geostationary orbits, communication satellites can also use a low-earth orbit (LEO) somewhere 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 to have one in sight at all times. LEO constellations have the advantage of shorter transmission delays because they are much closer to the Earth’s surface.

While the 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 satellite broadband start-up Teledesic: Teledesic’s initial plan for 840 LEO satellites was eventually cancelled before a single satellite had been launched.[25]

The constant battle between satellite and terrestrial technologies is set to continue with the growth of the broadband market. Advantages of satellite technologies include ubiquitous coverage, simplicity in network design, reliability (with few points of failure) and rapid deployment. The downside includes security weaknesses, less bandwidth, higher latency and poorer signal quality. However, there are specific areas where satellite consistently proves cost effective: for example, for point-to-multipoint, occasional use applications where bandwidth is required on a part-time basis. Satellite also serves as a last resort, since it is the only technology that boasts 99 per cent coverage of world landmass. Satellite broadband is particularly attractive in areas not reached by cable and DSL networks such as rural areas that still lack wired access.

Satellite broadband connections were initially constrained to satellite communication for downloads and a dial-in connection for the upstream. However, new technology has allowed for two-way communication, meaning that all Internet communication can take place through the satellite dish. Several companies around the world have introduced broadband services via satellite, for example, BT Openworld in the United Kingdom and WildBlue in the United States.

Satellite broadband providers rely on a customer base that is out of range of DSL and cable modems. However, as the rollout of DSL and cable modem networks proceed at the current rapid pace, the number of customers with satellite broadband as their only high-speed option decreases. This has been a nagging problem for the broadband satellite industry because their connections have traditionally been more expensive and significantly slower than DSL and cable.

2.3.3 Wireless LAN technologies

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

The limited range of wireless LAN technologies means they most often must be used in conjunction with another broadband connection to the Internet. Wireless LANs are most commonly used as last 100 metre diffusers of a broadband connection. Indeed, one of the biggest uses of wireless LANs is to share a cable or DSL connection with multiple computers in a house or office. Wireless LANs are already an important technology where broadband is concerned, and are likely to grow in importance in the future.

In 2002, wireless LAN technology became a bright spot in the beleaguered telecommunication market. Wireless LANs can effectively be used to share Internet access from a broadband connection over 100 metres, although they are also being used increasingly as methods of providing broadband access over longer distances in rural areas. This is accomplished by increasing power levels of the equipment, using specialized antennae, and ensuring line-of-sight access. Of all WLAN technologies, the most popular and widely known is IEEE 802.11b, commonly referred to as "Wi-Fi".[26] It should be noted that Wi-Fi is one of several WLAN standards (see Table 2.1), and is not synonymous with wireless LAN, despite the fact that many now use it as a catch-all term for WLAN.

One fast-growing use of WLANs is the provision of wireless hotspots in public areas such as airports, conference halls, and cafés, offering high-speed wireless Internet connections to users. Beyond the "hotspot" concept, several businesses are even looking into ambitious plans to develop a patchwork network of wireless LAN connections across entire countries. Zamora, a Spanish town with a population of 65'000, already boasts 75 per cent Wi-Fi coverage.[27] Paris, France has also taken steps towards becoming a Wi-Fi city (see Box 2.1).

Box 2.1: Paris Unplugged

In Paris, France, a dozen Wi-Fi antennae have been set up outside Metro (underground train) stations along a major north-south bus route, providing above-ground Internet access to anyone near them who has a laptop computer or personal digital assistant (PDA) equipped to receive the signals. Access is free of charge for the first three months.

The success of this experiment will determine the future of Wi-Fi in Paris—at least above its Metro stations, where the plan is to provide service at all of the 372 Parisian Metro stations linked via 2 or 3 antennae in combination with the existing fibre optical network underground in the tunnels themselves.

This would effectively provide seamless wireless coverage throughout the metropolitan area of Paris. Subscribers could access the Internet from parks and cafés, for example, while businesses could use virtual private networks (VPN) for transactions from any point in the city.

Source: International Herald Tribune and http://www.kewney.com/articles/030527-paris.html.

Several factors have contributed to what is becoming the phenomenal growth of wireless LANs: a steep drop in prices, the mobility benefits of wireless connectivity, off-the-shelf availability, and easy installation. With its "hotspot in a box" solution, for example, Toshiba plans to provide the basic equipment to set up a public hotspot in the United Kingdom for US$ 660 (GBP 400), including the link-up to a centralized billing system.[28]

The combination of inexpensive equipment and easy installation has also made wireless LANs particularly attractive for rural connectivity (see Box 2.2). Many projects around the world are looking for ways to use wireless LAN technology to bridge the last mile. The ITU Development Sector (ITU-D), to cite just one example, is in the process of implementing three pilot projects to determine the performance of WLANs for provision of community access for rural areas of Bulgaria, Uganda and Yemen.[29] Wireless LAN is also being rolled out in many rural areas of other developed economies.[30]

Box 2.2: Rural broadband access via WLAN
Pay-as-you-go wireless broadband in the UK

The Wireless Rural Broadband (WRBB) group is experimenting with the use of 802.11g (54 Mbit/s) and 802.11b (11 Mbit/s) WLAN technology to provide high-speed services to rural customers in the United Kingdom who live out of range of DSL and cable networks. The services began in June 2003 around Stamford in Lincolnshire, and are available for business and domestic use.

WRBB charges for the quantity of data used rather than for the speed of the connection. Service plans are similar to mobile phone contracts with unused data being rolled over to the following month. Customers can buy additional data at any time. On-demand pay-as-you-go service is available for visitors, children, and cash customers with no minimum term or set-up charges.

Prices begin at GDP 10 (around US$ 17) a month, and are competitive with ADSL, cable, and satellite services. There is no minimum term and no setup or installation charge.

Source: Wireless Rural Broadband (WRBB) at: http://www.wrbb.net.

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

802.11b (Wi-Fi)

802.11b, or Wi-Fi (Wireless Fidelity), as it is commonly known, has more or less become the standard wireless Ethernet networking technology for business, schools, public access points, and hotspots around the home. Strictly speaking, Wi-Fi is a certification that manufacturers can apply to their products once they pass the requisite interoperability criteria.

Wi-Fi uses the 2.4 GHz frequency band to deliver 11 Mbit/s of data over a range of 100 metres, although these are theoretical maximums (see Table 2.2). Obstacles (such as trees or walls) between the wireless adapter and the access point cause the speeds to drop. Directional antennae and amplifiers can be used to extend the range of 802.11b products, as can the method of using amplifiers (provided the total power radiated does not exceed what is allowed by nationally applicable regulations, if these are followed).

802.11b is a half duplex protocol—whereby transmissions can be sent or received, but not simultaneously. It shares the 2.4 GHz range with many cordless phones, microwave ovens and some wireless local loop (WLL) radio systems, so interference is possible.

Table 2.2: Wi-Fi ranges

	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.

In terms of security, Wi-Fi also opens up considerable vulnerabilities, and its built-in security—called wired equivalence privacy (WEP)—is flawed and easily overcome. However, there are many other solutions for securing wireless networks such as the Remote Authentication Dial-In User Service (RADIUS) protocol and Point-to-Point Tunneling Protocol (PPTP), which offer end-to-end encryption over Wi-Fi networks.

802.11a (Wi-Fi5)

802.11a, or Wi-Fi5, was conceived earlier than 802.11b, hence the “a” in its name. It took longer to develop and was later to market than its more popular relative, 802.11b. While the two share a common heritage, they are considerably different from one another and are incompatible. 802.11a uses the less-crowded 5 MHz band and enables speeds of up to 54 Mbit/s, almost five times faster than Wi-Fi.

While 802.11a offers some advantages over Wi-Fi, it has not been adopted by users in great numbers. To date, 802.11a has been more of a corporate Wireless LAN product, although dual 802.11a/b cards are available on the market. Wi-Fi products are currently less expensive and much more prevalent that 802.11a technology, and the arrival of newer technologies such as 802.11g are making 802.11a even less likely to gain a large following. If 802.11a succeeds, it will be because it operates at fast speeds in an open area of spectrum. The recent 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.

HiperLAN2

HiperLAN/2 stands for “High Performance Radio Local Area Network” and is a European WLAN standard developed by the European Telecommunications Standards Institute (ETSI). It is similar to IEEE 802.11a[31], in that it operates in the same 5 GHz frequency band using orthogonal frequency division multiplexing (OFDM) and offering data rates of up to 54 Mbit/s. While they even have the same physical layer, their modulation schemes are different.

HiperLAN has several advantages over 802.11a. First, while the throughputs are the roughly the same (54 Mbit/s), HiperLAN makes more efficient use of the spectrum and can transfer more data at any given time. In addition, HiperLAN offers quality of service support that is not possible with 802.11a. This makes HiperLAN a better choice for time-sensitive transmissions such and video, audio, and voice.

However, HiperLAN has not been very successful for several reasons. First, poor coordination, regulatory issues and lack of support have stunted its adoption in comparison to the success of the 802.11 family of products. And as the 802.11h Task Group works on revisions to 802.11 to make it more suitable for deployment in Europe, HiperLAN/2 is facing tough competition.

802.11g

802.11g is the latest WLAN standard, and has recently become available off the shelf. In fact, many vendors started offering products even before the standard was finalized. One of the advantages 802.11g has over 802.11a is its backwards compatibility with Wi-Fi. Both run in the same frequency band of 2.4 GHz. The advantage that 802.11g has however, is that, by using the same Orthogonal Frequency Division Multiplexing (OFDM) modulating technique, it enables speeds of up to 54 Mbit/s. 802.11g is the “up and coming” standard that is poised to become the next generation of Wi-Fi, particularly as equipment is closely priced to 802.11b devices, while providing five times the speed and backwards compatibility.

2.3.4 IMT-2000 / Third-generation mobile technologies

While today’s broadband solutions are based largely on fixed networks, mobile telephone networks may one day be the preferred broadband conduits for all our communication needs. But that day is still far in the future. International Mobile Telecommunications (IMT-2000—equally referred to as third-generation or 3G systems) are sometimes hyped as “broadband for mobile phones”. In reality though, this claim is still somewhat exaggerated: current 3G speeds are technically too slow and the technologies are only available in some countries.

IMT-2000 is an international standard (or rather a “family of standards”) that was harmonized at ITU to cover so-called 3G mobile systems. Work began on the standard in the mid-1980s, and the 1992 ITU World Radio Conference (WRC-92) identified the 2 GHz band for the global deployment of IMT-2000. Eight years later, WRC-2000 allocated additional spectrum for 3G services in three frequency bands: one below 1 GHz, another at 1.7 GHz (where many second-generation systems currently operate) and a third band in the 2.5 GHz range. Once the three bands were allocated, the worldwide mobile industry was able to start building out IMT-2000 networks.

Despite these concerted efforts at global standardization, the major industrialized economies were unable to agree on a single standard. The result was an IMT-2000 standard with a number of “flavours”, that is to say five possible radio interfaces based on three different access technologies (FDMA, TDMA and CDMA). Without going into any depth on these technologies here, thus far, the vast majority of industry attention has been directed towards the CDMA technology and in particular wideband CDMA (or “W-CDMA”—known in Europe as UMTS) and CDMA2000 (including CDMA2000 1x, which is widely deployed in Korea and Japan). Thus far, national licence allocation has been limited to these two radio technologies, though China may license a third technology, TD-SCDMA. [32]

Typically, 3G systems provide data rates at a minimum of 144 kbit/s for all radio environments and 2 Mbit/s in low-mobility and indoor environments, though these high speeds will not be available for some time in service offerings. Current 3G offerings offer very low data transfer at high prices. However, as the technology and speeds improve, we should expect to see the prices for 3G data access decrease.

While 3G and future generation mobile networks may be able to offer broadband speeds over mobile connections, the problems with the rollout of 3G around the world have put a damper on the early enthusiasm. In Europe in particular, companies overbid on spectrum for 3G licences, essentially leaving no new money to spend on building network infrastructure. This has slowed the introduction of 3G network rollout and will serve to push back the possibility of truly high-speed Internet connections over mobile phones.

2.3.5 Free space optic (FSO) technologies

As mentioned earlier, fibre optic technology greatly increases the amount of data that can be sent over a line by using infrared light waves rather than radio or electrical waves. The key component is the laser that can quickly turn on and off, signalling to a receiver at the end of the line. Free space optics (FSO) make use of this same laser technology but without wires.

FSO technologies send laser transmissions back and forth to communicate data over line-of-sight distances. The technology focuses a laser through a lens that transmits it into the air. On the receiving side, a lens captures the transmission and sends it on to be decoded. The laser technology allows very fast transmission speeds of up to 1.25 Gbit/s.

FSOs offer one method for solving the last mile problem in cases where there is line-of-sight connectivity. One benefit of FSO technology is that it does not require spectrum like other wireless technologies. It is also inexpensive to install and can be implemented very quickly. Box 2.3 gives an example of how FSOs and Wi-Fi have been used to bring broadband to Belfast, Ireland.

While FSOs do allow for quick set-up and inexpensive operation, they may be subject to several technical problems. First, as the lasers send data through the atmosphere, they are easily affected by atmospheric disturbances, in particular humidity—and especially fog, whose tiny water particles can distort transmission. Second, the lasers must be kept entirely static to ensure reception on the lens at the other end. Tall buildings that sway in the wind are therefore problematic. Other disturbances can include temporary interruption due to moving objects, such as birds flying through the beam. Another problem is scintillation caused by heated air, which can cause disruption to the signal.

Despite these minor drawbacks, FSOs serve a useful purpose as a niche broadband tool that is used for quick installation and deployment until such a time as fibre optic cable can be installed. Once fibre is in place, the equipment can be dismantled, moved, and reinstalled elsewhere.

Box 2.3: Free space optics in Belfast
Using wireless solutions to bring broadband to the city

Belfast has a sprawling wireless network over which free space optics and Wi-Fi are used to deliver broadband to homes, schools and small businesses. Free space optics form the backbone of the network, connecting Wi-Fi hotspots around the city that deliver the last 150 metres of the connection. In addition, given the poor terrestrial reception for television in some areas of the city, the high-bandwidth backbone network also serves to carry television programming.

The Flax Trust sponsored the network to bring growth in education and business in a disadvantaged area of the city. They found the costs of laying their own fibre or leasing lines was too expensive and instead opted for a combination of free space optics and Wi-Fi.

fSONA has provided the network that consists of 17 point-to-point free space optic links (see graphics below), which serve 23 Wi-Fi wireless access points throughout the city. When completed, the network will support 7'000 residential users along with schools and businesses in the area. Schools are connected to the network at 100 Mbit/s free of charge and businesses can subscribe to a 10 Mbit/s service for a monthly fee.

Initially, the free space lasers were met with public scepticism, as they resembled security cameras perched on top of buildings. However, as awareness grew about cheap Internet access, subscribers have been more than willing to sign up to the inexpensive and fast broadband service at US$ 18 (GBP 10.66) a month.

Source: fSONA at: http://www.fsona.com, Belfast Beacon Ltd. at: http://www.rosebank.com, the Flax Trust at: http://www.flaxtrust.com.

2.3.6 Mesh network technologies

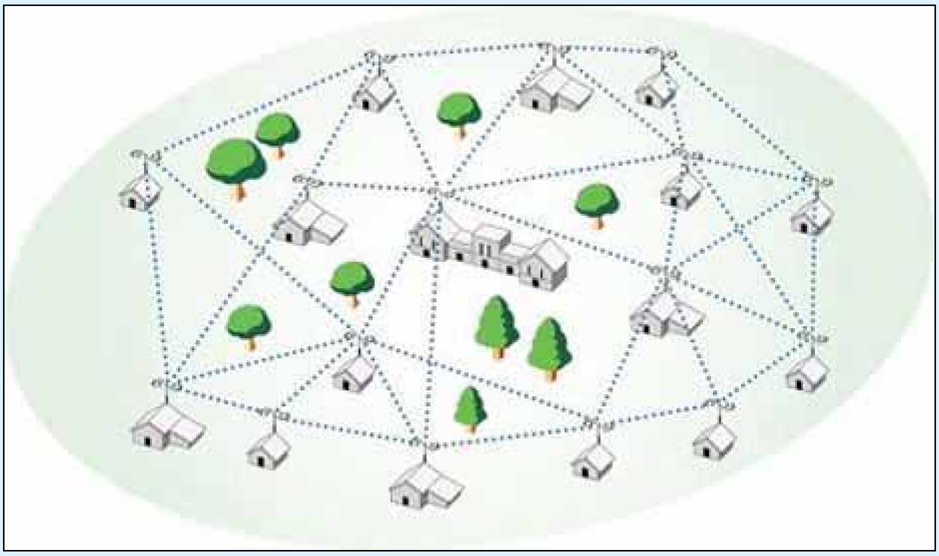
Current wireless technologies are based on either point-to-point or point-to-multipoint technology. However, a new wave of technologies, called "mesh networks", is emerging that will enable multipoint-to-multipoint networking. Mesh networks rely on each user also becoming a broadcaster in the network. Technically, each subscriber access point is also part of the routing infrastructure. As users are added to the network, the reach of the entire network expands (see Figure 2.7).

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. 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 outer areas of network reception.

Another benefit of mesh networks is 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 work around obstacles by essentially routing to bypass them.

Figure 2.7: Mesh networks

Each user on the network can use the broadband connection while forming part of the infrastructure that carries others' traffic too



Source: "Wireless Mesh Networks for Residential Broadband", Dave Beyer, Nokia. http://www.iec.org/events/2002/natlwireless_nov/featured/tf2_beyer.pdf.

2.4 Other broadband technologies

2.4.1 Power line communications

One of the most promising outlets for delivering broadband to homes is via the use of power line communication (PLC). Power lines form one of the most extensive networks in the world, surpassing the phone network in size and coverage (see Figure 2.8). Sending data over power lines can save the cost of building out a telecommunication infrastructure from scratch. Developed economies have been the first to make use of PLC, but they offer even more promising opportunities for developing economies.

For PLC, electrical signals act as a carrier for data transmission to and from end-users. Much like DSL, the data piggybacks on the network and is filtered out at the end points. For example, power is sent over the line at 50-60 Hz while data is sent via the 1 MHz range, thus avoiding interference.[33] These signals are sent over medium voltage wires, the lines running between substations, and local transformers.

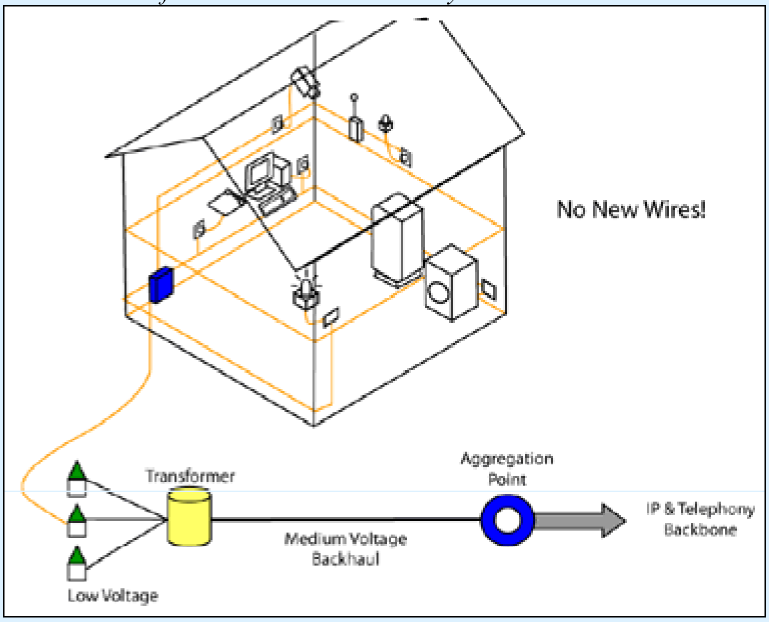
One of the problems with PLC is that it can be difficult to avoid data being lost as it passes through the transformers. In the past, cable bridges had to be built to "bridge" transformers by extracting and reinserting data from and into the line on either side of the transformer. This has made costs prohibitively high in North America, where each individual transformer serves just 5 to 10 households compared with over 150 in Europe.[34] Recently though, new technology has been developed that allows signals to make it directly through the transformer and is making PLC a viable option in many parts of the world.

However, PLC is not without other obstacles. First, there are problems with data signal disruption due to noise interference and attenuation over long distances. Second, PLC can interfere with radio, television, telephone, and DSL signals.[35]

Iceland has been one of the leaders in use of PLC to deliver high-speed access. Lina.net, a subsidiary of Reykjavík Power, connects power transformers to the fibre optic network in the country. Then, at the transformer, data is transferred onto electric lines to deliver them to homes.[36] India has also recently begun using PLC to deliver broadband in Assam, where power lines will be used to carry both broadband and telephony services.[37]

Figure 2.8: Power line communications

How power lines can be used to transfer both data and electricity



Source: Power Line Communications Association at: http://www.plca.net.

HAPS/LAPS

One idea that has been "floated around" in the technical world is that of using balloons and other low or high altitude platform stations (LAPS or HAPS) to provide fast, wireless Internet services over a large area. These systems are significantly less expensive than satellite systems and can be deployed quickly. Typically they either involve having a tethered balloon (similar to a weather balloon) hovering from 3 km, or an untethered stationary object at 21 km about the ground. The tether includes fibre optic cables that send information to and from the balloon, while untethered versions use radio signals to transmit data to the backbone network.

The United States Government has already been using balloons for some time for collecting data along its borders. Several companies around the world are working on developing HAPS/balloon technology. Skylinc has proposed deploying 18 tethered air balloons across the United Kingdom to supply ubiquitous coverage. The balloons would hover 1.5 kilometres in the air and supply access within an 80 kilometre footprint.[38] Other companies around the world, such as SkyStation, plan to use untethered balloons at very high altitudes to provide a much wider coverage area, but with lower power. A third company, SkyTower, has developed a pilotless, solar-powered aeroplane to hover over an area and provide broadband access from high altitudes. However, SkyTower's solar-powered plane crashed in June 2003 on a test flight, highlighting the difficultly of ensuring reliable wireless service through HAPS.[39]

LAPS and HAPS may offer an inexpensive alternative to satellite service, especially in underserved areas, but the technology is new and faces stiff competition in developed broadband markets. Indeed, the viable niche for LAPS and HAPS markets may turn out to be in areas not served by traditional wired and wireless connections. They may also prove popular in areas where there is community opposition to the erection of unsightly transmission masts.

2.5 Technology choices

As can be inferred from the wide range of different technologies described above, there is no one-size-fits-all solution for providing broadband connections—either now, or in the foreseeable future. As has already become clear in the world of tele- and info-communications, different economic, political, and geographical situations lend themselves to different types of network. Of all the different ways to deliver broadband to end-users, each has specific benefits and drawbacks.

Many developed economies, such as Japan, have made wiring the entire country with fibre optic cable an important part of national policy. Other countries, such as the United States, have taken a much more hands-off approach and let private companies, individual states and municipalities take on those types of infrastructure projects. Still other countries, such as the Republic of Korea, have put more emphasis on VDSL technologies rather than pushing fibre to every home. Mexico meanwhile, has focused on broadband community access centres to bridge the digital divide until access to individual households becomes economical. What is clear from these and other examples, is that broadband networks around the world will consist of many different technologies for some time.

As economies at different stages of development can use different technologies to spread broadband, it is helpful to look at which technologies are the most appropriate for different countries. On the basis of the major considerations looked at so far in this chapter, the following sections give a considered (albeit not comprehensive) summary of the best approaches to broadband in each of three categories of economy: low-, middle- and high-income.

2.5.1 Low-income economies

Many low-income economies face difficult challenges in building out telecommunication infrastructure. However, new wireless technologies provide the most promise to connect areas that have not previously had Internet, cable TV, or even phone connectivity. Fibre optic lines that form a large part of telecommunication networks in developed economies may be too expensive for developing economies, especially given other pressing needs. However, wireless solutions can be much less expensive to install and can provide connectivity to remote regions. Where economies develop and incomes rise, regions will eventually be able to support the installation of fibre and other faster fixed-line connections. Chapters six and seven of this report discuss particular challenges for developing countries in more detail.

Technologies such as WiMAX can be used to connect distant communities with a backbone Internet connection. Optimally, there will be a point in the community to "land" the wireless connection, such as a community access centre, school, hospital, or government office. From there, the Internet connection can be distributed locally to residents via technologies such as Wi-Fi. In addition to offering broadband, the signals can also carry voice traffic, helping to bring connectivity to even the most remote regions.

Ironically, the lack of current infrastructure in developing economies can also result in an advantage, in that any new networks can make use of the most current technologies. In a sense therefore, newly installed networks can leapfrog older copper network technology. As the costs of fibre optic cable and termination equipment approach the low cost of cable, developing economies would be well advised to install fibre connections wherever possible.

2.5.2 Middle-income economies

The network decisions facing many middle-income economies are different than those in least-developed economies. First, many middle-income economies already have substantial phone and/or cable networks that can be leveraged to provide broadband services. Even though urban areas in these economies may have fairly extensive networks, rural regions often fare much worse.

In urban areas, the existing networks can be upgraded for broadband. This temporarily saves the expense of building out a new network. Technologies such as ADSL g.lite and ADSL2 may help extend broadband connections further from central offices in areas where networks already exist. While the speeds may be slower than other ADSL technologies, their long-distance lines will allow more users to eventually connect to broadband. However, current copper networks should eventually be migrated to fibre as and when this is economically feasible.

Wireless technologies can be used in middle-income economies to bring access to underserved rural areas. In these areas demand for services can be pooled to justify establishing a long-distance wireless link. A WiMAX (or other fixed wireless) connection can then be extended among users in the community via DSL, cable, or wireless technologies. If rural areas are successful in pooling enough demand, they may also be able to attract fixed-line connections such as a fibre link to the community.

As with all other economies, for all-new network build-outs, fibre-optic connections should be given serious consideration owing to the ability they offer to provide the most bandwidth for prices that are comparable to copper cabling. These fibre networks can then form the backbone for wireless and other last-mile technologies further out from city centres.

2.5.3 High-income economies

Most high-income economies have very high telephone penetration rates, implying that most consumers in both rural and urban areas already have phone access. Extensive cable TV networks are also common among high-income economies, introducing inter-modal competition to broadband. One of the key elements of broadband deployment in high-income economies is the continual extension of fibre backbone technologies towards end-users. This can be in the form of fibre-to-the-neighbourhood or even fibre-to-the-building/fibre-to-the-home. Once the fibre connections are terminated close to users, other technologies such as VDSL and Ethernet LAN can efficiently maintain high speeds into residences by avoiding the difficulties of wiring internally with fibre.

The economics of fibre-to-the-home deployments have yet to evolve, but a case can surely be argued for fibre in the middle-mile. Many phone and cable networks already use fibre to carry connections between the central offices that serve their customers. As the fibre moves closer, the connection speeds increase and new broadband services can develop and flourish.

Surprisingly perhaps, even high-income countries have difficulties connecting rural areas with broadband. This is often due to distance limitations of DSL or the absence of cable networks. Wireless technologies (e.g. satellite and fixed wireless) are gaining popularity in rural areas as a temporary solution until fixed networks expand within reach. In some cases, communities themselves are building their own local networks and essentially moving closer to the large network. This is discussed in chapter three on supplying broadband.

2.6 Conclusion

Whatever stage of developmental stage of a country, enough broadband solutions exist to effectively serve most populations, whether by using individual copper, fibre, and wireless technologies, or a combination of different technologies. The key is to maximize adaptability: the higher costs of fibre infrastructure development may make fibre solutions more common in developed economies, while the low cost of wireless broadband may be more appropriate in developing economies. What is important, is that broadband technologies already exist that make it possible to bring broadband connectivity to all countries of the world.

A major consideration for policy- and decision-makers when choosing a technology, is that of “how much broadband is enough”, especially given the quandary between current economic constraints that are affecting most of the world’s markets, and the need to plan for future network needs. While fibre optic technology brings data at speeds up to 100 Mbit/s, there are very few, if any, applications that can currently make use of such high-speed connections even in developed economies. Policy-makers and broadband providers must find a delicate balance between utilizing existing networks to their fullest, while building out next-generation networks. For instance, VDSL offers up to 52 Mbit/s over short distances (300 m) and can use preinstalled copper wiring, possibly mitigating the need for fibre connections to each user.

While fibre optic technology can currently supply the highest bandwidth, policy-makers must consider whether broadband will eventually become mostly wireless, or whether fixed-line connections will continue to be the main access method in the future. Each technology is rapidly advancing and several technologies will continue to co-exist for some time, just as mobile and fixed-line phone networks do currently. It seems as if the type of technology used for broadband access will, in great part, depend on the types of applications and uses of broadband prevalent in a given economy—and it is for this reason that understanding the wider market, social and technological picture that is unique to each economy is essential. These issues are therefore discussed in the following chapters of this report.

[1] See ITU Recommendation ITU-T G992.1 at: http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-G.992.1.

[2] See ITU Recommendation ITU-T G992.2 at: http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-G.992.2.

[3] See ITU Recommendation ITU-T G992.5 at: http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-G.992.5.

[4] See ITU-T publication ITU-T G.991.2 at: http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-G.991.2.

[5] See ITU-T publication ITU-T G.995.1, "Overview of digital subscriber line (DSL) Recommendations" at: http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-G.995.1.

[6] See the DSL forum FAQ page on SHDSL for more information: http://www.dslforum.org/aboutdsl/shdsl_faq.html.

[7] See ITU Recommendations ITU-T G.992.3 and ITU-T 992.4 at: http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-G.992.3 and http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-G.992.4.

[8] See ADSL2 and ADSL2plus – The New ADSL Standards at: http://www.dslforum.org/aboutdsl/ADSL2_wp.pdf.

[9] See ITU Recommendation ITU-T G992.5 at: http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-G.992.5.

[10] See ITU Recommendation ITU-T G.993.1 at: http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-G.993.1.

[11] See ITU Recommendation J.112 at: http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-J.112.

[12] See ITU Recommendation J.122 at: http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-J.122.

[13] See http://www.cablelabs.com/news/pr/2002/02_pr_itu_docsis_2.0_121902.html for a summary of the two recommendations.

[14] Engineering and the Advancement of Human Welfare: 10 Outstanding Achievements 1964-1989 (1989), National Academy of Engineering (NAE), pg 38-39.

[15] See http://www.gigaport.nl/netwerk/access/doc/ftthc/en_h7.html for more information.

[16] See "Gigabit Ethernet Over Copper Deployment Guide" at: http://intel.com/network/connectivity/resources/doc_library/white_papers/solutions/copper_guide/gigabit_lan.htm.

[17] See "Fulfilling The Promise of MPLS: Ethernet Private Line Services Emerge as a First Killer App" at: http://www.convergedigest.com/Bandwidth/archive/010806GUEST-stephenvogelsgang1.htm for more information.

[18] 802.11b arrived before 802.11a but the letters refer to the order in which the different standards were proposed.

[19] ITU's Radiocommunication Sector (ITU-R) is responsible, *inter alia*, for coordinating global spectrum management, and holds the World Radiocommunication Conference (WRC) where ITU Member States negotiate radio spectrum management worldwide. More information can be found at: http://www.itu.int/itu-r.

[20] See http://networkcomputing.com/netdesign/bb2.html for more detailed information.

[21] See the WiMAX Forum at: http://wimaxforum.org/tech/tech.asp.

[22] The WiMAX forum has detailed information on 802.16 at: http://wimaxforum.org/tech/tech.asp.

[23] 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.

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

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

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

[27] See "Wi-Fi will be next dot.com crash" at: http://news.bbc.co.uk/2/hi/business/3006740.stm.

[28] For more information see See "Wi-Fi will be next dot.com crash" at: http://news.bbc.co.uk/2/hi/business/3006740.stm.

[29] More information is available from: http://www.itu.int/ITU-D/fg7/.

[30] The ITU publication, *Trends in Telecommunication Reform: Promoting Universal Access to ICTs – Practical Tools for Regulators* – 5th Edition, 2003, devotes an entire chapter to discussion of the use of wireless technologies to achieve universal access in rural areas of developing countries. Available at: http://www.itu.int/itudoc/gs/subscirc/itu-d/index.html. Further in formation is also available at: http://www.itu.int/ITU-D/treg/

[31] See: http://www.80211-planet.com/tutorials/article.php/1436331 for more information.

[32] These technologies and standards are explained in depth in the previous edition of the ITU Internet Reports and on the ITU Strategy and Policy Unit website. See: *ITU Internet Reports 2002: Internet for a Mobile Generation, ITU, 2002* at: http://www.itu.int/osg/spu/publications/sales/mobileinternet/index.html. For a description of IMT-2000 and third-generation (3G) technologies see the webpage at: http://www.itu.int/osg/spu/ni/3G/technology/index.html.

[33] See: http://www.ipcf.org/powerlineintro.html.

[34] See: http://www.plexeon.com/power.html for more information.

[35] See: http://www.lonestarbroadband.org/technology/powerlines.htm.

[36] See the ITU case study on promoting broadband in Iceland at: http://www.itu.int/broadband.

[37] See http://www.mainnet.co.il/pr_assam.htm for more information.

[38] See the SkyLinc web page at: http://www.skylinc.co.uk/main.html for more details.

[39] See "Record-setting solar airplane crashes" MSNBC, 26 June 2003 at: http://www.msnbc.com/news/931926.asp?cp1=1.

3 Chapter Three: Supplying Broadband

3.1 Broadband supply and demand

With broadband being increasingly regarded as a catalyst for economic success in the information economy, more and more economies are focused on ensuring that access to broadband is both available and affordable to their population. In most economies, the availability of affordable broadband access has been driven largely by the private sector—particularly where effective competition is present in the market—and supported by government intervention, especially where the market is perceived to have failed in achieving broadband public policy goals. Supplying broadband is therefore an issue for both the private sector, and for governments and regulators.

Broadband technologies may exist, but how do they translate in the world of supply and demand? Faced with the presence in the global marketplace of a wide range of current broadband technologies (described in Chapter two of this report), providers and governments need to address the question of how best to supply broadband in their particular economies. In this chapter, supplying broadband is broken down into three broad areas:

- A global picture is painted of broadband supply around the world in terms of penetration, access technologies and networks.
- Corporate strategies are described in terms of technology, infrastructure and pricing.
- The role of government intervention and strategies are examined, including the delicate area of interaction between the public and private sectors with regard to platforms, services and networks.

On the basis of these trends, it is possible to draw a number of conclusions that are valid in varying degrees to economies at different stages of development.

3.2 Current trends

As at year-end 2002, broadband services had been made commercially available in 81 out of over 200 economies worldwide (see Figure 3.1) Following the introduction of commercial broadband services, many economies have enjoyed a continued period of growth in broadband subscriber numbers, with the number of broadband users rising impressively during the past four years (see Figure 3.2, left chart).

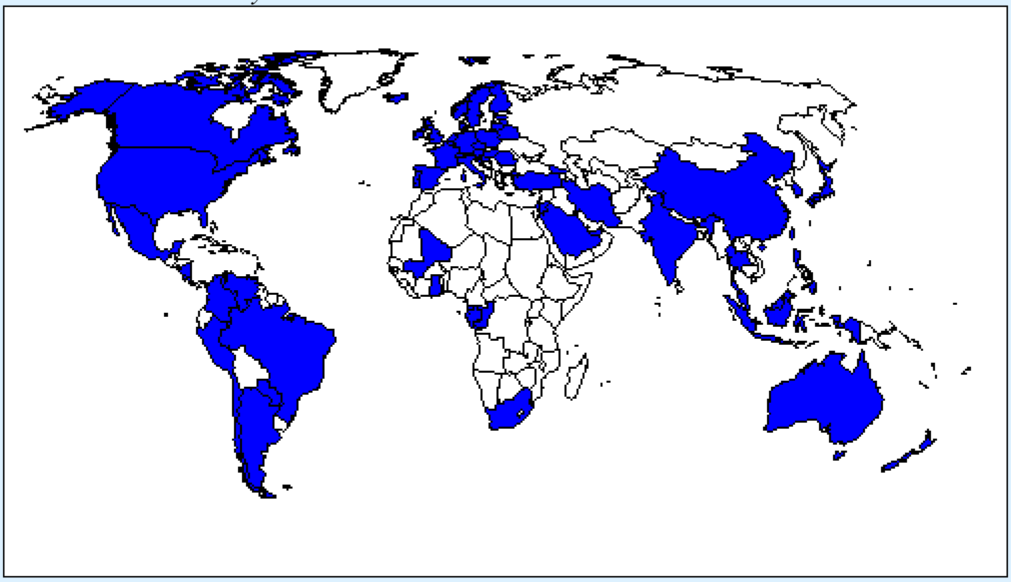
By mid-2002, it was estimated that operational broadband networks had a reach of well over 300 million households in the world's 20 largest economies, with more than 40 million households and businesses actually subscribed to broadband.[1] In certain markets, broadband is predicted to be one of the fastest-growing communications-based consumer services. For example, in the United States, broadband is likely to reach the 25 per cent penetration mark more quickly than either PCs or mobile telephones did (see Figure 3.2, right chart).[2]

3.2.1 Broadband availability

Despite the overall growth in broadband penetration, it is apparent that certain economies have enjoyed more success than others in advancing broadband adoption. Most economies are still struggling to realize nation-wide broadband access principally because broadband network deployment comes with high fixed costs. Although much of the technology is available to provide broadband access on a scale matching that of fixed-line telephony, for largely economic reasons, the availability of broadband has lagged behind—especially in developing economies, as well as in rural and remote areas worldwide. (The related issues of broadband access and the digital divide are discussed in Chapter seven of this report.)

Figure 3.1: Broadband worldwide

Shaded countries had commercially available broadband services at 31 December 2002



Note: Other countries may have experimental services, or other commercial services not yet reported to ITU.
Source: ITU World Telecommunication Indicators Database.

While the availability of broadband access is not the only determinant of broadband penetration levels, it certainly plays a key role: analysis shows that where there is extensive broadband network coverage, this has characteristically been accompanied by high broadband penetration levels (see Table 3.1).

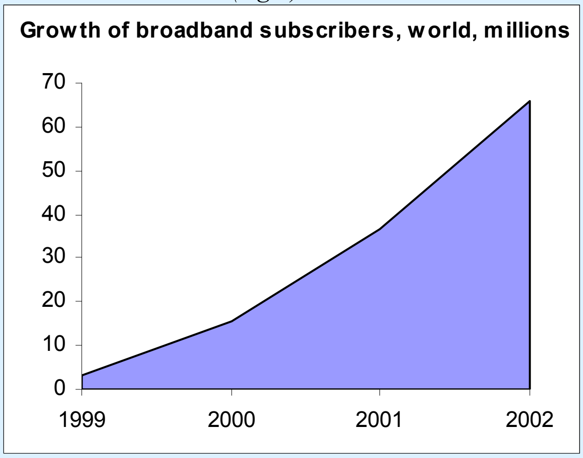
With satellite and wireless broadband solutions still in their relative infancy, most broadband users rely on fixed-line connections to access the Internet, mainly through DSL (using traditional fixed telephone lines) or cable modems (using cable television networks). Unfortunately, however, the construction of new broadband networks and the provisioning of existing telecommunication and cable TV networks for "last-mile" broadband access to the home constitute the most expensive and least profitable part of broadband infrastructure deployment.[3] Consequently, broadband networks have been rolled out primarily in areas where sufficient returns on investment are assured, particularly metropolitan areas in developed countries.

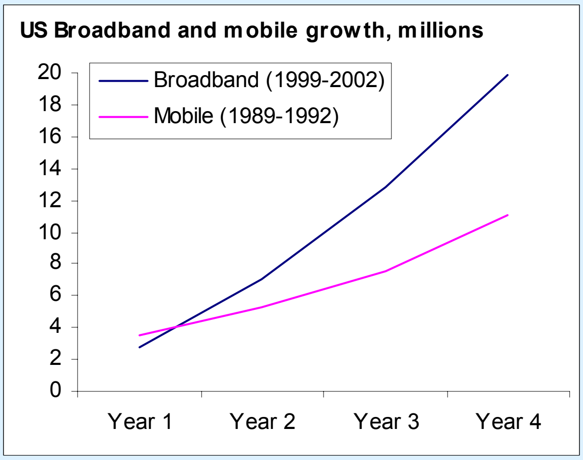
In general, countries with high levels of gross national income (GNI) per capita can be expected to have high broadband penetration levels (see Figure 3.3). Likewise, there is a strong correlation between urbanization and population density and the supply of broadband services. Given the lower cost of connecting users who live within a short distance of each other, broadband providers have found it easier to achieve a higher return on investment in urban areas, especially where a high percentage of potential users live in apartment blocks, where the short distances involved make provision even easier.

Table 3.2 shows the correlation between population density, the level of urbanization and broadband penetration among the most successful broadband economies worldwide. Generally speaking, economies with high levels of population density and urbanization have a greater chance of having high levels of broadband penetration. Some of the apparent discrepancies in this correlation can be explained by the fact that although some countries, like Canada and Iceland, have extremely low population densities (with 3 people per square kilometre, or 3/km^2) most of their population is concentrated in major urban centres. In Canada, more than 78 per cent of the population lives in cities and towns with more than 50 per cent living in the 10 largest urban centres. In Iceland, 92 per cent of the population lives in urban areas, with 62 per cent living in the capital, Reykjavik, alone.

Figure 3.2: Growth in broadband penetration worldwide

Worldwide broadband penetration growth has increased at compound annual growth rate (CAGR) of 155 per cent since 1999 (left). US broadband growth has far outstripped mobile growth for the four years after reaching 2.5 million subscribers (right).





Source: ITU World Telecommunication Indicators Database.

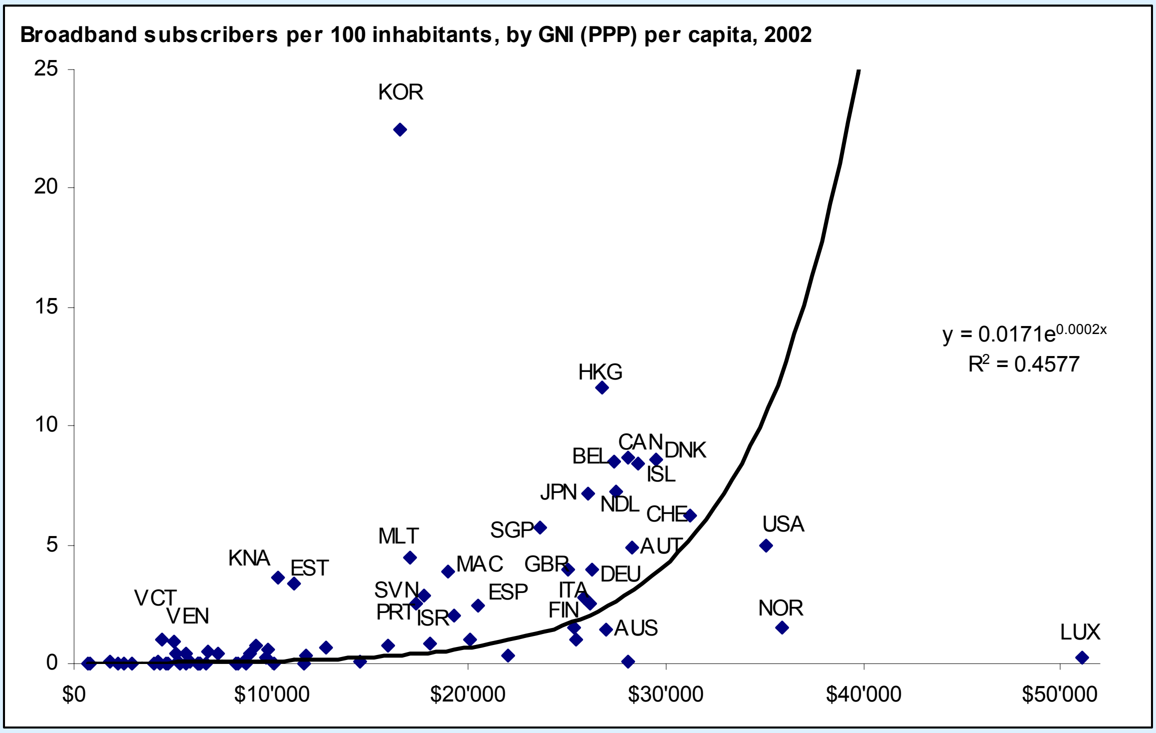
Table 3.1: Broadband penetration and DSL coverage

Top 20 economies by DSL penetration, 2002

Economy	Lines		Ratios	
	DSL	All fixed	DSL per 100 inhabitants	DSL per 100 fixed lines
Korea (Rep.)	6'386'646	23'257'000	13.42	27.46
Iceland	24'270	180'690	8.43	13.43
Hong Kong, China	559'000	3'842'943	8.25	15.35
Taiwan, China	1'820'000	13'099'416	8.10	13.89
Denmark	307'055	3'739'247	5.71	8.21
Japan	7'023'039	71'149'000	5.51	9.87
Belgium	518'919	5'132'427	5.02	10.11
Singapore	162'000	1'930'200	3.89	8.39
Macao, China	16'954	176'106	3.87	9.63
Germany	3'195'000	53'720'000	3.87	5.95
Canada	1'086'049	19'962'072	3.46	8.65
Malta	11'505	207'269	2.91	5.55
Sweden	241'000	6'441'000	2.69	3.74
Switzerland	195'220	5'335'000	2.68	3.66
Estonia	33'000	475'000	2.44	6.95
Netherlands	370'000	10'000'000	2.28	3.70
United States	6'471'716	190'000'000	2.15	3.41
France	1'277'000	33'928'746	2.14	3.76
Austria	151'600	3'988'000	1.86	4.50
Israel	120'000	3'100'000	1.81	3.87

Source: ITU World Telecommunication Indicators Database.

Figure 3.3: Broadband penetration and income (GNI)



Source: ITU World Telecommunication Indicators Database, World Bank.

Table 3.2: Demographics and broadband penetration, 2002

Economy	Broadband penetration (per 100 inhab)	Population density (per sq. km)	Population residing in urban areas (%)
Korea (Rep.)	21.28	484	81.9
Hong Kong, China	14.90	6'378	100.0
Canada	11.19	3	78.7
Taiwan, China	9.35	624	83.5
Denmark	8.60	125	85.1
Iceland	8.43	3	92.5
Belgium	8.41	338	97.3
Sweden	7.83	20	83.3
Netherlands	7.22	393	89.5
Japan	7.13	338	78.8
United States	6.89	31	77.2
Austria	6.61	97	67.3
Switzerland	6.32	176	67.4
Singapore	5.53	6'099	100.0
Malta	4.46	1'253	90.9
Germany	3.92	231	87.5
Macao, China	3.87	18'391	98.8
St. Kitts and Nevis	3.62	180	34.1
Estonia	3.37	30	69.4
Slovenia	2.84	99	49.2

Source: ITU World Telecommunication Indicators Database.

3.3 Corporate strategies

In general, the extent to which broadband services are supplied on a commercial basis rests largely on a company's ability to generate a sufficient return on investment. Companies have been known to resist the adoption of new services especially when they threaten to cannibalise the market share of an established product or when they threaten to make infrastructure investments obsolete. Conditions also eventually arise where it no longer makes sense to extend the service to new clients when the cost of adding new clients consistently outweighs the marginal revenue they add. In the case of broadband, the strengths and limitations of the last-mile technology employed to deliver broadband access plays a significant role in defining the extent and quality of commercial broadband supply in an economy. Companies would do well to maximize the long-term ratio of cost to the extent of access they can supply through strategic planning, and also to explore the possibilities of sharing infrastructure and participating in government initiatives, as will be discussed in the final section of this chapter.

3.3.1 From narrowband dial-up to broadband "always on"

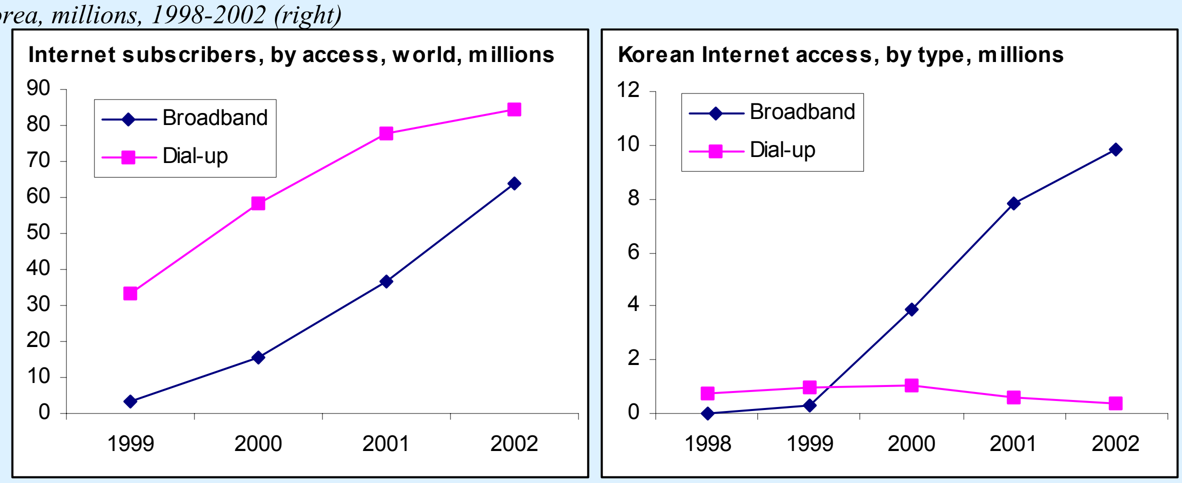
One area where there has been overlap in services, and thus some competitive tension, has been between traditional "dial-up" Internet access, where users plug a computer into their phone line via a modem, and broadband access, which is "always on".

Where broadband services have been introduced, in the initial period most markets saw a gradual slowdown in the growth of dial-up access subscriptions (see Figure 3.4, left chart). Furthermore, in economies where dial-up subscriptions had already reached saturation point, broadband services, in particular low-priced access plans, have gained market share at the expense of dial-up services (as shown by the example of the Republic of Korea in Figure 3.4, right chart).

Although now viewed as a positive sign, the inevitable migration of users from dial-up access to broadband access was initially the source of considerable concern among dial-up access providers. In some cases, ISPs and telecommunication companies with large dial-up customer bases resisted introducing broadband services themselves for fear of cannibalising their own customer base. This reticence typically only lasted until market share gains by cable modem providers ate considerably into their dial-up customer base.[4] In the absence of viable competition from cable modem providers, resistance to broadband lasted longer.

Figure 3.4: Dial-up and broadband

Dial-up and broadband subscribers worldwide, 1999-2002 (left), Dial-up and broadband access in the Republic of Korea, millions, 1998-2002 (right)



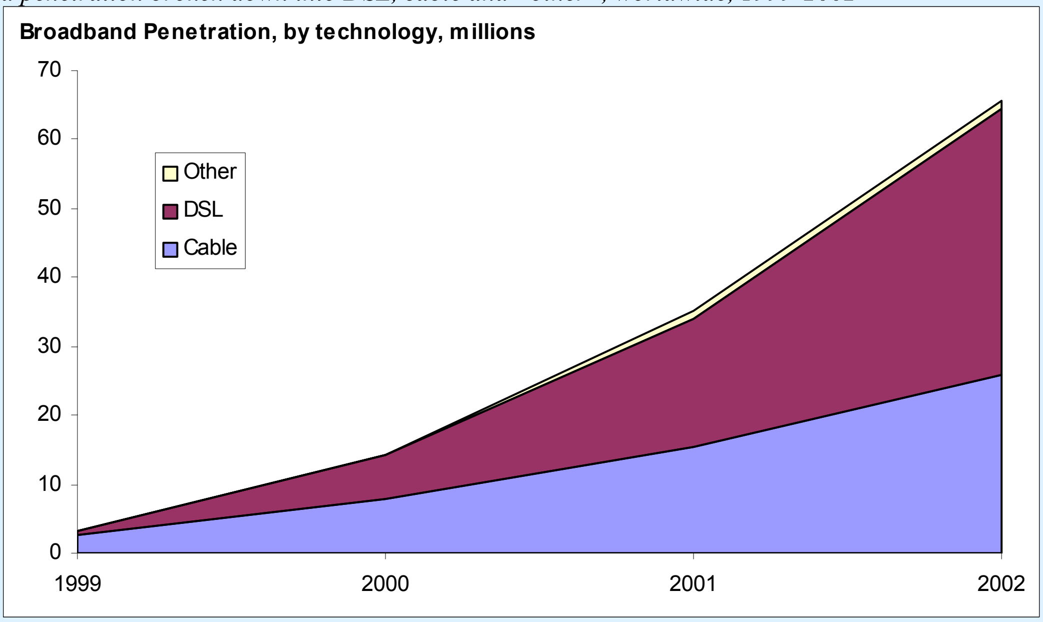
Source: ITU World Telecommunication Indicators Database.

3.3.2 Technology, infrastructure and access

In the current broadband environment, there are four main underlying broadband technologies for providers to choose from. These technologies currently define the scope of access to commercial broadband services. They are: DSL, cable, fibre-to-the-home (FTTH) and fixed wireless. (For a detailed explanation of these technologies and of the many subsidiary technological choices for service providers to make, see Chapter two of this report.) The worldwide evolution of DSL and cable modems, the most popular of these technologies, from 1999 to 2002 is shown in Figure 3.5. By contrast, other forms of access, including FTTH and fixed wireless, account for far fewer broadband connections.

Figure 3.5: Broadband penetration by technology

Broadband penetration broken down into DSL, cable and "other", worldwide, 1999-2002



Source: ITU World Telecommunication Indicators Database.

DSL over existing infrastructures

DSL services were first launched commercially in 1996. Since that period, DSL has become the most popular form of broadband access with nearly 32 million subscribers worldwide at the end of 2002. Favoured by telecommunication companies, it was a technology that was adopted to protect the value of the existing copper wire telephone infrastructure while offering connectivity at speeds higher than dial-up connections. This initial appeal of DSL for telecommunication companies was the higher return on investment. This was particularly because DSL leverages on the existing "plain old telephone service" (POTS) infrastructure and dispenses with the need to roll out new infrastructure.

As a technology, however, DSL suffers from a number of shortcomings that have a significant impact on its deployment and performance. For instance, due to signal attenuation, the maximum distance between the exchange and the user is relatively short, typically up to five kilometres for an asymmetric DSL (ADSL) service, with other forms of DSL service (e.g. SHDSL, and VDSL) having an even shorter distance capability. While shortening the wire distance by installing DSL nodes closer to the users is a solution, the high cost of network expansion in this way can only be justified where there is a large concentration of potential users. This again adds to the global tendency for high broadband penetration in urban, highly populated areas with existing wireline infrastructures.

Incumbent telecommunication companies have also had little incentive to rush to deploy symmetric higher-speed broadband services as the demand for higher speeds from individual or residential users is still relatively low. Those users who require higher speed broadband service are typically business users, and these tend to tolerate high access premiums, leaving the incumbent providers able to forgo the necessity of updating their services. For instance, premium services (such as "T1" at 1.5 Mbit/s and "T3" at 45 Mbit/s leased lines) provide high returns to telecommunication incumbents as they can be supplied to the business users at a high price without significant investment in new technology and infrastructure. Nevertheless, in many instances telecommunication incumbents have been forced to enter the business DSL market as new entrants have sparked off competition—often by using unbundled local loops to offer single pair high-speed (SHDSL) services.[5]

Cable modem technologies

The other major access technology for broadband is cable modem. Commercially launched at around the same time as DSL services, worldwide cable modem subscriptions initially took the lead. Currently, however, the popularity of cable modem services lags below that of DSL at 21 million subscribers worldwide (see Box 3.1).

Box 3.1: Cable vs. DSL—why is DSL overtaking cable?
DSL may be slow off the starting blocks but is overtaking cable in many parts of the world

Cable broadband networks are usually the first to offer broadband in markets where they exist. This is because they can offer fast access without eating away at their profits from cable TV subscribers. Telecom companies, on the other hand, already have a lucrative business with dial-up and leased line access to business and typically enter the market only after cable starts pulling away subscribers.

While cable starts out strong in many markets, DSL is taking the lead overall in terms of the number of subscribers it claims. This may be due, in part, to the prevalence of telephone networks around the world. The PSTN is well developed in many economies and serves as the base network for DSL connections. In addition, cable networks are usually tied to residential areas and bypass many of the more lucrative business customers who are signing up for DSL.

Another reason may be the effects of open access. While local loop unbundling (LLU) is common among telecommunication companies, it is relatively new for cable. This means easier access for competitors on the local loop and lower prices for consumers.

Source: ITU research.

Cable modem does have some of the same advantages as DSL, but is also hampered by significant drawbacks. Like DSL, cable modem technology has been designed to preserve the value of the existing coaxial cable network. Unlike DSL, however, there is little risk that an efficient cable broadband offering will cannibalise the existing business of cable companies. In that respect, cable modem providers have had the incentive to roll out broadband services earlier and to provide the maximum possible bandwidth. One of the main drawbacks of cable modem is that, during times of congestion, average speeds available to the user (who shares total capacity with other local users) are considerably reduced.

For cable networks to provide broadband service, costly two-way upgrades on cable networks have also to be performed. Although signal attenuation is not a major problem in the distribution of cable broadband services, not all areas served by cable television can be offered cable broadband services. Remote and rural locations may have a local cable loop but often satellite receivers that deliver television signals to the loop lack the capacity to provide sufficient two-way bandwidth for broadband services.

Fibre-to-the-home (FTTH)

As an access technology, fibre-to-the-home (FTTH) has far lower levels of deployment that DSL and cable. Together with fixed wireless and satellite, FTTH currently accounts for less than a 5 per cent share of broadband subscribers worldwide.[6] One of the reasons for this is the cost of laying new fibre, especially when using existing copper lines is a viable alternative.

Although the cost of fibre strands have dropped considerably over the past few years, the relatively high cost of laying new underground wireline infrastructure, together with the problem of acquiring rights of way, have hindered the widespread commercial deployment of FTTH in most economies. To make matters worse, telecommunication and cable companies seeking to protect their investment in the existing copper wire infrastructure lack the economic incentive to deploy FTTH networks. As a result, FTTH is usually only deployed where obstacles associated with earthworks and rights of way are not an issue. In Japan for example, FTTH has achieved widespread availability and relative affordability partly due to the ease with which optical fibre networks can be deployed over aerial cables supported by ubiquitous electrical poles (see Figure 3.6).

Figure 3.6: Fibre-to-the-home (FTTH) in Japan

FTTH reaches homes over aerial poles; and FTTH subscription prices, Japan, 2003

FTTH prices, Japan, 2003		
Service	USEN	NTT East
Speed	100 Mbit/s	100 Mbit/s
Installation	US$ 281.33	US$ 231.03
Monthly line	US$ 40.92	US$ 38.36
Monthly ISP	US$ 0.00	US$ 17.05
Equipment rental	US$ 7.67	US$ 9.38
Total per month	**US$ 48.59**	**US$ 64.79**

Note: Exchange rate of US$ 1 = JPY 117.3 (15 July, 2003).

Source: ITU case study on promoting promoting broadband in Japan at: http://www.itu.int/broadband.

Fixed wireless technologies

With the high cost of deploying wireline last-mile access in low-density areas, fixed wireless technologies have been gaining in popularity—particularly as a means of deploying broadband access in rural areas. Fixed wireless networks have proven to be relatively quick to deploy and offer a scalable solution for rural areas where the level of demand for broadband services varies widely and where customers are scattered over a wide area (see Box 3.2). However, despite cost savings in terms of wireline network construction, the

Box 3.2: Fixed wireless access in rural Canada

Affordable access at Saint Pierre-Jolys, Manitoba, Canada

In 2001, the tiny community of Saint Pierre-Jolys—a small Canadian town with a population of less than 900 inhabitants—sought to deploy a high-speed network in spite of prohibitive costs for fibre construction from the incumbent telecommunication carrier. Led by the inter-community Rat River Communications Co-operative, the community found a way to bridge the divide using broadband fixed wireless technology. Today the town and its partners operate their own wireless ISP.

The network model involved partners from Manitoba Hydro, a telecom provider spun off from a power utility, and Wicomm Inc., a unique middle-mile wireless carrier.

The cost of constructing the network proved to be extremely low. Through extensive bargaining with Hydro and Wicomm, the co-op paid a little over CAD 5’000 (US$ 3’150) toward construction of the fibre connection and the point-to-point wireless links. It currently pays about CAD 2’500 (US$ 1’575) a month for the Internet connection to Winnipeg, the provincial capital. It also paid a total of about CAD 20’000 (US$ 12’600) for equipment and installation for the local fixed-wireless distributions system. Funding to build additional towers was received from the Red River School Division, which provided CAD 40’000 (US$ 25’200) to build two radio-towers in neighbouring communities.

The service, initially targeting business customers only, has been functioning since late 2002. Businesses pay about CAD 950 (US$ 598.50) for hardware and installation and CAD 125 (US$ 78.75) a month for bandwidth burstable to 1 Mbit/s and 5 GB of downloads. A 1 Mbit/s residential service has recently been released at a starting price of CAD 50 (US$ 31.50) a month.

Source: ISP-Planet, Crossing the digital divide at: http://www.isp-planet.com/fixed_wireless/business/2003/st.pierre.html and Rat River Communications Co-op at: http://www.ratrivercomm.ca.

deployment of fixed wireless solutions to remote areas still remains difficult owing to the need for line-of-sight transmission (requiring construction of transmission towers) and the lack of backbone services to which to connect the towers. Often expensive satellite services must be relied upon for connection to the Internet backbone.

Some wireline broadband providers have also deployed fixed wireless solutions as a means to rapidly expand their network coverage in urban and peripheral areas. However, this strategy has proven to be commercially difficult to sustain—especially where the service competes alongside wireline DSL and cable modem services.[7] Despite the potential for lower prices of fixed wireless broadband, higher equipment costs have generally led to pricing that is similar, or not far below, those applied for DSL or cable modem services.

3.3.3 New players, new businesses

Given the limitations of the predominant forms of broadband and supply models, and the widening of the broadband user base to include more segments of the population, alternative approaches to broadband supply are beginning to flourish in certain contexts. These are spurred by advances in technology, growing dynamism and global competition in the communication marketplace as a whole, as well as by increased user demand—not overlooking the fact that consumers have become more technically savvy.

Customer-owned fibre networks

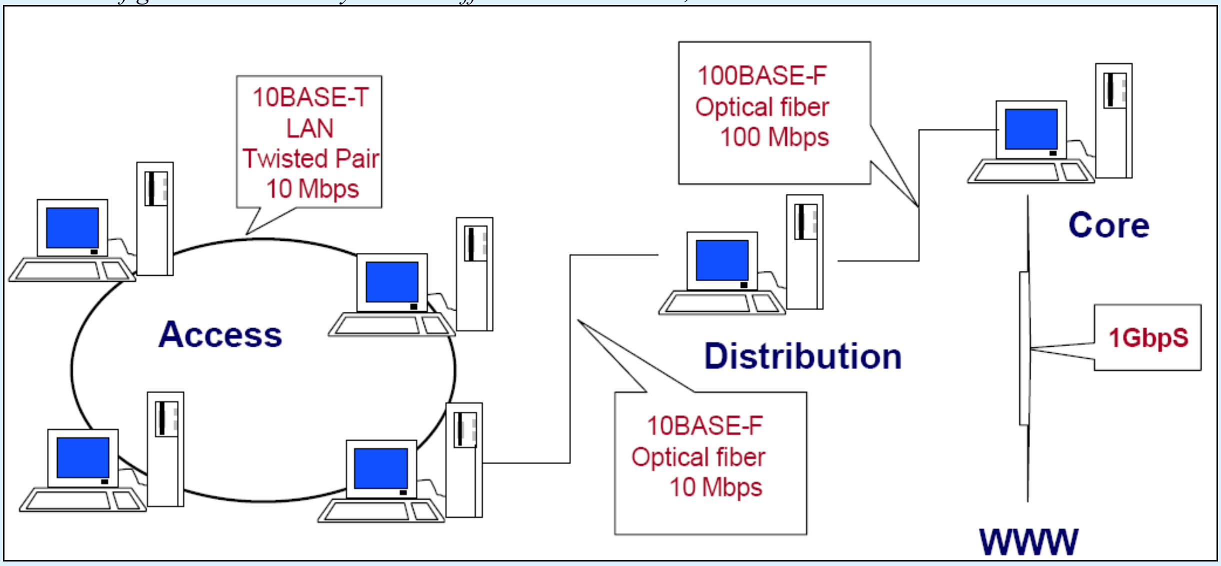
In one such turnaround in the broadband supply model, some users with particular needs have turned the available technologies to better suit their requirements. For instance, small-scale customer-owned fibre networks are becoming popular in some countries, even though FTTH deployment on a mass scale is still largely commercially unfeasible.[8] Typically, the reason for such initiatives—usually involving heavy users—has to do with the high costs associated with the purchase of premium high-speed services from established broadband providers. This self-provisioning approach capitalizes on the low marginal cost of installing additional fibre when establishing a fibre-optic network.

In particular, public institutions, such as schools and hospitals, have found it more economically feasible to initiate the construction and operation of their own broadband networks. In a sense, this inverts the traditional model of supply, with users building networks to providers, rather than providers building them to users. Under this model, a fibre consortium is established consisting of a group of customers who each own a predetermined number of dark-fibre strands within a fibre optic loop. Each customer is responsible for providing the electronics to light up its own fibre, effectively creating a number of private networks which can then be connected into the carrier backbone network. The customer owns and controls the actual dark fibre network and chooses the service provider they want for Internet connectivity. In practice of course, it is rarely the customer who actually rolls out the fibre: third-party professionals specializing in dark fibre systems take care of installation and maintenance on behalf of the customer. In Canada, for example, a significant number of customer-owned broadband networks have emerged. This model has been utilized in the Canadian province of Quebec, where 26 school boards and the regional university research network have entered into a “condominium arrangement” with a number of carriers (see Figure 3.7). The model is also gaining in popularity among businesses and communities eager to bypass the high charges associated with the purchase of commercial solutions.[9]

In order to achieve more cost savings through demand aggregation, customer-owned fibre networks usually involve more than one user investing in a network build-out. The biggest cost component of fibre networks is the installation cost, and the size of the cable is largely irrelevant: there is not much cost difference between a 12-fibre or a 864-fibre strand cable. The model therefore benefits from economies of scale: as more users invest in the network being built through the purchase of strands, the cost of owning an individual fibre strand falls dramatically. Often dubbed as “condominium fibre build”, this model allows multiple users to purchase individual fibre strands according to their needs. Each user decides what to do with their fibre strand while a third party operator charges the owners of the individual strands of fibre a small annual maintenance fee covering maintenance and right of way.

Figure 3.7: Diagram of a customer-commissioned fibre optic network

Network configuration selected by the Des Affluent School Board, Canada



Source: IMS Consulting and the Des Affluent School Board, Canada.

Broadband over unlicensed spectrum

Wi-Fi, or the 802.11 family of standards, have emerged as the most popular standard for wireless LAN solutions using the 2.4 GHz unlicensed potion of the radio spectrum. In general, the commercial deployment of Wi-Fi services is subject to different considerations than commercial broadband services using licensed radio spectrum, such as fixed-wireless.[10] Constrained by its limited range on the one hand but benefiting from greater affordability and scalability on the other, providers have come up with a variety of business models exploiting unlicensed portions of radio spectrum. Currently, there are two popular ways of distributing Wi-Fi access.[11] The first of these is the "top-down model", which has been adopted by large network providers who charge a fee for broadband access at public locations, called "hotspots", in such places as airports and train stations. These hotspots enable users to gain Internet access without having to plug in their laptops or PDAs. The second is the "bottom-up" model, where wireless access is provided free of cost by enthusiasts. Both of these models have disadvantages however. The former suffers from market fragmentation, with different hotspots served by different providers, meaning that the user has to open multiple accounts to gain Internet access each time they use a different location. The latter suffers from a lack of economic sustainability (no profit is made) and the risk of customer abuse. Recently however, hybrid business models combining the two have emerged, giving users the advantage of a single wireless access account, coupled with a financial incentive for providers to join such a scheme. An example of this is the approach taken by a United States-based Wi-Fi start-up, Boingo Wireless, that acts as an aggregator, allowing users to access Wi-Fi hotspots deployed by all existing providers with a single account.[12]

The greatest impact of Wi-Fi, however, has been felt in the area of broadband access deployment in developing countries. Low equipment costs, ease of installation and scalability have allowed broadband access to be deployed rapidly in unserved areas (see Box 3.3).

Box 3.3: Wi-Fi and the road to reconstruction
From rags to routers in Kosovo

Internet Projekti Kosova (IPKO) was launched in Kosovo in the weeks after the war as a project of the International Rescue Committee (IRC). It was started with a US$ 175'000 loan from the IRC and a donated satellite dish. The team installed a 3.8mm satellite dish and an 802.11b wireless network in Prishtina. IPKO sold service to every UN agency, NATO, international NGOs, Internet cafes and businesses while providing free connectivity to schools, hospitals, the university and local NGOs.

After six months, IPKO was incorporated as a local NGO. After a year of operation, IPKO launched the IPKO Institute of Technology, a not-for-profit technology-training institute in Prishinta that now provides CISCO, Microsoft and other training courses to more than 200 students at a time. The IPKO Institute now provides broadband connectivity grants to public institutions and local NGOs under its Internet Connectivity Grant Programme that is funded by its partnership with IPKONet.

In June 2001, the Internet service provider business was spun off as a for-profit subsidiary, IPKONet, owned by the IPKO Institute and its employees. IPKONet now has a nation-wide 155 MB wireless backbone, a wireless link across Albania to the fibre optic backbone in the Adriatic Sea, Wi-Fi networks in the main cities of Kosovo, and national dial-up access. It is now the leading Internet provider and one of the largest businesses in Kosovo.

Source: IPKO Institute at http://www.ipko.org.

Broadband over existing infrastructures

In a number of economies, companies supplying public utilities, in particular power companies, have started to make use of their existing infrastructure to transport broadband traffic to businesses and residences. They typically have good customer penetration, a robust communication infrastructure and an incentive to respond to current customer needs. As an example, electricity utilities have internal needs for data communications within their power networks. These companies often have extensive networks of fibre-optic cables within the power grid to enable communications between electrical sub-stations. Once fibre is installed in the power grid, the excess capacity can be used to accommodate other rural users in the service area. Most of the cost of laying the fibre can be justified through savings achieved from more efficient electricity distribution. As a result, the incremental cost of opening up the network for broadband communications can be minimized.[13]

Using a range of transmission mediums such as fibre, fixed wireless access and new technologies, such as power line communication (PLC) and others (highlighted previously in Chapter two), power companies have entered the broadband access market in a number of countries such as Iceland and Japan by leveraging the existing telecommunication infrastructure between their installations. For example, the Reykjavik Power Company (OR) has established a data transmission network over its power grid that connects its power transformer stations around the capital. Supplemented by fibre and fixed-wireless access, the company currently offers broadband solutions to corporate customers.[14]

The power network, however, is not the only public infrastructure network to be leveraged on to expand broadband access. In developing economies in particular, alternative networks to power or telephone lines can be a bonus for long-haul broadband supply. India provides an example of the ingenious use of its vast railway network to extend broadband access to its rural areas (see Box 3.4). These examples illustrate the vast range of possible approaches to supplying broadband, particularly when fixed and wireless technologies can be combined to resolve long- and short-distance, rural and urban broadband infrastructure problems.

3.3.4 Affordable access

As consumer surveys, and statistical analysis have consistently shown, a decisive factor affecting broadband take-up is the price charged to the user.[15] As a whole, the trend towards service diversification represents a general shift towards a more user-oriented focus, often including a drop in prices. The positive message is that, since they were introduced commercially, broadband services have become more affordable to the end-user.

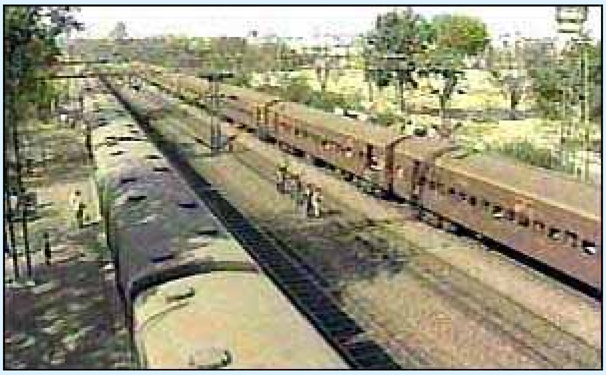
Box 3.4: Railway lines lead to broadband access in rural India

Using excess capacity on existing signalling cable in India's vast rail network to supply broadband

In 1994, India's attempt to introduce fixed-line competition proved unsuccessful once winning bidders realized that their bids were too high for them to be able to make a profit subsequently. As a result, India has looked for other innovate methods to expand access. One such approach has been to allow winning bidders for fixed-line services to convert their licences to wireless local loop (WLL) licences in a bid to expand the network.

Perhaps the most intriguing innovation has been the use of the railway network to provide Internet access. India has one of the world's most widespread and dense rail networks with 8'000 train stations nationwide and an average distance of only eight kilometres between stations. India has found an innovative way of using this rail network to bring broadband access cheaply and quickly to its rural population.

In a plan launched in 2000, the Railroad Internet project aims to make use of roughly 65'000 kilometres of underused cable infrastructure already in place. This signalling cable (which is usually copper based, although fibre is used on several main routes) runs along the train tracks and has large amounts of spare capacity. It will be used to transmit Internet traffic to outlying areas, avoiding the time and cost of laying a new cable network.



Indian railways	
Track kilometres	108'706
Route kilometres	63'028
Electrified route kilometres	14'856
Number of stations	6'853
Average distance between stations, kilometres	8
Bandwidth capacity of cables, Mbit/s	1

Under the project, it is envisioned to set up special cybercafé kiosks (providing community Internet access as well as ticket retailing and train information) at each train station with half a dozen computers networked together and linked up to the railway cable. The speed of the connections would vary according to the quality of cable segments. The railway system would link up to the standard telephone network through high-speed digital links at major towns. In addition, there is the possibility of providing wireless Internet access within a 10 km radius of each station.

The project is being piloted in a small area first: along 40 km of railway track linking the southern towns of Vijaywada and Guntur. This initial phase of the project has been launched through cooperation between Indian Railways (State owned) and private investors (largely comprised of Internet service providers). There are concerns however, that the wide scale rollout of the project will be delayed by regulatory issues regarding telecommunication supply, an unsure electrical supply, and the vast bureaucratic structure of Indian Railways.

Sources: Indian Railways (2001), http://www.indianrailways.com; BBC (2000). Fast track for Indian Internet, http://news.bbc.co.uk/1/hi/world/south_asia/769635.stm, and Crampton, T. (2000), Rail Network to Bring India Up to Web Speed, http://www.whosea.org/isma/railnet.htm.

Nevertheless, broadband subscriptions worldwide lie within a range that doesn't always reflect average incomes in individual economies. Affordability is, therefore, relative. As Table 3.3 shows, in the fifty *cheapest* broadband economies, monthly subscription as a percentage of monthly income can range from just over 1 per cent (Japan) to over 20 per cent (Costa Rica, Saudi Arabia), and the price per 100 kbit/s as a percentage of monthly income can range from 0.01 per cent (Japan) to over 12 per cent (Saudi Arabia). These remain the most affordable broadband supplies, with offerings in other economies truly stretching affordability and limiting growth of the broadband market.

Table 3.3: Broadband costs may be equal, but incomes are not

Lowest broadband price offering as a percentage of monthly income, fifty cheapest countries, 2003

Country	Subscription/month (US$)	Price per 100 kbit/s (US$)	Subscription as % monthly income	100 kbit/s as % monthly income
Japan	$24.19	$0.09	0.87%	< 0.01%
Korea (Rep.)	$49.23	$0.25	5.95%	0.03%
Belgium	$34.41	$1.15	1.78%	0.06%
Hong Kong, China	$38.21	$1.27	1.85%	0.06%
Singapore	$52.99	$3.53	1.81%	0.12%
United States	$33.18	$2.21	1.92%	0.13%
Canada	$51.55	$3.36	2.58%	0.17%
Netherlands	$32.48	$3.25	1.75%	0.17%
Macao, China	$46.16	$6.56	1.46%	0.21%
New Zealand	$38.34	$2.56	3.20%	0.21%
Germany	$33.93	$4.42	1.80%	0.23%
Norway	$40.61	$2.71	3.55%	0.24%
Israel	$45.20	$5.89	2.32%	0.30%
Austria	$32.59	$6.37	1.55%	0.30%
Slovenia	$57.84	$11.30	1.83%	0.36%
Italy	$73.59	$6.13	4.66%	0.39%
United Kingdom	$44.56	$8.91	2.15%	0.43%
Luxembourg	$79.54	$3.88	9.73%	0.48%
Sweden	$51.46	$10.05	2.81%	0.55%
Switzerland	$51.82	$20.24	2.05%	0.80%
Australia	$91.77	$17.92	2.84%	0.55%
France	$50.56	$9.87	3.07%	0.60%
Ireland	$61.69	$12.05	3.10%	0.61%
Portugal	$73.66	$14.39	3.16%	0.62%
Cyprus	$39.64	$7.74	4.39%	0.86%
Iceland	$58.03	$9.07	5.65%	0.88%
Lithuania	$57.36	$22.41	2.93%	1.14%
Malta	$53.34	$10.42	6.96%	1.36%
Jordan	$49.72	$4.86	14.59%	1.42%
Denmark	$47.63	$18.61	3.96%	1.55%
China	$12.80	$5.00	4.20%	1.64%
Croatia	$14.06	$2.75	9.59%	1.87%
Estonia	$30.10	$7.84	7.79%	2.03%
Venezuela	$2.78	$0.54	11.51%	2.25%
Hungary	$42.95	$11.18	9.76%	2.54%
Finland	$29.21	$7.61	9.90%	2.58%
Spain	$24.26	$9.48	7.05%	2.75%
Malaysia	$22.44	$8.77	9.45%	3.69%
Argentina	$76.15	$14.87	20.00%	3.91%
Brazil	$35.50	$13.87	10.00%	3.91%
New Caledonia	$15.71	$3.07	20.05%	3.92%
Poland	$68.90	$13.46	20.36%	3.98%
Chile	$106.10	$41.44	11.44%	4.47%
Bahrain	$57.46	$22.44	11.67%	4.56%
Mexico	$68.97	$3.37	98.53%	4.81%
Latvia	$85.13	$16.63	26.53%	5.18%
Costa Rica	$129.00	$16.80	54.89%	7.15%
Peru	$88.17	$17.22	40.69%	7.95%
Grenada	$171.64	$67.05	21.12%	8.25%
Saudi Arabia	$80.00	$31.25	23.41%	9.15%

Source: ITU Research.

Although increased competition and technological advances have contributed largely to the general fall in prices, greater marketing sophistication has also led to a wider diversification of access plans by many providers. This has resulted, in many cases, in the introduction of a low-priced entry-level broadband service. Bandwidth tiered pricing and volume-based pricing, in particular, are two popular pricing strategies that have departed from the single flat-rate price strategy that was initially practiced by most providers.

Pricing strategies

An increasing number of broadband providers have introduced bandwidth tiered pricing which involves a range of pricing plans at different connection speeds and corresponding prices. Instead of a single flat-rate broadband service, a provider can offer a cheaper service offering a slower connection speed while maintaining a higher priced service that offers a faster connection speed. While price differentiation gives users greater choice, it also allows a provider to offer a lower entry point for light bandwidth users without cutting into its higher bandwidth user subscription base. For example, a user who makes use of his or her broadband connection for online chatting and e-mail may not value a high-speed connection as much as a user who uses the connection for video-conferencing. Nevertheless, they would still be enticed to migrate from dial-up to broadband to take advantage of an always-on connection if the service is priced sufficiently close to dial-up prices.

A number of providers have also started to introduce volume-based pricing on some broadband price plans. These have typically been introduced in the form of a download limit with additional charges for exceeding this limit. These limitations have been largely introduced in order to meet the cost of bandwidth to the provider—typically international Internet connectivity—as well as to allow the introduction of lower-price offerings (see the example of Australia in Box 3.5). It should not be forgotten that, for many users, broadband access merely remains a more convenient way to access narrowband applications such as web browsing or e-mailing. Flat-rate charging, unless offered at very low prices, would serve to exclude many light users.

Box 3.5: Australia: paying for broadband byte by byte
International Internet connectivity and volume based charging for broadband services

Since 2001—largely in an effort to ensure that broadband access revenues were proportionate to costs—Australian providers have implemented virtually industry wide broadband download limits. In the preceding period when dial-up was prevalent the discrepancy between heavy users and light users was insignificant, however, with broadband speeds and always on connections, this discrepancy has increased, leading to costs far outstripping revenue in the case of heavy users.

To a large extent, Australia's practice of volume based charging for data has its roots largely in the high cost of international Internet connectivity with international bandwidth costs amounting to more than half the cost of providing broadband access. While North American based ISPs have long been blamed for the high cost of connection to the US Internet backbone, Internet usage patterns in Australia have exacerbated this situation, with around 70 per cent of data downloaded in Australia originating from overseas.

Although the cost of international Internet connectivity has fallen worldwide with more fibre being lit, Australian providers have nevertheless maintained volume-based charging for broadband services based on its commercial profitability.

Source: Australian IT, Broadband bytes users, 19 November 2002 at: http://australianit.news.com.au/articles/0,7204,5512001%5e15388%5e%5enbv%5e,00.html.

Nevertheless, considerable criticism has been levelled at these emerging broadband-pricing strategies. When broadband services were first introduced, broadband providers largely marketed broadband access as a way to enjoy bandwidth-hungry applications and content such as streaming video and audio. Coupled with flat-rate pricing for broadband, this has created usage patterns and customer expectations linked to bandwidth-hungry uses. With low-priced, low-bandwidth services, new users may not receive the full benefits of broadband they were initially led to expect. Furthermore, low bandwidth and download limitations may also restrict usage patterns and demand, discouraging the future development of applications and content that are optimized for high-speed delivery.

With the gradual fall in broadband pricing and increasingly tight margins on access services, broadband providers are gradually shifting their business models towards other value-added elements, rather than concentrating on transport and access. On the basis of an established billing relationship with the user, broadband access providers are increasingly looking towards providing a whole suite of communication and entertainment services to their customers over on their broadband connections. The emergence of a new value chain with new businesses and partnerships is more fully discussed in Chapter four of this report.

3.4 The role of government

While the active participation of the private sector is essential to ensuring effective and viable broadband supply, in the most successful broadband economies, governments have also played a direct role in expanding and accelerating network development through direct spending. To drive broadband supply, governments have resorted to a range of strategies that include, *inter alia*, government incentives and the construction of public-owned networks.

Government incentives

In situations where the return on investment is insufficient to attract private sector investment in deploying broadband infrastructure, some governments have stepped in to offer incentives aimed at increasing the value proposition of network deployment.

In general, direct government subsidies typically take two forms: subsidies for consumer usage and investment subsidies, often for network construction in areas that are not yet served by broadband. Usage subsidies are often granted on the basis of introductory or one-time offer, with governments hoping that once users become accustomed to broadband connections they will continue to subscribe after the subsidy ends.

Meanwhile, some governments have provided direct subsidies for the construction of broadband networks. The Government of the Republic of Korea, for example, has provided direct subsidies of more than US$ 1 billion for the construction of a national broadband backbone although the local broadband access network itself was constructed and funded by the private sector.[16] On a more modest scale, direct subsidies for network construction are commonly offered on a community or municipal level. In some unserved communities in Canada, broadband network deployment has been undertaken on the basis of matching funds by municipal or state governments, subject to rigorous requirements that indicate eventual long-term self-sustainability.[17]

Indirect government subsidies, most often in the form of tax credits and low interest loans, are another common form of government assistance—in this case directly to the private sector—for broadband network construction. The Japanese Government, for example, has put in place a number of programmes ranging from tax credits to no or low-interest loans to give broadband operators incentives to invest in broadband infrastructure (see Box 3.6).

Government incentives, however, are not confined to financial assistance alone. Often, a government can act as a catalyst to private sector broadband network deployment by guaranteeing to act as an “anchor” tenant for broadband networks deployed by the private sector. Government institutions such as schools, hospitals and community centres can provide an assured customer base for broadband services. This effectively provides a guarantee to private sector providers, creating an incentive for to enter unserved markets. For example, the North Carolina Information Highway (NCIH) in the United States is a state-wide, broadband network serving businesses, government, and educational institutions. [18] Although it is privately owned, the state government and educational institutions act as anchor tenants until the network has achieved a critical mass. This will in turn increase its affordability, and make it possible for many other major institutions in North Carolina to connect to the NCIH. As can be seen, the benefits of this approach are mutual, but the government role is essential to broker such public-private agreements. Furthermore, the approach is not watertight: sometimes the incentives don’t outweigh the cost to private companies.

Box 3.6: Japan's comprehensive support for the private sector

The Government of Japan offers support for the private sector under three broad categories: financing systems, tax benefit incentives, and guarantees of liability. Each is discussed in more detail below.

1. Financing systems

- No/low-interest financing by the Development Bank of Japan (DBJ); no/low-interest financing by the DBJ for operators introducing broadband access networks; no interest for public corporations, low interest for private corporations).
- Ultra low-interest financing by the DBJ and Telecommunication Advancement Organisation (TAO). TAO gives interest-based assistance for private corporations with low interest financing from the DBJ.

2. Tax benefit incentives

- Special redemption for corporate tax; Operators introducing broadband access networks can apply for a special 6-18 per cent redemption on corporate tax.
- Decrease of the tax standard for fixed assets tax; Operators introducing broadband access networks can decrease the tax standard for fixed assets tax by 20-25 per cent.

3. Guarantee of liabilities

- TAO guarantees the debt liabilities of operators introducing broadband access networks.

To receive support, applicants are required to obtain authorization of deployment plans from the Japanese Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT) in line with the Provisional Measures Law for Telecommunications Infrastructure Improvement.

Source: MPHPT, "Outline of the Telecommunication Business in Japan", October 2002.

3.4.1 Public-owned networks

In certain areas, notably rural and outlying ones, there is often insufficient private sector investment interest despite the offer of government incentives. Where such a strategy fails, full public funding for the deployment, ownership and operation of a broadband network is often the only recourse—especially where governments, notably at the local and municipal level, have regarded broadband infrastructure as an essential public utility and its rollout as a public sector responsibility.

Most governments have nevertheless remained on their back foot in their level of market participation, deploying and operating broadband networks only where the private sector has shown itself to be unable or unwilling to do so. Again, it is through government initiative that successful partnerships can actually come to fruition. For example, launched by the state government of Alberta in Canada, the Alberta SuperNet project is an initiative that combines commercial ownership and public ownership of a statewide broadband network connecting 422 communities. The project is divided into two portions: a "base area network", covering 27 larger communities, and an "extended area network", covering 395 smaller outlying communities. The first of these is owned and operated by Bell West, a provider that has undertaken to spend CAD 102 (US$ 64.3) million on the build-out and is contractually obligated to act as a provider of last resort to residents of any rural community in which no high-speed provider emerges in the base rate area. The second, the extended area network is owned by the government of Alberta, which invested CAD 193 (US$ 121.6) million in its deployment. It offers lit-fibre to ISPs.[19]

Although a number of other public-owned networks emulate the Alberta SuperNet model in providing lit fibre to ISPs, public-owned networks tend to avoid moving into higher-layer offerings, offering instead dark fibre. When taking a decision of this nature, a public-owned network provider typically examines market size and the type of likely market entrants to determine how elaborate its offering must be to function effectively. In particular, it considers whether what it offers will contribute to lowering barriers to market entry. In one successful example in Sweden, Stokab, a company owned jointly by the City of Stockholm and the County Council, operates its network as a wholesaler, offering dark fibre to ISPs that provide broadband services to business and residential customers in the city (see Box 3.7).

Box 3.7: Telecommunication infrastructure as a "public good"
Supplying dark fibre to the city of Stockholm

In 1994, the city of Stockholm chartered a company called Stokab to lay a public owned fibre optic network throughout the city to provide dark fibre to telecommunication operators and other users at cost-based rates. The fibre-optic ring is an open access network, enabling all carriage service providers to use the network for the delivery of their services. Based on the theory that telecoms infrastructure can be separated from telecom services, this model focuses on supplying dark fibre to other carriers and resellers, who terminate and light their own fibre and supply all services above the fibre layer. Stokab is not involved in customer premises wiring and all operators accessing the network can customise their own fibre structure in order to reach a specific customer. Operators light their own fibre, and provide all service layers above that.

Under Swedish law, a municipality-owned company must be run for the benefit of the citizens at large and not to make a profit. So Stokab does not compete with private business. Instead, it rents out "dark fibre", to anyone requesting it and then leaves it to the market to offer telecom services. The idea of Stokab acting as a carrier and service provider was abandoned in 1994 for a number of reasons. Firstly, there was a realization that Stokab's expertise lay in the area of infrastructure and government should not be involved in the service delivery level. Secondly, Stokab's focus on dark fibre promoted trust, keeping Stokab from competing against its customers. Finally, given that the city wanted to establish a competitive market, and several commercial operators had expressed interest in the Stockholm market, a competitive approach at the service delivery level was essential.

Another key advantage of the Stokab model is its direct access to city-owned ducts and tunnels. Stokab blew fibre optic cable in the subways and alongside steam pipes, water pipes, electric cables and sewer lines. Through its close links to the city, Stokab encountered minimal red tape from municipal agencies and acquired city permits with ease.

The Stokab fibre-optic network began service in the commercial districts of central Stockholm and the large industrial areas around the city. By 1999, the network covered most of the central city connecting public schools, libraries, district administrations and industrial and business centres in the Stockholm area. Currently there are more than 3 000 kilometres of fibre-optic cable with a total of 450 000 kilometres of fibre. More importantly the Stokab model is spreading outside of the metro area. It now covers all the municipality centres in the surrounding county covering over 6'500 square kilometres and includes even some of the larger islands in the rural archipelago surrounding the city.

Source: AB Stokab at: http://www.stokab.se.

In some economies, governments have deployed broadband networks for the exclusive use of public sector applications such as intra-governmental traffic, public access points, libraries, telemedicine, distance education, and other public sector uses. Functioning essentially as very large wide area network (WAN), this strategy works by converging disparate public-sector networks onto a common platform. By doing so, significant economies of scale and of scope are achieved. In Jordan, for example, an ambitious project dubbed "Connecting Jordanians" launched in mid-2002 aims to introduce a broadband intranet network that promises to connect 3'000 public educational facilities comprising all schools, universities, and colleges by the beginning of 2005.[20]

Some public-sector networks are less absolute with regard to prohibiting non-public-sector Internet traffic. In underserved and rural areas, public-sector networks may be able to do "double duty" as commodity broadband infrastructure. This is particularly useful in such locations, where no other transport network may be present and it is uneconomic to add new facilities when existing facilities could support existing bandwidth demand.

It is nevertheless important to highlight that infrastructure deployment initiatives involving public ownership and service provision of broadband networks, at the community level or otherwise, have been greeted with concern by some commercial broadband providers. Particularly at issue are the numerous advantages enjoyed by public owned networks over commercial networks and their effect of on fair competition. In addition to advantages in terms of land ownership, and access to and control of rights of way, public-owned networks also have access to public financial resources and have fewer financial performance requirements imposed on them. It has been argued that the entry and operation of public networks on such advantageous terms run the risk of excluding any further commercial entry into the market.

To some extent, some of these concerns can be mitigated by a government's efforts to clearly highlight the necessity and benefits of government intervention and to ensure transparency in the decision-making process and implementation of public-owned network models. At the same time, clearly impartial decisions by regulators, such as those regarding decisions on municipal rights of way, can act to reassure the market of regulatory parity between all market entrants, both government and private sector.

3.5 Conclusion

Globally, broadband has made considerable progress in terms of both availability and affordability. With more than 80 countries offering commercial broadband services, signs indicate that broadband is poised to achieve worldwide ubiquity this decade in the same way dial-up Internet access has in the last. Notably, world broadband penetration rates have grown at a compound annual growth rate (CAGR) of 155 per cent since 1999.

The extent of broadband penetration in the most developed, "networked" and ICT-friendly economies of the world has already reached impressive levels. Box 3.8 shows the top 20 broadband providers worldwide, between them accounting for some 37.5 million subscribers, or 60 per cent of total global broadband subscribers, at the end of 2002. In some countries such as Korea, policy-makers are already concerned that broadband penetration rates are approaching saturation levels.

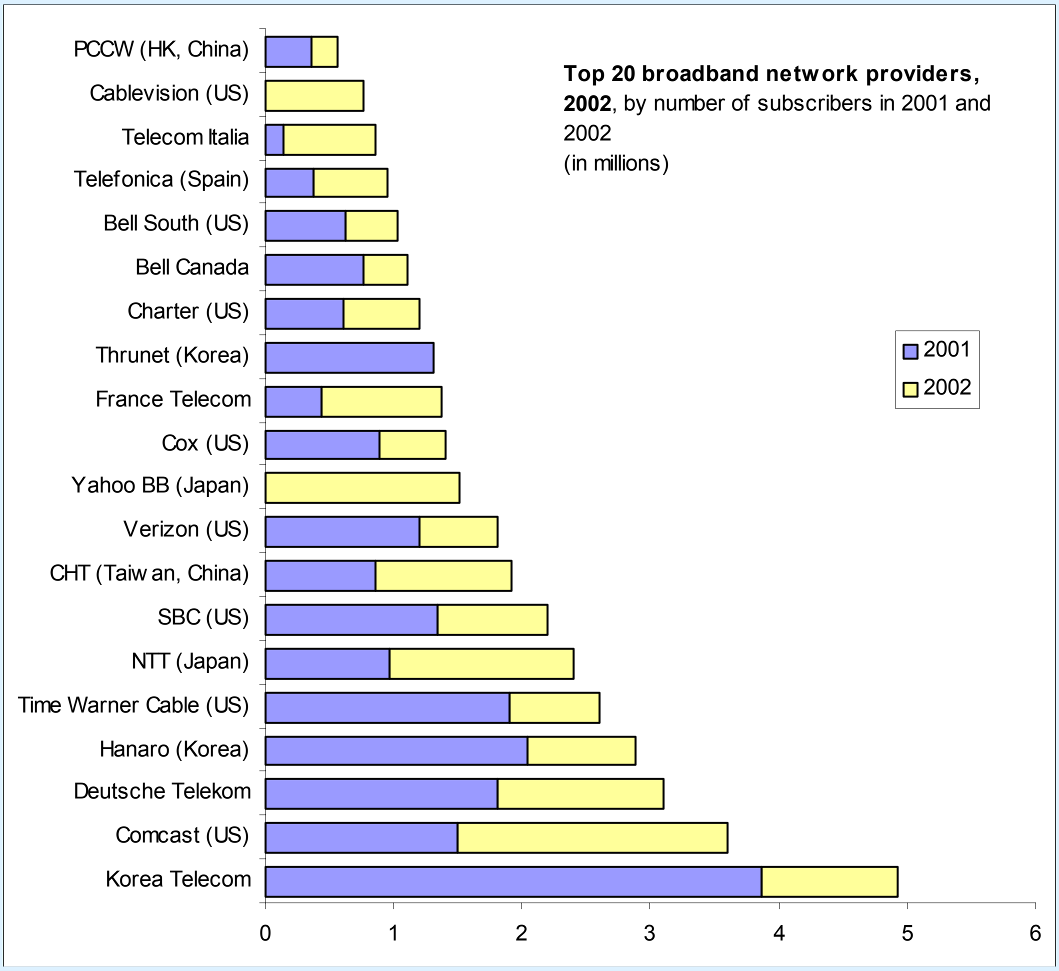
Nevertheless, significant obstacles still remain in achieving universal broadband availability—especially with regard to extending affordable broadband network coverage into rural and remote areas—particularly in developing countries. Prohibitive costs and insufficient demand in these areas have, for the large part, left them devoid of commercial broadband services at affordable prices. Fortunately, however, developments in technology and the launching of innovative business models have given broadband deployment efforts a significant boost. The use of Wi-Fi technology and alternative infrastructures such as power grids have allowed broadband access to be deployed and distributed more cost effectively in these areas while new business models such as customer-owned fibre networks have provided viable alternatives to prohibitive commercial broadband offerings.

With broadband access being increasingly seen as a key requirement for economic growth, governments have also played a growing role in broadband deployment, funding the construction and operation of broadband networks or providing financial incentives to broadband providers to extend and develop their networks. Although public entities have entered the broadband market as providers in a number of countries, the trend is also toward greater public-private sector collaboration that minimises government intervention to the extent the market has failed in the supply of affordable broadband access.

Box 3.8: Who's who in broadband?

The top 20 broadband providers worldwide had some 37.5 million subscribers at the end of 2002, accounting for just under 60 per cent of the global total. Among the top 20 were nine companies from North America, seven from Asia and four from Europe. Korea Telecom remains the world leader, though the merger of Comcast's broadband subscribers with those of AT&T has propelled it into second place worldwide, overtaking Hanaro Telecom. After Comcast, Yahoo BB! added the most new subscribers in 2002 (1.5 million) followed by NTT (1.4 million) and Deutsche Telekom (1.3 million). The majority of the top 20 broadband providers already have a large installed base of either telephone or cable TV subscribers. The two main exceptions to this are Hanaro Telecom and Yahoo BB!, which have emerged as leading second fixed network operators in Korea and Japan respectively, on a broadband platform.

Top 20 broadband network providers worldwide, 2002, by number of subscribers in 2001 and 2002 (in millions)



Source: ITU Public Telecommunication Operators Database (see Table 11 in the Statistical Annex).

1 ITU World Telecommunication Indicators Database.

2 For an overview of the rapid growth of broadband in the context of other ICT developments, see the McKinsey Quarterly, "Making Sense of Broadband", 2003 Number 2, available at: http://news.com.com/2009-1085-995960.html?tag=fd_nc_1.

3 For example, an exhaustive list of factors affecting broadband deployment in the United States can be found on the website of the National Telecommunications and Information Administration (NTIA) at: http://www.ntia.doc.gov/ntiahome/broadband/.

4 For an example of a dial-up ISP company facing consumer migration toward broadband, see Business Week Online, "America Online's Subscriber Challenge", 2 January 2003 at: http://www.businessweek.com/bwdaily/dnflash/jan2003/nf2003012_7497.htm.

5 For a comparison in pricing between leased line services and DSL services, see OECD, Broadband Access for Business, 4 December 2002 at: http://www.olis.oecd.org/olis/2002doc.nsf/LinkTo/dsti-iccp-tisp(2002)3-final.

6 ITU World Telecommunication Indicators Database.

7 For example, Sprint has suspended the marketing of its broadband direct wireless service due to the difficulties in realizing an "optimal cost structure" based on the level of broadband wireless technology it uses to operate the service. For more information see: http://www.sprintbroadband.com/.

8 For a good overview regarding customer owned dark fibre business models, see: http://www.canarie.ca/canet4/library/customer/frequentlyaskedquestionsaboutdarkfibre.pdf.

9 See: http://www.canarie.ca/canet4/library/customer.html.

10 For an example of some of the considerations behind the use of licensed or unlicensed spectrum, see Tom Flak, "Licensed vs. Unlicensed Spectrum – Making the Choice", Broadband Wireless Online, March/April 2003 at: http://www.shorecliffcommunications.com/magazine/volume.asp?Vol=34&story=332.

11 For an overview of current business models utilizing the 802.11 family of standards, see The Economist, "Making Wi-Fi Pay", 4 April 2002 at: http://www.economist.com.

12 For more information, see the Boingo Wireless website at: http://www.boingo.com/.

13 The utility conversion model has been utilized widely in the US, where in many cases electricity distribution is still controlled by municipally owned power companies. An organisation called the National Rural Telecommunication Cooperative, has been established to provide telecommunications and IT solutions for rural electricity and telephone utilities, information about which is available at: http://www.nrtc.org.

14 For more information, see the ITU case study on promoting broadband in Iceland at: http://www.itu.int/osg/spu/ni/promotebroadband/casestudies/iceland.doc.

15 For example, Yankee Group research indicates that 63 per cent of dial-up households in the United States have not subscribed to broadband because it is "too expensive". See Yankee Group, "The Realities of Tiered Broadband Service", 13 Feb 2003 at: http://www.yankeegroup.com/public/products/research_note.jsp?ID=9691.

16 See ITU Country case Study: The Internet in Korea at: http://www.itu.int/ITU-D/ict/cs/korea/material/CS_KOR.pdf.

17 See for example, Upper Canada Networks at: http://www.uppercanada.net.

18 For more information on the project see: http://www.itc.org/aaron/states/northcarolina.html.

19 For more information see: http://www.albertasupernet.ca.

20 For more information see: http://www.mop.gov.jo/page.php?menu_id=41.

4 Chapter Four: Using Broadband

4.1 How broadband is used

Having examined the development of broadband technologies and infrastructure, competition and price considerations, the next question that naturally arises about the development of broadband has to do with its utilization. In short, how is broadband used today, and what are the implications for future uses, for market development, for regulators and policy-makers, and for users?

The Internet has already led to the creation of a wide array of new applications, including web surfing, instant messaging, file sharing, e-commerce and e-mail. With the advent of broadband and its faster always-on connections, the possibilities for opening the path to interactive applications, virtual reality and other high-quality digital services are growing dramatically. Broadband arrives at a time when the revolutionary potential of the Internet has still to be fully tapped, and is serving to accelerate the process of integration of Internet technologies into everyday life. As we are already witnessing, the refining of content and increased sophistication of applications is being given a huge boost by the arrival of broadband. And although the earliest impact is being seen in developed economies, with the potential of broadband to expand ICT access in less wealthy economies, similar issues will soon need to be examined in these economies too. In particular, the language in which content is produced, and the local relevance of content, are very important particularly in the less developed economies of the world.

It would seem a safe prediction that the variety and quality of specialized applications—for instance online entertainment or educational material—will grow with broadband, but so too will the implications as more material is made available in digital form, especially in areas such as intellectual property and security (explored respectively in this chapter and in Chapter six). It also comes at a time of technological convergence, during which computer applications are spreading to other devices (mobile phones, television sets, etc.), and vice versa (e.g. voice communications over computers) (see Box 4.1).

Box 4.1: Internet TV and home networking in Japan

In the broadband era, personal computers and personal digital assistants (PDA) are not the only types of terminal for accessing the Internet. Since the advent of higher-speed networks, manufacturers have been developing other broadband terminals, such as video game consoles, Internet TV appliances, set-top boxes (STB) and home servers.

In Japan, the Ministry of Public Management, Home Affairs, Posts and Telecommunications' (MPHPT) latest annual random sample survey concluded that there were 3.64 million people who accessed the Internet from their game console or from a television set in 2002.

Internet TVs started to emerge in 1999 in Japan, but the products available at the time did not attract many consumers. However, technology has evolved since then and the user interface has also improved substantially. Sony's Airboard was one of the first products and it was a state-of-the-art wireless video device at the time of launch, created as a wireless Internet tablet rather than audiovisual equipment. Improvements added over the years have culminated in the IDT-LF3 version, released in January 2003. Compliant with the IEEE 802.11b standard, it can be connected to the Internet at up to 611 Mbit/s, and can be used almost anywhere within a 30-metre radius, in the home or garden, and even in the bathroom (with a protective cover). One of its features is the ability to capture video images from the TV. The battery life is currently quite short, but with improvements expected in the near future, devices like these will certainly change the way an increasing number of people use video information.

STBs, on the other hand, are defined as devices that are connected to the TV to watch various content. Although there are many possible uses, STB can also be used for broadband content distribution: in Japan, BB Cable TV, for example, offers its subscribers STB, as does the fibre-to-the-home (FTTH) service provider, Bbit-JapanB. One of the main benefits of STB is that it offers higher quality video than a PC. 2002 also saw the emergence of home servers in Japan, consisting of an PC integrated with other devices such as TVs and DVDs. Sharp's personal server (HG-01S), produced in February 2003, is one example. It can interconnect a PC, mobile phone, TV, and other appliances. The device even enables the user to access their home network when absent from home, by, for example, setting the video timer via their mobile phone and watching recorded TV programmes on their PC.

Source: ITU case study on promoting promoting broadband in Japan, at: http://www.itu.int/sgo/spu/casestudies/.

While the legal and regulatory aspects of these developments will be further explored in Chapter five, this chapter attempts to give an overview of current and future applications for broadband technologies, including consumer-oriented services such as Internet browsing, voice services, entertainment and information supply. Specifically public domain services are also looked at, including e-government, e-education and e-medicine, as well as a variety of other services such as e-commerce and business uses. The other main focus of this chapter is content. Most applications *per se* would have very little market value without relevant content. This section looks at the evolution of models for the development and distribution of online content—including regulatory and ethical concerns associated with content—and possible bottlenecks in the commercialization and distribution of broadband services.

4.2 Consumer-oriented services

In the early days, most broadband applications will be asymmetric, that is to say the content or services will be pushed from a provider to an end-user (e.g. web browsing). However, as broadband becomes more widely available, the use of two-way consumer and business applications, such as gaming, file sharing (e.g. Kazaa[1]), and video conferencing, will become commonplace. This section provides an overview of some of the main current and future applications of broadband technologies.

4.2.1 Traditional browsing and person-to-person communications

Person-to-person communications still figure as one of the most important uses of the Internet. It is telling that, given the choice of which service they would rather give up for one day, most users would rather give up general web surfing than e-mail. Although e-mail, together with its mobile counterpart, messaging, are not bandwidth-hungry applications, higher bandwidth improves these services in two key ways: it allows for "always on" communication and the exchange of larger attachments. Broadband boosts even the most in-demand and fundamental applications already on offer today—indeed, one of the main incentives for residential broadband users is simply to enhance the overall web browsing experience.

In addition, higher speeds can better the user's experience of certain types of content, such as product images, software downloads, and so on. Broadband enables shorter downloading sessions. Indeed, some bulk file transfers, such as software upgrades or audio/video files, are simply not efficient without a high-speed connection. Broadband is also having an impact on traditional voice telephony services.

Voice services

Voice services over data networks have recently emerged as an alternative to conventional telephony and the lower cost to users is making them highly popular in some markets. Running telephony over general-purpose data networks such as IP is cheaper due to a number of factors. First, telephony over dial-up connections, charged at a flat-rate, or always-on broadband connections[2], avoids the per-minute charges of a traditional public switched telephone network (PSTN). Second, a long-distance or international call can be placed through a local call to an ISP, thus bypassing the carrier. In North America for instance, where voice over IP (VoIP) is treated as an "enhanced" service rather than a basic service, the ISP can avoid paying the per-minute access charges that phone companies are required to pay to local carriers to terminate long-distance calls. A number of different technologies (e.g. ADSL, IP, asynchronous transfer mode (ATM), cable modem, etc.) can be used in a single "voice over broadband" call. For business applications using broadband, virtual private networks (VPN) have been a source of significant revenue for service providers. It is also telling that cable companies have been quick to enter the broadband VoIP scene in some markets, notably in the United States, to the extent that incumbent telephony operators are considered to be at severe risk from competition.[3]

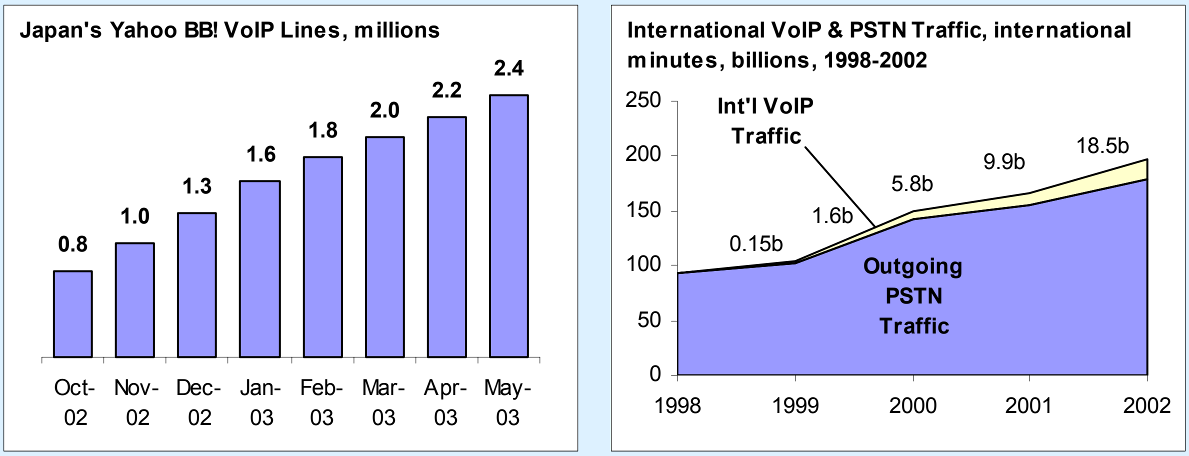
Previously, the key barriers to VoIP take-up were not necessarily bandwidth, but rather the integration of network-based voice telephony with convenient handsets and call services (e.g. making a phone call, call waiting, caller display, voice mail, etc.). However, recent VoIP service offerings seamlessly include these benefits on traditional telephone equipment as well as other services not available over traditional fixed lines, such as the ability to listen to voice e-mail online. VoIP voice quality approaches, or may even match, traditional fixed-line voice since voice applications do not require very high bandwidth: just 64 kbit/s in each direction (even less when compression technology is used) is sufficient to provide the requisite quality of service. Users are able to place and receive phone calls directly via a phone and an adapter connected directly to their broadband connection, with no need for a standard telephone line or even a computer. They can also be offered in conjunction with traditional PSTN, e.g. by covering only the local access link.

Many companies have now deployed VoIP solutions, and a number of broadband providers have chosen to add them to their service packages, in some cases at very low tariffs. Yahoo BB! in Japan for example, offers its 2.4 million subscribers free calls to one another across the country. Not surprisingly, subscriber growth has been significant (see Figure 4.1, left chart). Calls outside the network in Japan are billed at a flat rate of 2 US cents a minute, as little as one-tenth the price of the same call over NTT's network. Growth of VoIP traffic is a worldwide phenomenon. At the end of 2002, VoIP traffic accounted for more than 10 per cent of all international traffic. Only four years ago, it accounted for a mere 0.5 per cent (see Figure 4.1, right chart).

IP telephony is particularly appealing in countries with metered local calls, although these services are also popular in areas with unmetered local usage, but metered long-distance calls. Vonage subscribers in the United States, for example, can pay a flat rate of US$ 39.99 per month for unlimited calling throughout the United States and Canada via their broadband connection. Both Vonage and Yahoo BB! are heavily promoting their services and this marketing push should help convince users that broadband can be more cost effective than they may think. For example, at the Ann Arundel Hospital, in Maryland (United States), when patients need an additional dose of medication or an extra helping of lunch, they are able to make a voice call directly over the hospital's Wi-Fi network. Old-style paging buttons have been re-designed to connect to the wireless handsets of staff anywhere in the building. Indeed, voice over broadband can transform almost any device (PC, laptop, table PC or medical console) into a voice communication device.[4]

Figure 4.1: VoIP is catching on

Subscriber growth for Japan's Yahoo BB! Phone service, 2002-2003, and International VoIP traffic summary, 1998-2002



Source: (Left-hand chart), SoftBank BB; (right-hand chart), TeleGeography Inc at: http://www.telegeography.com/ (2002 figures are estimates).

4.2.2 Information and entertainment services

There is a plethora of information and entertainment services on offer online. This section attempts briefly to describe those services that are enhanced by broadband. For many information and entertainment applications, broadband is almost a *sine qua non* for acceptable usage conditions. This is because some entertainment and information services are particularly sensitive to delays and latency (the delay between a signal being sent and received) that are incurred at lower transmission speeds. Multiplayer gaming and two-way video conferencing are two such examples. Moreover, latency is a particular problem over broadband networks built around satellite or cable modem platforms.

Numerous other information and entertainment services are, however, truly ameliorated by higher bandwidth. For instance, users can be given the opportunity to view the world from their armchair. Many of the world's most famous museums and art galleries, such as the *Louvre* (Paris, France)[5] and the Smithsonian Institute (Washington DC, United States)[6] offer virtual tours on their websites. The most sophisticated tours provide 360-degree panoramas of the venue and allow visitors to pan the camera around the room, zoom in and out and click on individual items of interest to learn more. In many respects, audio and video services that stand to benefit the most from higher speeds have received the most interest to date.

Audio

Audio services, unlike video applications, do not require especially fast connections, though faster speeds certainly help, especially for downloading audio files for later listening. All of the broadband technologies currently deployed (a 256 kbit/s ADSL connection being the benchmark) are fast enough to support the main audio applications on the market. These include conventional voice, games, and music. There are two principal ways in which an end-user can listen to an audio file: it can be downloaded to a local computer or streamed from a remote computer and played as it is being received. The latter, streaming audio, does not necessarily involve real-time transmission but requires faster connections than the straight downloading method.

One of the most common audio applications is music playback. Users can share music through peer-to-peer networks, listen to various radio stations that don't necessarily broadcast over-the-air in their geographic region, and listen in to special events (sports, commercial conferences, interviews, poetry readings, etc.). Numerous sites, such as Shoutcast.com[7], provide links to streaming MP3s in every imaginable genre of music, in a wide variety of languages. Most streams require bit rates between 64 kbit/s and 320 kbit/s, making broadband connections indispensable at the higher end, particularly if users wish to stream and participate in other Internet activities simultaneously. Yet other sites such as Live-radio.net[8] offer links to audio streams by country. Of course, Internet audio and radio applications are, in some respects, a transposition of traditional services in the network environment. BBC Radio in the United Kingdom, for instance, offers audio-on-demand services to web users.[9]

There are also more specialized, and often non-traditional, applications that are growing as specific user groups gain interest and the products on offer are gradually refined. One example of a non-traditional audio application for broadband that is under development is "search and filter". This application potentially allows users to search for keywords in one or more audio streams, using sophisticated voice recognition technology. Voice recognition software would need to be significantly improved to enable this type of application. When a keyword recognizes a pertinent file is recognized, it can take various actions, such as notifying a user, playing the stream or saving a segment on the user's PC. The main advantage to users of such an application would be the possibility of saving streams of audio for playback at a later time. This kind of application may be just the tip of the iceberg where possibilities for niche markets are concerned, especially for sight-impaired users.

Video

With the widespread popularity of video entertainment, video applications are considered by many Internet users to be the principal *raison d'être* of broadband technologies. Even though the quantity and quality of streaming video is still limited, Internet users can already enjoy live news broadcasts and pre-recorded programming. And the future promise of such uses is even brighter as quality increases.

Once video content becomes more widely available, and with higher resolution and screen sizes, one of the main benefits of broadband connections for users will be the possibility for users to watch what they want, when they want. Video on-demand via broadband is already available in some parts of the world and could drastically change the way people watch television. As an example, the broadband portal Now.com.hk[10] (see Box 4.2) in Hong Kong, China delivers true video-on-demand to broadband subscribers, including premium content such as first-run movies or live sporting events. This has in part contributed to the economy's success with broadband: Hong Kong has the second highest per-capita broadband penetration in the world.[11] In Japan, users benefit from high definition television (HDTV) programmes delivered to them directly over fibre optic connections. These programmes arrive over fibre and are viewed on the television set, but they could just as easily be viewed by a personal computer or be saved on the hard drive of a digital video recorder for future playback. Japan's fibre networks allow for very high-bandwidth HDTV signals. However, many DSL and cable technologies are not fast enough to offer a digital signal for high-definition television. New compression technologies and faster line speeds continually improve the quality of the picture above and beyond that of traditional television. However, it will take some time before broadband TV catches up with traditional television (see Figure 4.2).

Box 4.2: Right here, right Now

Internet content in Hong Kong, China driving broadband

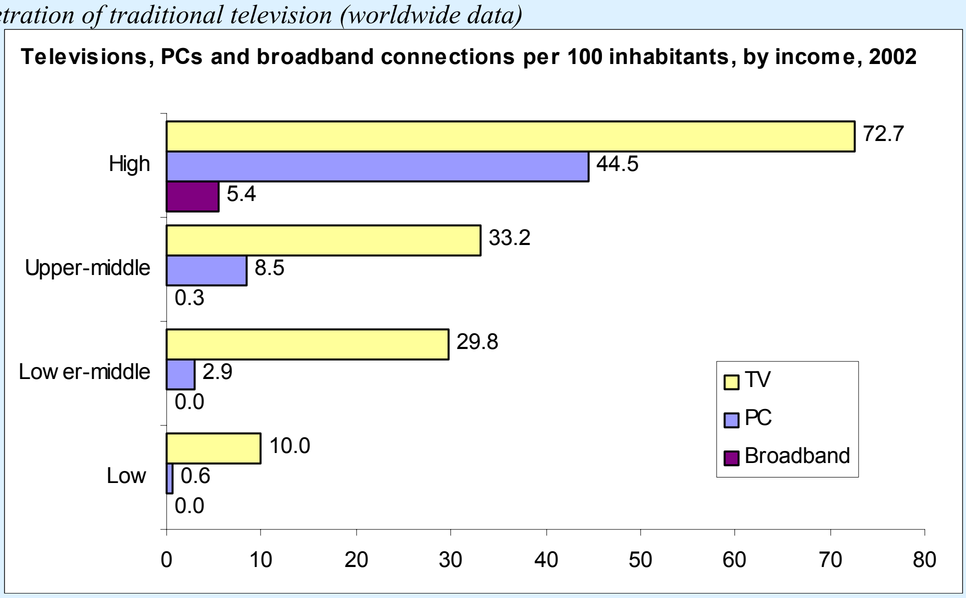
Hong Kong, China's incumbent telephone company, PCCW, launched a Chinese portal in April 1999 that featured Chinese language search engines and e-mail. The main goal was to attract Chinese-speaking users the world over, in an attempt to drive advertising. The 1999 portal has since evolved into the well-known broadband portal, called "now.com" (http://www.now.com.hk/). i-Cable, the cable television and cable modem provider also has a broadband portal, which was launched in March 1999 (at: http://www.i-cable.com/). Content is aimed at niche interests such as horse racing, stocks, gaming and sports. It is the only Cantonese news portal updated on a 24-hour basis and attracts a lot of traffic from mainland China. A significant reason for the strength of the Internet and portal development in Hong Kong is the growing amount of Chinese content on the Internet. There are also Chinese versions of major software packages such as Microsoft Windows Explorer and Office. The Hong Kong Government portal, http://www.info.gov.hk, is available in Chinese as well as English, as is the Electronic Service Delivery e-citizen portal, http://www.esd.gov.hk. Moreover, all of the top global websites accessed by Hong Kong's Internet users (e.g. Yahoo, MSN, Lycos) provide Chinese interfaces.

Source: Now.com.hk at: http://www.now.com.hk, and the ITU case study on the Internet in Hong Kong, China, at: http://www.itu.int/ITU-D/ict/cs/hongkong/material/CS_HKG.pdf.

Not surprisingly, in terms of subscriber numbers, entertainment (e.g. gaming and video) is being touted as the main online attraction. As early as 2001 in the Republic of Korea, SBSi, the interactive division of the Seoul Broadcasting System, began offering streaming video programmes, such as soap operas. The cost to users was a mere KRW 500 (or 40 US cents) a show. The service has attracted 1.8 million registered users and 4'000 more are signing up every day. Korean broadband providers offer speeds of up to 40 Mbit/s, much faster than anything commonly available in the United States or Europe, where even 1 Mbit/s to 3 Mbit/s transmission rates are still rare.

Figure 4.2: The long road for broadband to catch television

While some have claimed broadband will be the future of video delivery, it has a long way to go before it competes with the penetration of traditional television (worldwide data)



Source: ITU World Telecommunication Indicators Database.

Non-commercial video content is also gaining popularity among some user groups. Through services that are currently available, users can for instance conduct video chats with several other users at a time by joining a chat room and typing their messages on a community board. Each participant's video image is then simultaneously broadcast on the screen of other users, creating a video mosaic of all the participants involved in the session. Several video conferencing packages, such as Microsoft's Netmeeting, integrate work-sharing applications, such as white boards, document exchange, and instant messaging. Higher bandwidth makes full duplex audio and video possible with document sharing, thereby enabling high-quality video conferencing at a relatively low cost.

Online photo exchange and storage

Another area which visual media are entering the broadband scene is photography. As digital cameras become more sophisticated, image resolution is approaching film quality. But while larger file sizes have meant higher-quality prints, they can be problematic for many Internet users who wish to share photos online with family and friends, or who wish to save them. With greater file sizes, more memory is required to store photos, and downloading a 5-megapixel photo with JPEG compression over a 56K modem takes at least two and a half minutes. With the availability of both uplink and downlink high-speed broadband, however, online photo sharing will be facilitated. Online content providers such as Yahoo! Photos[12], have created sites geared specifically to the uploading and viewing of photos on the Web. These types of application could potentially mushroom as digital cameras, including those built into mobile phones, become more commonplace.

Internet gaming

In the entertainment category, online gaming is obviously an important area of usage, particularly among younger users, and it is considered to be one of the key broadband drivers for the youth market. Higher-speed broadband connections enable new interactive multiplayer games and enhance current gaming applications. Online games come in many forms: some can be played free of charge, some require a one-off fee to purchase the software and others require a monthly subscription. As part of the trend towards higher-speed interactive games, some leading game console manufacturers, such as Sony and Microsoft, are adding Ethernet ports and broadband capabilities to their devices.[13] With such developments well under way, game consoles are likely to become increasingly "networked", gradually changing the dimensions of gaming and generating greater interest from users.[14] While in some economies this will take some time yet, the more technology-savvy economies, such as Korea and Hong Kong, China, for example, have benefited from embracing the interactivity of online gaming, which has served to spur broadband take-up. In fact, Korea's NCSoft, with a service charged at US$ 25 per month, became the world's largest online gaming network in 2003, with some 3.2 million subscribers.

Future applications[15]

As can be seen from the examples of gaming and video conferencing, the potential for interactive applications is clearly one of the major impacts of broadband on usage. This report has highlighted the fact that the full potential of high-speed Internet networking will not be realized for some time, but it seems certain that greater bandwidth is set to accelerate the growth of newer and increasingly interactive applications—and in future this interactivity will not only be between humans, but will spread to include machines and devices. Whereas at present, the vast majority of broadband applications target human end-users to whom content is being delivered, in the future, analysts anticipate a demand for Internet appliances in the home and business environment, which will rely on fast, always-on connections. Already, there exists a handful of examples of home content, such as Internet photo frames, which download new photos of friends and family from a common family website at off-peak hours.

Although it seems a distant prospect, we are perhaps not so far from having appliances in the home that can automatically pre-order new parts after having detected a failure, or can download software updates or local language support without human intervention. Similarly, an appliance could be designed to automatically pre-order prescription medication when it runs out, saving the user from having to repeat the administrative procedures time and time again. Among other applications that may see widespread future use, radio frequency identification (RFID) tags can be used to track items, and particularly to carry out scans or inventories of products without needing to read individual bar codes.[16]

The key to realizing this vision will be the development of home automation servers that are connected, upstream, to an always-on broadband connection, and, downstream, to a variety of different programmable devices, like Internet photo frames, refreshable Internet newspapers, electronic shopping lists, personal video recorders, etc. Thus broadband has the capacity to facilitate demand for new devices as well as new services.

4.3 Public services

It is not only commercial, entertainment-oriented applications that are set to benefit from broadband, but the public sphere also provides a rich terrain in which to develop and promote services, especially given the price advantage of broadband over comparable leased line networks (see Table 1.1 in Chapter one). Moreover, and perhaps most significantly, it is through the government's promotion of online services that economies benefit most in the long term: raising educational and health standards are recognized factors in improving economic status. Already in some countries, the public sphere has been transformed by e-government initiatives, with, for example, citizens filing their tax forms, or registering for various public services over the Web. These and other public services, such as health and education, stand to benefit from the possibility of higher-speed connections, particularly through the extension of access to underserved or rural communities. Whereas the impetus for commercial services has largely come from the private sector, albeit on the basis of a favourable market and infrastructure environment, public service initiatives have been hugely boosted by governments that have been willing to foster content development with a view to better meeting users' needs. The ways in which the two sectors successfully promote, and interact in order to promote broadband, is further discussed in Chapter six of this report. This section draws out a few of the most important public service areas that can profit from broadband technologies.

E-health and telemedicine

Examples of successful online initiatives in the sphere of health and medicine abound, but there is still considerable potential for further development.[17] Specific examples include government broadband initiatives have enabled doctors in rural areas to consult with urban specialists. In other initiatives, radiologists study X-ray results online from remote clinics, and surgeons have been able to perform surgery from afar through video conferencing[18]. Such applications have been fairly simple to implement in hospitals already connected to a high-speed Internet backbone. In some economies, public programmes geared towards providing broadband to hospitals are being implemented, for instance in Iceland.[19] However, because few policy-makers are aware of the potential of telemedicine, residential e-health applications have yet to take off, despite the apparent potential of such applications. Broadband can facilitate instant healthcare information and personalized information available to the end-user, regardless of geographic location. The empowerment of patients through information and access to services can bring about significant benefits in terms of treatment and prevention.

If current technological trends continue, with proper government support, broadband will help educate, inform, and treat patients through a wide array of online services, ranging from video demonstrations, confidential video conferencing with doctors and specialists, and patient support groups. Online medical services can also serve to enhance current doctor-patient relationships and reduce costs. Patients can, for instance, contact their doctor online to ask questions when physical visits are not necessary, review prescriptions or receive test results. Sites like Nexcura.com[20] are already offering a scaled-down version of such services. But while such services may be just a next step in developed economy households, where users are already Internet-literate, in rural and poorly served developing economies such services may be more realistically accessed through community medical projects intended to facilitate the exchange of know-how across geographical and financial boundaries.

Although they will probably never replace the face-to-face contact that is necessary in many cases, broadband connections can help alleviate overburdened medical facilities and long waiting times. A fast Internet connection can, for example, allow chronically ill or disabled patients to continue to live at home, rather than at the hospital, through constant body monitoring. Family members can also monitor elderly parents and children in day care, or loved ones in remote locations. In addition to enhancing quality of life, these applications can prove cost effective and also contribute to economic well-being.

E-education

Another major area for broadband in the public sphere is education. E-education is a method of learning that is valuable in both developed and developing economies. In the industrialized world, continuing education and updating of skills have become indispensable, while in developing, rural or underserved communities, e-education (for example through telecentres, community centres and schools) can provide access to learning that would otherwise be out of reach financially or geographically. Distance learning is therefore an important residential application of broadband technology. Broadband can also improve the learning experience by providing real-time interactivity and the possibility for online group learning (see Box 4.3).

As discussed in more depth in Chapter six, access to e-learning has a beneficial economic impact too. The availability of always-on, low-cost, and high-quality education over the Internet will serve to stimulate broadband demand in the home. Introducing high-speed access in schools and other educational institutions has been shown stimulate broadband take-up as a whole in a given economy.

At the school level, the Internet can extend educational programmes to students who are unable to get an adequate education in the classroom. At colleges and universities, broadband connections facilitate online activities such as “streaming” lectures, participation in discussion groups, collaborative projects, web-based research, and one-on-one interaction between students and teachers. It also makes it easier for students to find customized and international instruction on a wide range of topics for lifelong learning. Fast access to databases and library catalogues saves time and money and is sometimes indispensable for research purposes.

However, it must be noted that improving educational benefits in this manner is not only a question of improved capacity: people need to understand what broadband can achieve, whether they be policy-makers, pupils, teachers or parents. Furthermore, the introduction of broadband in schools represents a major change to traditional methods and therefore needs to be supported by appropriate staff training and effective policies for the integration of new technologies into curricula. This is one of the objectives of the British Government, which in 2002 launched a project to provide a broadband connection to every school by 2006. The initiative was well received by participants, who saw in it the opportunity to put in practice their ideas, improve their pupils’ learning experience, broaden the resources available and increase the number of activities available to them.[21]

E-government

Apart from initiating and providing support to the kinds of health and education projects mentioned above, the most important way in which governments can play a role in promoting broadband is through improving their own connectivity. Not only can they encourage their citizens to go online, but government and administrative processes can be substantially improved. Many governments around the world have embraced the Internet as a means to streamline public sector processes and to provide citizens with easier access to government services. As a desirable knock-on effect, this increase in information flows can also help establish an environment of trust and reliability between citizens and elected officials.

The Government of the Republic of Korea was one of the first governments to emphasize the importance of ICTs in stimulating the economy and its role in fostering a productive society and a democratic government. The country’s e-government Initiatives, established in January 2001, specified 11 actions to enhance the development and use of government applications. These included the home tax service, the e-procurement system, the financial/education information system and the personnel management system. In addition, the country is also developing an integrated database covering five major areas of government activities: real estate registry, citizen’s registry, automobile registration, enterprise information, and taxation. Organized on the federal level, it will cut across all government agencies, including the 16 provincial and 232 local governments. Not surprisingly, some cost savings are also expected: according to the Government, the project will reduce the average number of paper documents required for a resident from 1.9 to 0.1, and the average number of visits from 4.5 to 1.2.[22]

Box 4.3: Learning in the Internet age

From narrowband to broadband: How faster Internet connections can help people to learn

Many delivery options for instruction and knowledge transfer have become available over the past several years. The Internet has been the most significant development, in this regard, as it facilitates the rapid and efficient dissemination of information and knowledge to a global body of learners. We have, however, only seen its "narrowband" beginnings, and thus the true potential of learning via the Internet has yet to be fully tapped.

In a narrowband environment, online or web-based learning already offers a number of advantages, which are only to be enhanced through higher-speed connectivity:

- Physical convenience;
- Global access and interactivity;
- Promotion of diversity;
- Efficient use of student and instructor time;
- Customization of learning experience;
- Promotion of reflective thought through online discussion groups (e.g. bulletin boards);
- Timely feedback between instructors and teachers;
- Facilitated delivery of complex messages and materials to a large group instantly and at low cost.

The main advantage of online learning is the ability for students to proceed at their own pace, at anytime and at any place. The asynchronous and interactive nature of the Internet makes for a dynamic and flexible learning experience. Web-based learning is also conducive to collaborative and exploratory learning environments. The Web offers many options for communicating and interacting (e.g. asynchronous, synchronous, one-to-one, one-to-several, several-to-several). In the future, audio and video content over broadband networks will serve to enrich the material available to students online.

Online learning, however, does have some disadvantages, including:

- Need for a minimum level of computer literacy and access to equipment;
- Certain positive aspects of person-to-person communication may be missed;
- Difficulty in cementing teacher-student relationship. In this respect, broadband networks facilitating video-conferencing would have a positive effect. Another option is for instructors to hold an initial in-person interview with the students of the online class;
- Need for learners to assume more responsibility for their learning process, i.e. online learning is generally not suitable for students with a low degree of motivation;
- Perceived lack of accountability.

In order not to restrict access, instructors and educational institutions must design online courses with the lowest common denominator in mind. In other words, most online courses today are geared towards the dial-up Internet user. When broadband access becomes more commonplace, however, the true potential of online learning will be realized, to the delight of curious minds, everywhere.

Source: ITU research.

Singapore's e-Citizen project[23], launched in 1999, has become one of the country's most important and successful e-government initiatives. E-Citizen is an Internet portal created to provide Singaporeans with a single, organized access point to all government services. E-Citizen is organized according to area of activity, rather than by Ministry or Department, covering such areas as family planning, education and recreation. Beyond providing citizens with a central window to government services, e-Citizen has also helped facilitate coordination between disparate government agencies. Although current users of programmes such as e-Citizen may not necessary require a broadband connection, the future evolution of e-government will entail a shift from static to dynamic web services. Services geared to the individual citizen could range from video conferencing for citizenship interviews to streamlined renewal of drivers' licence photos.

4.4 Business applications

While many commercial endeavours and much broadband policy-making have focused on bringing fast Internet connections into homes, businesses are also becoming major beneficiaries of new broadband technologies. Small and home businesses are increasingly benefiting from the possibility of sending and receiving large e-mails and attachments, and are exploiting the new capacity and speed to create centrally-hosted business resources, such as customer databases. Also, broadband allows employees to work effectively from home over their connections, and constitutes a cost-effective solution for small and home businesses, which are using broadband to share Internet access around the office. In this section, some of the main business applications that are benefiting from the availability of broadband are described.

Voice over broadband

While the cost benefits of VoIP for personal voice communications are already convincing to private users in many parts of the world, VoIP is also proving useful for business users. In the new global world of business, employees may be scattered around the world but must remain easily reachable by voice. Voice over broadband technologies has effectively made it possible to extend the private branch exchange (PBX) around the globe. Phone calls can now be initiated over broadband connections and patched into the phone system at office headquarters, without the need for the user to have access to a telephone. While this was previously an onerous technological feat, it is now a feasible solution for many companies. It also permits greater corporate flexibility, because voice over broadband is geographically neutral. This means, for instance, that a salesperson living in Germany who does business in Spain can have a Spanish phone number forwarded to their German office or home using voice over broadband.

Video conferencing

Another "freedom factor" of broadband is the ability to carry out video conferencing for businesses. Broadband connections allow video to be sent along with voice signals for video conferencing, whereas previously video conferencing required expensive, dedicated circuits and was a costly affair. As broadband connections become more common, especially among smaller businesses, it is becoming easier to video conference in business. This not only substantially saves individual businesses both money and time, but also reduces travel, thereby contributing to containing the burgeoning levels of environmental pollution due to harmful transport emissions.

To give just one of many possible examples of video conferencing over broadband in action in the business world, freelance graphic designers who create and move around large files as part of their work can carry out important client meetings over such connections. As they may work from home, sometimes in remote locations, it is vital for them to have good contact with their clients during all stages of design development. Some graphic designers have begun to use video conferencing and whiteboard sharing via their broadband connections, allowing conferencing participants to see their work on a whiteboard and make adjustments in real time. Clients can, for example, ask for colour changes and other adjustments that are re-posted nearly instantaneously on the whiteboard. In this way, business deals can be concluded in less time and at less cost.

E-commerce

While private consumers may choose to use e-commerce services to order from home, businesses also benefit from the increased speed of e-commerce that comes with broadband connections. Many business-to-business (B2B) transactions are already processed over the Internet and faster connections equate to less time spent navigating and ordering products. Broadband can also offer technically savvy businesses a way to implement secure servers for e-commerce on their premises. While many companies decide to outsource web hosting, an always-on broadband connection allows faster access to a wide array of information and communication by consumers and businesses alike.

Application service provisioning

Application service provisioning is the provision not of goods, but of services over the Internet. IT companies can, for example, offer the provision of services remotely linked to an outside server. This means that those working on a PC from home or the office can benefit from the capacity of a full network, without needing to be connected to their own network. However, there is some debate over how broadband will eventually be used for application deployment. Some software and hardware companies have predicted that users will start using broadband connections to run all their applications remotely. Despite showing promise, early attempts have failed to convince users of the benefits and have shut down.[24] Many users simply feel more comfortable when their applications are not tied to a network. However, as broadband networks become more commonplace and reliable, users may very well gravitate towards smaller devices that run applications off a network.

Application service provisioning may find its ultimate user base on mobile/portable devices with limited physical space for memory. Also, delivering software as a subscription-based utility may present several advantages for companies, even the larger ones, which are not satisfied with the way software is traditionally sold. This is often because subscription-based software services can be less expensive than buying the programme, running it, providing necessary IT support, and so forth. One apparent example of the successful implementation of this software-rental model is the provision of "customer relationship management" (CRM) software by the web-service company Salesforce.com,[25] which stresses the importance of targeting suitable applications which customers are willing to outsource because they are too complex and costly to manage internally, and not linked to sensitive/reserved information.[26]

Teleworking

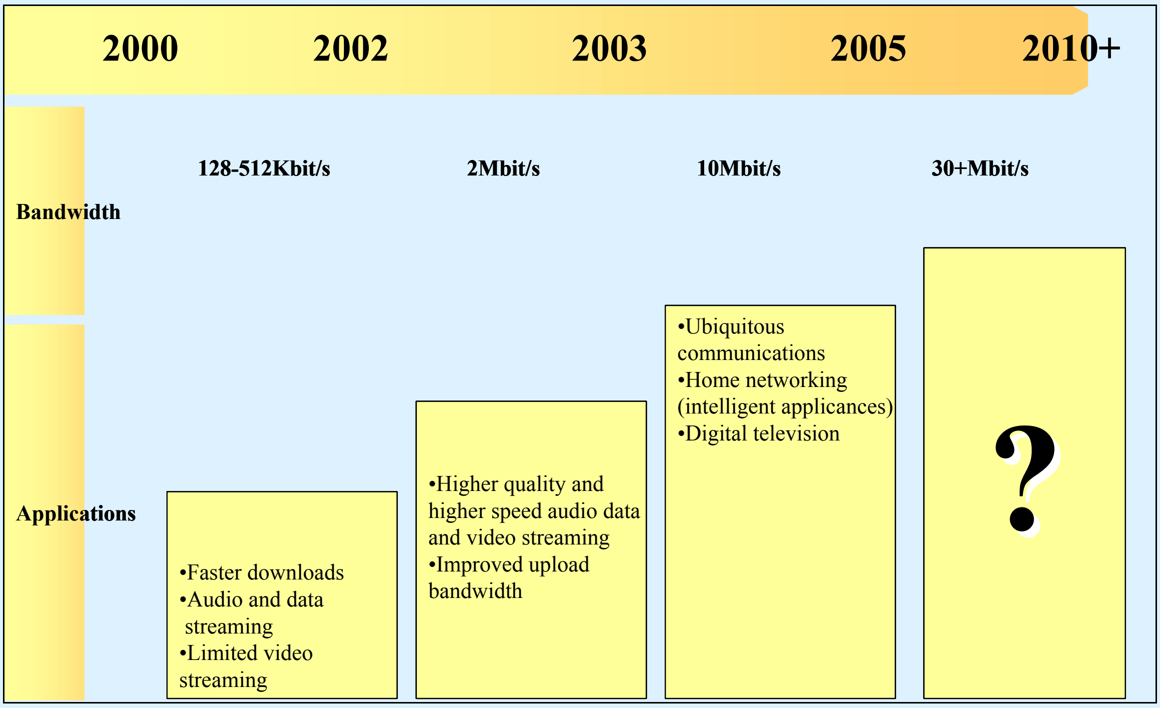
Teleworking is perhaps one of the most commonly talked-about areas of the business world that has entered directly into people's lives on the personal and social plane. The Internet, and the flexibility it has afforded, has enabled people to change location easily while staying in contact. Is has long tempted businesses and users to explore the possibilities of teleworking. But businesses were initially slow to take advantage of teleworking because of concerns over data security and employee malfeasance. In addition, early Internet connections were not fast enough or cheap enough to support the data transfers common in the workplace. Nevertheless, many companies have gone over to partial or total teleworking arrangements, and the trend is continuing to grow. With the birth of broadband however, the advantages of teleworking have been greatly enhanced. The fast, always-on connections allow workers to be in constant communication with the office, using tools such as e-mail and instant messaging software. In some countries, there are public policy programmes encouraging employers to subsidize home broadband connections for their employees. Positive spill-over effects include environmental benefits of telecommuting and reduced business overheads.

4.5 Content

While the applications and usage patterns examined above provide part of the picture, no analysis of this topic would be complete without some consideration of content. As broadband opens up a greater variety of applications, greater usage of existing applications over new platforms, and use of Internet content by users with specific areas of need or interest, the quality and appropriateness of Internet content is becoming an increasingly important issue. Moreover, with the diffusion of content in new media formats and over national boundaries, a host of security and intellectual property issues are raised. Furthermore, the development of broadband content and applications not only needs a large pipe and suitable technological infrastructure, but equally an appropriate strategy for service evolution, and an adequate environment for the creation of new content.

From the user's perspective, the main point about content is that innovative applications and new content are fundamental drivers of broadband services. Once subscribers have a faster Internet connection with broadband access, the availability of compelling content is the main source of attraction—and with faster speeds, users seek new types of content, or require the content that is available to be more pertinent, in-depth or specific (see Figure 4.3).

Figure 4.3: Broadband content development



Source: ITU adapted from OECD Joint WP TISP/IE Workshop, Paris 2001.

From the regulatory perspective, with faster connection speeds, an entire new set of transactions is being—or can be—carried out online. This has caused a shift in the models for commercialization and distribution of goods and services. It also challenges existing regulations, which are not always ready to deal with digitization of content and pervasive online transactions. Furthermore, content and applications need to be adapted for the needs of different users living in diverse realities. For this reason, targeting specific markets, such as those in developing economies, and the development of local content are particularly relevant for an effective and efficient contribution of broadband services to social and economic development.

It should be highlighted that, although content and services are playing a fundamental role in this new high-speed environment, the production of content and the content that is on offer have not yet met expectations. The main hindrances here would appear to be the uncertainty of demand and the lack of a sound model for managing and charging for content.[27] Also, there is some debate as to whether the driving force in the broadband market is infrastructure or content. The danger of remaining in this stalemate situation is that a vicious circle may ensue, where compelling broadband content is not developed until there is mass adoption of broadband, and yet demand for broadband awaits suitable content in order to take off. To break or pre-empt this vicious circle, it is important that policy-makers and content providers be cognizant of the importance of content development, the real needs of users, and the regulatory, linguistic and cultural factors at play in specific content markets (see Box 4.4).

4.5.1 Evolving content models

In the era of analogue communications, the telecommunication industry could be roughly divided into three layers: equipment, network and services. The advent of telecommunication liberalization and competition began to change the structure of the market, allowing for the entrance of multiple players and the development of more fluid relationships among the different layers. The introduction of digital technologies brought in new possibilities for high-speed data exchange. The greatest change has undoubtedly been brought about by Internet technologies, which have given rise to new markets and have drawn players from other sectors—such as entertainment—into the fray.

Box 4.4: Local content

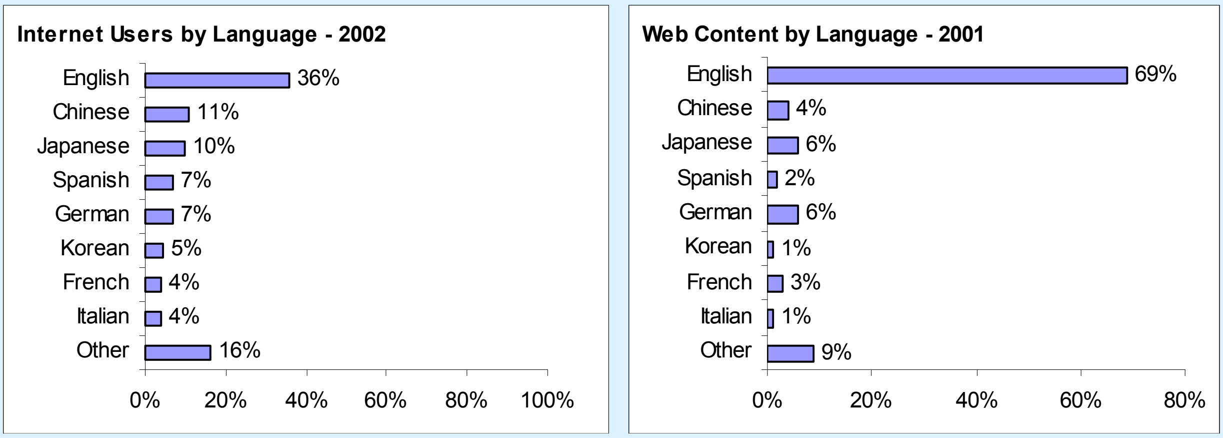
The development of appropriate content for broadband should also take into consideration the differences in languages and cultures around the world. As broadband is a new tool in the "infotainment" landscape, it is important, for its diffusion, that content be accessible and enjoyable to as much of the population as possible. Surveys have consistently shown how Internet usage tends to be much lower for people who do not speak English. It follows that Internet usage and broadband take-up is likely to increase substantially among non-English speakers when more local content is available (see charts below).

Recently, however, the development of Chinese, Japanese and Korean local content has progressed at a fast pace on the Internet. These three languages make up eleven per cent of web content, a higher figure than either French or Spanish. This corresponds to a level of broadband take-up, in Japan and Korea in particular, which far exceeds the level in most parts of Europe. Korea's most popular web portal, Daum, for instance, has always offered services in Korean, and has content tailored to local demand and is now one of the top five sites worldwide. Hong Kong, China has seen similar successes (see Box 4.2). In addition to several government website initiatives, all of the top global websites accessed by Hong Kong's Internet users (e.g., Yahoo, MSN, Lycos) have Chinese interfaces. It seems that governments in non-English speaking countries should ensure that policies are in place to encourage the development of local language content.

In Hong Kong, China, for example, barriers to working with Chinese text are being overcome. The Chinese alphabet uses ideographic characters where the appearance of the symbol is tied to its meaning. Though this can serve as kind of shorthand, reducing the number of symbols that are needed to represent a word, it also results in many more characters: the Hong Kong Chinese character set contains 4'818 symbols. The local government has been working to standardize various coding sets used to represent Chinese. But although Chinese can be difficult to type, 43 per cent of Hong Kong's population over the age of ten have used Chinese input methods for computers.

In short, efforts to increase the total number of websites about (and published in) a given country, as well as the amount of sub-national content (about states, provinces, and cities) is also likely to boost Internet usage and broadband demand. Links to local content on portals are also potentially useful for such things as news and entertainment in the city, sale of tickets for concerts in a certain region, bookings of restaurants or theatre shows, etc.

Internet users by language (2002) and web content by language (2001)

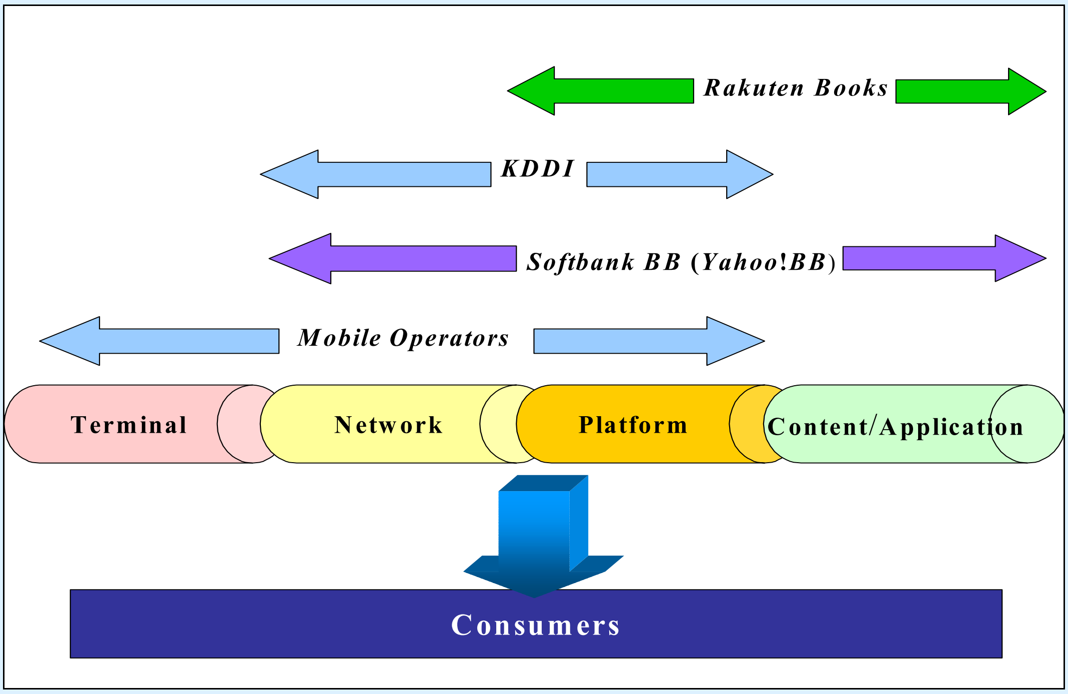


Source: ITU, adapted from Global Reach, Global Research Institute. On the importance of content in local languages, see also ITU case studies on broadband in Korea and on the Internet in Hong Kong, China at: http://www.itu.int/casestudies.

The mass diffusion of the Internet and the development of broadband technologies have further accentuated these changes, enabling the telecommunication industry to converge with other industries, which now have a prominent role in the market. Boundaries between content production, packaging and distribution are fading in the digital broadband environment, as well as the traditional separation between online and offline content producers. This gives operators, ISPs, access service providers (ASP), and content providers the possibility of developing their services in different business areas (see Figure 4.4). Such services can be financially more lucrative than the provision of traditional telecommunication services like voice and facsimile.[28] Broadcasters for instance, can produce and distribute their own content, and even undertake the production of online interactive content, such as television streamed directly to the Web. Publishers too, are offering their journals and magazines directly online, while companies such as News Corporation, AOL Time Warner and Microsoft provide services and content that is readily sought after by customers.

As the sector is undergoing structural changes, companies are trying to adapt their activities to strategically integrate between different stages in the value chain. They are extending their fields of activity to online services and gaining access to new customers, through mergers and acquisitions. Several approaches can be seen in the broadband content marketplace, including various mergers and alliances that cross the traditional

Figure 4.4: Telecommunication business unbundling and examples of cross-area businesses in Japan



Note: "Terminal" includes businesses involved in the production and sales of telecommunication equipment. "Platform" includes businesses involved in the authorization, charging, content distribution and copyright management. Finally "content/application" includes businesses involved in content/application production and sale.

Source: ITU case study on promoting broadband in Japan at: http://www.itu.int/osg/spu/casestudies/.

media boundaries. As is the case with VoIP, where cable operators are entering the voice services market, this results in new forms of competition and requires all players to keep abreast of developments. At the same time, the matrix of applications, hardware and content has grown more complex, opening the door to lower prices, better services and more choice.

4.5.2 Bundling and unbundling: Content in a high-speed world

In their endeavour to exploit the potential of broadband technology and services, broadband operators, ISPs, content providers, and the entertainment industry are studying new partnership models to offer a more complete range of services and applications and gain access to users, at the same time as guaranteeing revenues.

In 2001, one of the largest providers of dial-up Internet access, AOL merged with the entertainment giant Time Warner, and began upgrading its portal for broadband, providing more high-bandwidth content, such as full-motion video news, CD-quality audio, and video from the company's Time Warner division. In an attempt to maximize its market and counter the erosion of its subscriber base, AOL started an unbundled subscription to its portal services in addition to its standard access package. This is akin to a "bring your own (broadband) access" (BYOA) solution, and reaches a wider number of broadband users. However, this strategy did not seem to bring about the desired result, and the company was losing clients steadily[29]—at least until the deployment of AOL for Broadband, an effort to convert AOL dial-up customers into broadband users.[30]

A different example of partnership can be found in Japan, where Softbank Corporation, the holding company of the DSL provider Softbank and the ISP Yahoo Japan, launched Yahoo BB!, a service providing both broadband access and innovative high-speed services in the country. Softbank managed to attract some 2'822'000 subscribers (June 2003), i.e. about 30 per cent of the market, thanks to its low prices and diversified services (e.g. IP telephony, WLAN hotspots, and access to films and other content).[31]

The trend towards subscription-based access to content is continuing, with Yahoo and SBC—a large US telecommunication company—launching a co-branded service that features Yahoo's portal content and services bundled into SBC's Internet access. Earlier this year, Yahoo also launched a new portal in the United Kingdom aimed at broadband users and signed a distribution agreement with BT Broadband. They have been negotiating with other entertainment companies, such as Fox or ABCNews, for the inclusion of their content in its premium package.[32]

However, the shift from free to paid access, which becomes financially unavoidable when offering enhanced content, such as movies or music that are usually subject to copyright, is not easy. Internet customers have exhibited their unwillingness to pay for such content, especially if it can be obtained free of charge from an alternative P2P source.[33] Linking access and content allows players to have a closer (billing) relationship with their customers. It is akin to a one-stop-shop solution that includes all the services needed, and gives ISPs the opportunity to diversify their revenues. This is important when taking into account the decline of the online advertising market. In the United States for example, Yahoo receives a cut of subscriptions and will share its advertising revenues with the telecommunication company. Yahoo BB! in Japan makes a web page available detailing which part of the user's subscription rate is for ADSL access (Softbank BB), dry copper line rental (NTT), ISP (Yahoo Japan) and other enhanced services, such as voice over IP.

The availability of exclusive content packages bring us close to the so-called "walled garden" approach. This method has been used by AOL, which made exclusive content available only to its own subscribers. However this exclusivity was double-edged, as customers could not easily access websites external to AOL. Today the idea of a "walled garden" is gaining credibility again among other carriers, who see it as "a better way to organize the marketplace and monetize the network".[34] However, in this case, the idea is to propose preferential access to subscribers to specified content and premium services without limiting their opportunity to search the web for further resources.

The discussion thus far has been focused on content and service providers operating in the online market (AOL, Yahoo, MSN, etc). These companies provide mainly online services (e.g. e-mail or web hosting) and act as search engines or content aggregators, giving subscribers access (paying or free) to a series of resources through a single portal. There is also a second type of content provider in the Internet market, which traditionally offers its products offline, but is now exploiting the potential of the Internet to widen its reach. Newspaper and magazine publishers, for instance, now offer online subscriptions and news channels, and entertainment players (recording companies, film industry, etc) are beginning to make their entrance on the online market.

These players are offering their products either as part of the services of an ISP,[35] or as a stand-alone un-bundled and un-aggregated product. The Economist magazine, for example, is offering access to the magazine online for US$ 69 a year, or to both paper and online versions for US$ 129 (in the United States). The online version not only includes the availability of archives and search tools, but also provides the possibility of purchasing a one-off journal article. A similar service has been successfully implemented by the Wall Street Journal,[36] providing online news starting from US$ 79 a year. Some companies also provide enhanced services on the Web, such as video shots or highlights. The success of these services is probably linked to brand recognition, but of course there are other factors, such as the quality of content and value-added services. Also, the diversification of sources of revenue (on- and offline subscriptions, advertising, sale of single articles/copies, etc.) helps to ensure the sustainability of such services in the long term (see Table 4.1).

As mentioned earlier, traditional multimedia companies are making an appearance on the Internet stage. Although there are still many legal and regulatory issues to be resolved, in recent years many companies have started offering music online. A recent example is Apple iTune, which allows users to download a single song starting from US$ 0.99. Other services, such as MusicNet or PressPlay, propose a monthly subscription fee, which gives access to a certain number of services (e.g. streaming, downloading, etc.).

These activities open the door for future developments in the broadband market. For the moment, however, bundling access and services seems to be the most viable method to help the diffusion of this service, and to attract less technology-enabled users. In the future, the reason behind bundling strategies may relate more to the "organization" and selection of content, and the ease of utilization, rather than to exclusive access. Providers may find it more convenient to offer their content and services without discrimination to all users, who will probably look increasingly for specific content that is not offered by the generic portals or aggregators, and be willing to pay to access it.[37]

Table 4.1: Internet broadband services

Company	Subscription price	Services offered
Yahoo BB! http://bbpromo.yahoo.co.jp/	US$ 32.60/month for 26Mbit/s connection, ISP services and modem rental. JPY 990 (US$ 8.41) should be added for WLAN rental.	Access to traditional Internet services (e-mail, storage capacity, etc.) and to added value services, such as access to 802.11b Wi-Fi hotspot services and IP telephony.
AOL BB http://www.aol.co.uk/broadband	US$ 9.95/month (BYOA) (in UK GBP 27.99 /month (US$ 45.40) for 516 kbit/s connection).	Access to exclusive content, such as movie trailers, music, news. Internet services (e-mail addresses, storage capacity, parental control, etc.)
MSN 8 http://www.msn.com/	US$ 9.95 (BYOA) or US$ 49.95/month (broadband access + enhanced services)	Access to value-added Internet services, such as storage capacity, e-mail addresses, parental control, etc.
Now.com.hk http://www.now.com.hk/	HKD 30/month (US$ 3.85) + pay-per-view items.	Access to enhanced content for broadband users (video on demand, music, fashion shows, e-shopping, etc). More convenient packages for simultaneous subscription of now.com.hk and BB Internet access are proposed.
The Economist http://www.economist.com/	US$ 69/year	Online access to the journal. Enhanced services, such as archive and search tools.
Wall Street Journal http://www.wsj.com/	US$ 79/year	Online access to the newspaper + enhanced services, such as archive, research tools and personalized news tracking.

Note: BYOA = "Bring-your-own (broadband) access".
Source: ITU research.

4.5.3 Complementing broadband: television broadcasting and personal video recorders

Video and audio streaming, as noted earlier, are set to be two of the main broadband applications. The advantages offered by broadband will be the possibility for consumers to enjoy interactive services that are also tailored to their needs. Interactive television (iTV) will allow users to interact with their television set to select a movie from a central bank of films (known as video on demand, or VOD), playing games, voting, or providing immediate feedback over a television connection. With the improvement in broadband speeds, image quality will also be perfected in the future, thereby improving the overall viewing experience.

But this kind of interactive service also extends to other technologies. The personal video recorder (PVR), which can be defined as an interactive TV recording device, is in essence a sophisticated set-top box with recording capability.[38] Like the traditional video cassette recorder (VCR), a PVR records and plays back television programmes, with the difference that it is able to store the programmes in digital (rather than analogue) form. Most PVRs come as part of a subscriber service, which enables activities such as searching for shows according to type (e.g. films or football matches) or feature (e.g. a certain actor or player). Users could also choose delivery format, e.g. video-on-demand (VOD) options, streaming, etc. The service will also offer users a personalized list of likely programmes of interest, through a system similar to the one used by Amazon.com. There are a number of PVRs on the market, including TiVo's DVR, SONICblue's ReplayTV, Sony's Cocoon, and Philips' PTR.

While digital video on demand is still struggling, TiVo's product has been well received by users, owing to its low cost and ease of use, and the delay in broadband implementation. A TiVo Series 2 DVR costs about US$ 250, plus a monthly fee of US$ 12.95 for the service—or a one-time flat fee of US$ 299. In the United Kingdom, Tivo's PVR is sold by Sky, the major company in the subscription TV market, with 6.8 million subscribers.

Nevertheless, the use of PVR does not exclude broadband. (On the contrary, it even promotes its utilization, in particular for connecting to a home network, or providing enhanced home media services.) As it has been said, computers are moving from our offices to our living rooms,[39] where they are beginning to merge with home entertainment systems. Innovative models of PVR, such as TiVo Series 2 or Sony's Cocoon, can connect to a home network and stream audio content or display images, which are downloaded to a computer. New functions for TiVo include access to broadband content from Universal Music Group, enabling subscribers to play selected music and videos.

Starting from the basic PVR, broadband is accelerating progress towards "broadband media centres" which can then be connected to other devices such as home networks, intelligent appliances, navigation systems, and so on, either through wired or wireless connections. This development clearly points to the evident erosion of barriers between traditional television delivery and broadband networks.[40] Indeed, broadband high-definition television (HDTV) may be just around the corner.

4.5.4 Content protection and intellectual property rights (IPR)

While broadband is offering users access an increasing quantity and quality online content, such as music, films, archives, databases and information, this content often stems from media that are typically subject to intellectual property right (IPR) protection. The need for protection of content also extends to network security: with more information being transmitted over the network, users need a reliable and safe communication service to ensure adequate protection to their information and data. Moreover, with always-on Internet connections, computers operate in a constantly "networked" environment and are therefore more vulnerable than ever before to external attacks and intrusions. Network security issues are explored in greater detail in Chapter seven of this report.

In recognition of the implications of free-flowing information across national boundaries, and of the reproducibility of artistic and creative works across a large spectrum of media, intellectual property frameworks are constantly being adapted to new ICT-enabled media.[41] It is important for policy-makers to weigh the benefits and costs of current levels of copyright protection, particularly because "free" access to copyrighted material is a key driver of broadband take-up. One argument put forward is that copyright is being utilized beyond a "useful" level and may constitute a threat to legitimate, fair use of content in the public sphere. The primary undesirable effect of this is a stunting of competition and innovation, the very things copyright is designed to foster and protect. It is clear that better access to content will increase the attractiveness of broadband to users.

One of the main purposes of IPRs is to balance the incentive to producers, artists and authors to foster the creation of new content and applications with the ability of society to benefit from these creations. This is in the interest of developing and maintaining a rich public domain, a fundamental element for creativity and education.

Digital and communication technologies have certainly had a disruptive effect on the established IPR system, and have in many instances broken this delicate balance. In particular, since the well-known Napster case that blew up in 2000 over free music downloads[42], peer-to-peer (P2P)[43] technologies have been seen as a threat by the entertainment industry (see Box 4.5). With broadband, the type and quantity of content exchanged globally is set to increase drastically, raising the stakes around IP issues higher than ever.

This problem first arose with the launch of Internet P2P services, which have now become very popular among users of faster broadband services. However these files are often illegal copies of music, movies or software, which can be distributed seamlessly everywhere in the world. The music industry claimed a loss due to Web-based free swapping of digital music of about 7 per cent in 2002, and the same is feared by the movie and software industry.[44]

Online music services are currently provided by a handful of companies such as MusicNet and PressPlay, and more recently Apple's iTunes. Users have been adopting these services at a rapid rate – more than one million songs were downloaded in the first week of iTunes' launch. The high take up of iTunes seems to be due to the ease with which customers can access and use the service, and the relative freedom they can enjoy once they purchase music.[45] Apple is now trying to strike a deal with major music companies, and to get smaller independent companies on-board, hoping to obviate one of the main shortcomings of proprietary services – the limited variety and quantity of music available.

Box 4.5: P2P (peer-to-peer) networks
Content exchange across networks

The Internet is essentially a communication network, which allows people to connect with each other and to exchange resources and ideas. The dramatic evolution of networked communications, in both speed and capacity, has today brought the emergence of a new form of communication, no longer based on a client-server hierarchy, but on a equal relationship between groups of users, or peers, i.e. people at an equivalent level in the Internet hierarchy; hence the expression "peer-to-peer", abbreviated as P2P.

Systems using peer-to-peer technology, such as Kazaa, today allow for the sharing of files among individual users, and offer to them the possibility to exchange also copyrighted material, such as musical files, facilitating the violation of copyright laws.

A P2P network can be composed either entirely of peers at the same level (decentralised P2P) or a sort of hybrid system of client-server and a peer network (centralized P2P). In the second instance, a centralized server directly links all the connected users together. Without this server there is no network. An example of a P2P network using a centralized technology is Napster, which acted as an intermediary between two peers, facilitating MP3 file seeking.

In a decentralized network, conversely, each PC is a node, which is at the same time both a client and a server. Every computer in the network is connected to every other computer without the need for any centralized server to control the content. Equality among peers is perfect in this case, as the information goes through all the connected computers. Today there are numerous new decentralized architectures, such as Kazaa, Morpheus or Grokster, which have implemented new technologies and enhanced the accessibility and the quality of their services.

P2P allows the exploitation of the potential residing at the edges of the network infrastructure. Before P2P, the million of computers connected to the Internet were not really a part of this network. In fact they were nothing but clients. With P2P, all these computers can become a part of the network.

The P2P model is seen as the key element in the Internet evolution, and many of the most innovative initiatives on the Internet are deriving from the utilization of this model, the example being the famous Napster or Kazaa for the exchange of music, video or software. But P2P is also at the basis of instant messaging (IM) services, chat software (such as IRC), and SETI (Search for extraterrestrial intelligence) project (where the spare capacity of PCs is used for the elaboration of data). It is also used for university collaboration programmes, and helps the exchange of information among researchers. Additionally, as the cost of distribution through the Internet is practically inexistent, a host of unknown artists are likely to use the new potential provided by these technologies to spur their carriers, and be less dependent upon the traditional music distribution system. Peer-to-peer technology in itself can be the vehicle to foster innovation and the spread of new intellectual creations.

Source: ITU research.

Given that P2P systems cannot be blocked, and that online pirating will never be completely eliminated, the entertainment industry should probably try to offer users incentive to stay with them by providing improved services and convenience, as is the case with "premium services" and preferential access to content. The development of iTunes, although still in its early stages, seems to provide a good example. It is particularly easy to access the service, since it comes pre-loaded on Apple computers, and there is nothing to download from the Internet. Furthermore, there is no subscription procedure. Once songs have been downloaded, they are automatically saved in the folder "my music" in the user's music player, from where they can be copied onto CD-ROM or listened to from the PC. As with online newspapers, online music providers also offer previews of video-clips, information on artists and events such as concerts. Not all users have enough technical knowledge or time to access more complex services such as those offered by Kazaa, and thus, simplified services such as iTunes will be welcome.

While music has been the focus of IP discussions surrounding Internet content, the precedents set in this area will certainly remain valid for other media forms: the pertinence of IPR to content and to broadband development cannot be overlooked. IPR issues are adding to the growing concerns of content and entertainment companies, which are seeing their revenues from the traditional market decreasing, while trying to find an appropriate and secure system to provide their products online. If they are to benefit from the opportunities offered by the new broadband market, there is every need for IPR protection to strike the right balance across a new global multimedia environment.

4.6 Conclusion

In conclusion, the question that could be asked is: why do users need broadband?

Broadband has primarily been seen as higher-speed Internet access, rather than as an important driver for new applications and content, but perhaps the reticence of policy-makers, operators and content providers to make a greater investment in broadband—and more "noise" about its virtues—is misplaced. While this chapter has highlighted some of the current uses of broadband, and some of the types of content available, what is needed to show all the potential of this technology is still not there: truly innovative applications that are different from those available via traditional dial-up access. It is not just a question of improved access or web browsing, but of a completely new conception of entertainment models and knowledge building.

While there does appear to be a low-key approach to broadband in some markets, some application and service providers are promoting broadband as an indispensable tool. All too often however, the needs of the audience they are targeting are forgotten. While public institutions and businesses can find the utility of broadband in having always on high-speed access, private end-users should be given a good reason to justify the additional expense. With the current economic uncertainty and mistrust in the market (provoked by the still-fresh bursting of the dot.com bubble), the emphasis should be placed on breaking out of the "wait and see" mentality, which is in danger of jeopardizing the potential success of broadband applications. However, there is some "hype" surrounding broadband which may benefit from a dose of realism: the costs involved are far from negligible, and no number of applications will replace the need for relevant and accessible content.

Overall, it is essential to perceive today's market as one where the Internet is far from being limited to the World Wide Web. With the arrival of broadband technologies, particularly in combination with wireless technologies, the Internet becomes part of the wider entertainment chain, and for this it needs to change its position from a tool to improve existing services, to a doorway to a whole new world of anytime, anywhere connectivity. In the next chapter of this report, some of the ways in which these goals can be reached, and examples of how broadband has been successfully promoted, are explored.

1 See: http://www.kazaa.com/.

2 It is worth noting that in some cases, broadband connections are not billed on an always-on basis, but rather on the basis of a basket of hours, followed by a per-hour rate. See for instance, Hong Kong's Netvigator broadband services – http://www2.netvigator.com/services/netcs/prodandsrv/boardband/bb_detail_3m_iframe.html.

3 See for example the report by Equity Research at: http://www.vonage.com/media/pdf/res_05_21_03.pdf.

4 "Why voice over Wi-Fi has telcos dialling 911", Wired News, June 2003, at: http://www.wired.com/wired/archive/11.06/start.html?pg=8.

5 At: http://www.paris.org/Musees/Louvre/.

6 At: http://www.si.edu/.

7 At: http://www.shoutcast.com.

8 At: http://www.live-radio.net/.

9 See: http://www.bbc.co.uk/radio/aod/.

10 See: http://www.now.com.hk/.

11 See ITU case study on promoting broadband in Hong Kong, China, available at: http://www.itu.int/broadband/.

12 At: http://photos.yahoo.com/.

13 In addition to simply playing games against each other, Xbox users don a headset and actually can speak to all other player in the game. See "The Mixed Joys of Online Gaming", March 14, 2003, at: http://www.msnbc.com/news/884272.asp?0cv=TA01&cp1=1. See also ITU case study on promoting broadband in Japan, available at: http://www.itu.int/broadband/.

14 See: http://www.us.playstation.com/news/PressReleases/415014843.asp and http://www.microsoft.com/presspass/press/2002/jan02/01-08SuccessfulLaunchPR.asp.

15 Future broadband applications are discussed at greater length in Chapter seven.

16 See for example: "Has Benetton taken a "chips in clothes" U-turn?", Silicon.com, 7 April 2003, online at: http://www.silicon.com/news/500017/14/3640.html; "Benetton to track clothes with ID chips", ZedNet, 12 March 2003, at: http://news.zdnet.co.uk/story/0,,t269-s2131800,00.html; "Benetton to track clothes by using tiny chips", 18 March 2003, online at: http://seattlepi.nwsource.com/business/112912_clothingchip18.shtml; Benetton to track clothes with ID chips, ZedNet, 12 March 2003.

17 See for example the ICT Success Stories gathered by ITU/SPU at: http://www.itu.int/osg/spu/wsis-themes/ict_stories/.

18 For more information, see RAD Data Communications at: http://www.rad.com/cases/lindbergh.htm.

19 See the ITU case study on promoting broadband in Iceland at: http://www.itu.int/broadband.

20 See Nexcura.com at: http://www.nexcura.com/.

21 See: *Opportunities and barriers to the use of broadband in education*, Broadband Stakeholders Group (BSG), UK, 2003, online at http://www.broadbanduk.org/reports/BSG_%20Education_%20Report_03.pdf; S. Hoare "Broader Vision: Broadband for schools & colleges: Teaching the teachers", The Guardian, 3 Jun 2003; "Education faces BB changes", The Register, 29 April 2003.

22 See ITU, Broadband Korea: Internet Case Study, available at: http://www.itu.int/ITU-D/ict/cs/korea/material/CS_KOR.pdf.

23 See: http://www.ecitizen.gov.sg/.

24 See Ellison venture closes, June 10, 2003 at: http://www.news.com.au/common/story_page/0,4057,6569333%255E15306,00.html.

25 Salesforce.com, online at: http://www.salesforce.com/us/.

26 "Software's jolly iconoclast", The Economist, 5 June 2003.

27 See for example, "Filling the pipe: stimulating Canada's broadband content industry through R&D", May 2001.

[28] Fertig, Prince, & Walrod, 1999; Seaberg et al., 1997.

[29] The merger raised many problems inside the two companies, which are completely different industries, with separate objectives and agendas. Exploitation of synergies turned out as a theoretical possibility rather than a practical solution. See A. Klein *Stealing Time: Steve Case, Jerry Levin, and the collapse of AOL Time Warner* (Simon and Schuster ed., 2003).

[30] V. Vittore, "A broadband hierarchy of content kings", Telephony online, 12 May 2003. Online at: http://telephonyonline.com/ac/may_12_2003/.

[31] See the ITU case study on promoting broadband in Japan, available at: http://www.itu.int/broadband/.

[32] About the partnership, see "Semel paints bright future for Yahoo", Cnet News, at http://news.com.com/2100-1023-977771.html. The service is now available for subscription at www.sbc.yahoo.com/; For a review of the service see "SBC Yahoo DSL" online at http://www.cnet.com/internet/0-3762-8-20627373-1.html.

[33] As discussed later in this chapter, one of the most common utilizations of broadband is for illegal music trading.

[34] V. Vittore, "A broadband hierarchy of content kings", Telephony online, 12 May 2003. Online at: http://telephonyonline.com/ac/may_12_2003/.

[35] For example Yahoo in the United Kingdom is negotiating with Fox and ABC, among others, to include their content in its "Yahoo Platinum", a subscription-based service offered in the UK. In this case Yahoo! is acting as an aggregator, and the content provider will receive a percentage of Yahoo revenues based on subscription fees. See "Semel: Products to drive Yahoo in 2003", 12 February 2003, online at: http://news.com.com/2100-1023-984333.html.

[36] CNET, "WSJ Reaches Member Milestone", 15 April 1998, online at: http://news.com.com/2100-1023-210214.html?legacy=cnet.

[37] An example can be given of the success of news websites during the first and second Gulf War: paying access to websites broadcasting the attacks on Baghdad increased dramatically, reaching up to 70 per cent, demonstrating the availability of a market for online content—even though the time-span was limited in this instance.

[38] A set-top box is a device that enables a television set to become a user interface to the Internet and also to receive and decode digital television (DTV) broadcasts. See definition online at: http://whatis.techtarget.com.

[39] "Home networks move to the living room", NetworkWorld, 21 February 2002.

[40] "TiVo Launches Home Media Extension", Communications Today, Vol. 9, Issue 63, 9 April 2003; "TiVo gets networked", PC World.Com, 9 January 2003; "Interactive TV, the future or failure?", Satellite News, 13 May 2002.

[41] The main international body of the United Nations family concerned with intellectual property is the World Intellectual Property Organization (WIPO). See the website at: http://www..wipo.int. For more on intellectual property issues in the information society, see the ITU/SPU background paper "Intellectual Capital in the Information Society" at: http://www.itu.int/osg/spu/visions/free/ITUIntCapitalpaper.pdf.

[42] See the article at: http://shopping.guardian.co.uk/newsandviews/story/0,5804,349327,00.html/.

[43] On P2P see "The Heavenly Juke Box", the Atlantic Online, September 2000, online at: http://www.theatlantic.com/issues/2000/09/mann.htm; and "Peer-to-Peer: An e-mail exchange with Gnutella developer Gene Kan", The Atlantic Online, September 2000, at: http://www.theatlantic.com/issues/2000/09/mann-kan.htm.

[44] See: http://www.wired.com/news/technology/0,1282,58583,00.html.

[45] See: http://blogs.law.harvard.edu/cmusings/2003/06/10.

5 CHAPTER FIVE: REGULATORY AND POLICY ASPECTS

This chapter examines some of the regulatory and policy implications of the emergence of new broadband technologies and services. In most countries governments have intervened in the marketplace in a number of ways in order to realize the public policy goal of ensuring universal broadband availability at affordable prices. As discussed in Chapter three, government intervention has occasionally taken the form of direct government participation in the construction and operation of broadband networks. More often, however, governments have sought to encourage the efficient private sector supply of broadband services by establishing and maintaining a competitive broadband market environment.

Should governments regulate broadband? What policy instruments are best suited to promote competition? Basically, as has been shown throughout this report, where both the private and the public sectors interact to create the right framework, broadband growth makes greater headway. Tethered to government regulations and guidelines that are geared to fostering a healthy level of competition, broadband operators can grow their services and networks. Similarly, by lifting or modifying certain restrictive regulatory practices, governments can considerably boost the supply and demand cycle. From there, a virtuous circle of social gain and economic growth can emerge.

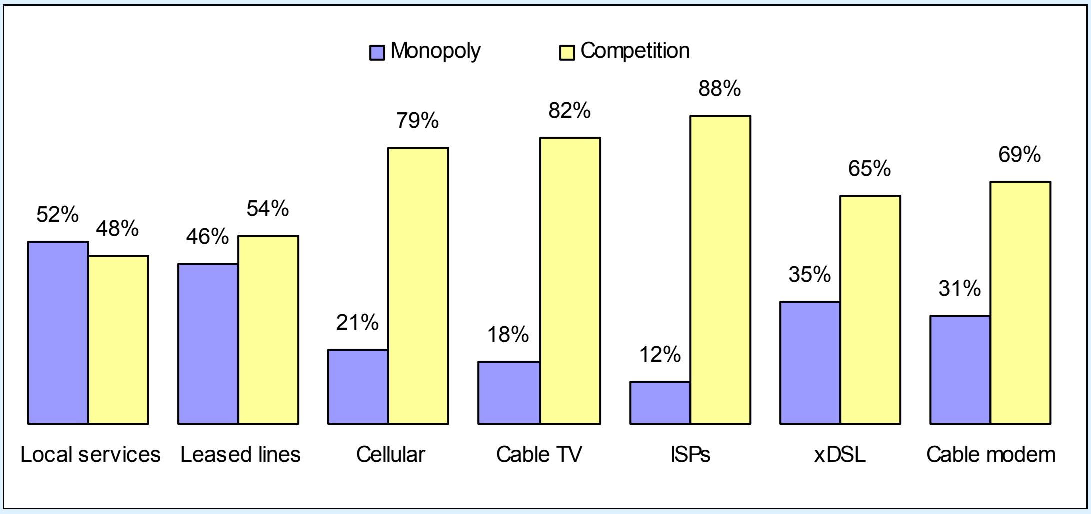
In addition to competition trends and policies, this chapter looks at, *inter alia*, how regulation can facilitate the market entry of new broadband providers, ensure fair competition in the marketplace and promote universal broadband service provision.

5.1 Trends in broadband competition

As the benefits of competition have increasingly made themselves felt, market liberalization has been embraced by a growing number of economies, particularly in the markets for newer services such as cellular services, Internet access and broadband (see Figure 5.1, showing the percentage of countries allowing competition in 2002).

Figure 5.1: New ICTs go hand in hand with competition

Percentage of countries worldwide allowing competition, for selected ICT services, 2002



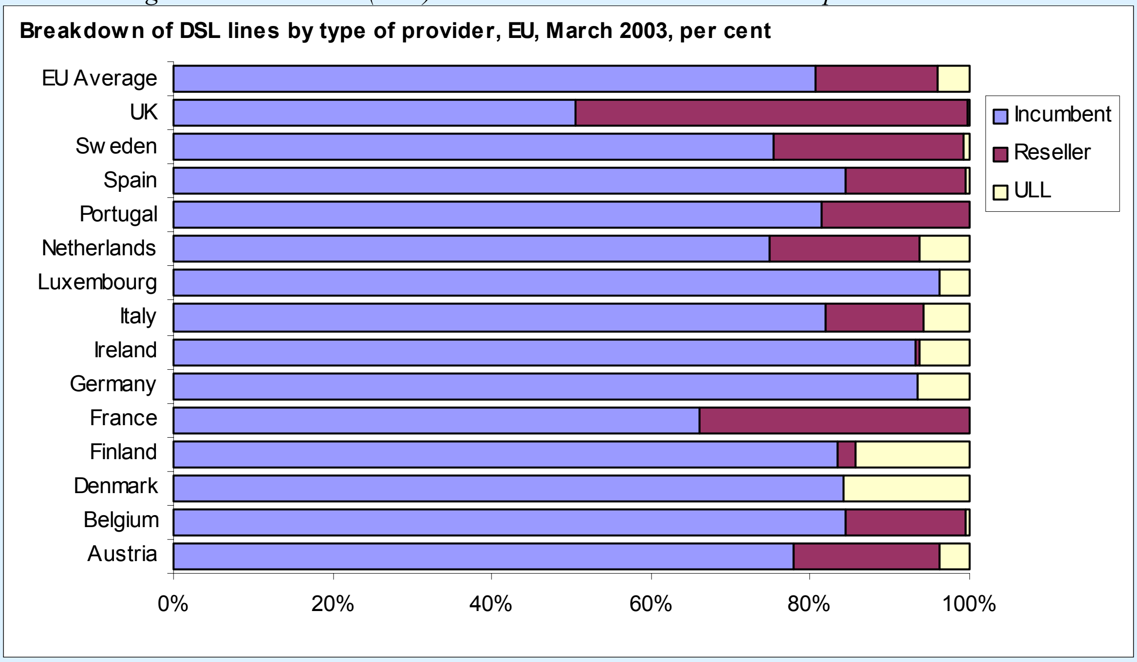
Source: ITU World Telecommunication Regulatory Database.

In spite of this trend towards market liberalization, especially in broadband services, there still remain significant concerns as to the true extent of meaningful competition in communication markets worldwide. In the provision of cable television (TV) services for example, although some 82 per cent of countries claimed to allow competition in their cable TV markets in 2002, the real number of countries with effective competition is far fewer. For example, although nearly all African countries had authorized cable TV competition, many of these countries did not even have a single cable TV operator.[1] A distinction therefore has to be drawn between hypothetical and actual competition.

Another notable trend has been for incumbents to continue to dominate in markets where they have been allowed to compete alongside new entrants, even in historically competitive markets such as for mobile and Internet services. In 2002 for example, incumbents operating in EU economies controlled more than 80 per cent of the broadband access market (see Figure 5.2).

Figure 5.2: Incumbents still dominate broadband—even in competitive markets

Broadband over digital subscriber line (DSL) incumbent market share in the European Union



Note: ULL = Unbundled local loop.

Source: European Competitive Telecommunications Association (ECTA) DSL Scorecard, April 2003 at: http://www.ectaportal.com/ectauploads/dsl_apr03.xls.

These figures corroborate the reality that even in countries where telecommunication markets have been liberalized, market opening by itself has not been sufficient to bring about the development of meaningful competition. Of course, this in part reflects commercial realities such as limited market size, lack of economic stability, and poor returns on investment, all of which affect new players' ability to compete effectively with an established incumbent operator. But it also reflects current government processes for setting competition policy. In this context, it has become increasingly important for countries to have the necessary policies and institutions in place to deal effectively with the increasing quantity and complexity of competition issues that are delaying the development of meaningful competition. Once the policy environment is right, then it can then be left up to the dynamic between business and consumers to determine the pace and direction of telecommunication market development.

5.2 The need for effective regulation

Although broadband is widely seen as a new phenomenon requiring new policy and regulatory approaches, most economies today already have a basic framework in place to drive competition in the broadband market. Infrastructure sharing, local loop unbundling and efficient spectrum management are some of the existing regulatory instruments that have been employed to create a pro-competitive environment for broadband.

There are, however, a number of distinctive implications for policy-makers with respect to broadband markets. Unlike the traditional market for voice services, the broadband market is a relatively new market that has been growing fast since the introduction of commercial services in the late 1990s. In most economies, it was initially seen as part of a wider Internet service market and as a result it was subject to less stringent regulation. However, with its dependence on facilities and networks that are still largely controlled by incumbent operators, policy-makers have nevertheless been required to intervene in the market to ensure fair competition.

Broadband communication services also cover previously distinct markets that have traditionally been regulated largely along technology lines. In other words, broadband simultaneously enters different fields that were previously the almost exclusive domain of, for example, fixed-line telecommunication providers, mobile providers, cable TV operators and ISPs. Regulators are therefore starting to adopt a more "technology-neutral" approach towards the regulation of broadband services. This includes taking into account the interaction between previously distinct regulatory market, for example in the form of cross-ownership of telecommunication and cable companies, in order to better formulate pro-competitive policies for broadband.

5.3 Facilitating market entry

Most governments have prepared for competition by taking measures to lower legal and regulatory barriers to market entry that have traditionally accompanied the provision of telecommunication and broadcast services.

Onerous and lengthy licensing procedures, local franchising of telecommunication networks and restrictive rights-of-way regimes, *inter alia*, have been identified by policy-makers as significant barriers to entry, which delay the establishment of facilities-based competition in broadband markets.

In examining how to facilitate or stimulate market entry, policy-makers should therefore weigh up the potential barrier effect of their licensing arrangements. While the revenue generated from licensing procedures can be a positive factor, when the cost is too high this can be a deterrent, and licensees may not be left with the means to invest in infrastructure. This scenario has already been met during the intense period of third-generation telephony licensing in many countries during 2000-2001. Similarly, the granting of rights of way in the case of municipalities and local governments may serve as a significant financial obstacle for competitors who are seeking to roll out broadband infrastructure while high licence fees for spectrum may preclude all but incumbents from participating in spectrum auctions for fixed-wireless broadband access frequencies.

5.3.1 Licensing and registration

Experience in several economies has shown that complicated and prolonged licensing procedures increase the cost of market entry and delay the commencement of operations. In streamlining their regulatory processes, some governments have implemented regimes favourable to building infrastructure by doing away with complicated licensing requirements altogether. In Canada for example, a company can become what is termed as a non-dominant carrier by registering through a simple letter, giving them the right to build facilities and facilitating their access to rights of way.[2]

Municipalities and local governments should also be constrained from granting franchises that create monopoly carriers on a local level. Where municipally-owned networks are necessary, in particular where private companies have failed to build out networks, conditions mandating open access to municipal networks for example, could be used to encourage competition at the Internet service provider (ISP) service level.

5.3.2 Rights of way

Often, governments are the largest landowners and therefore control the vast majority of rights of way. Governments can therefore do a lot to help improve access by streamlining and standardizing rights-of-way application processes, ensuring that fee structures are just and reasonable, and developing appropriate policies to ensure that telecommunication providers fulfill their rights-of-way obligations. Clear hierarchies should also be established where national regulators and municipal governments have jurisdiction over rights-of-way issues.[3]

Creative solutions, such as requiring new ducting for broadband to be laid when road works are undertaken, have also been considered by a number of local governments.

5.3.3 Foreign ownership restrictions

A number of economies continue to impose ownership and management control requirements on telecommunication and broadcasting companies—particularly those owning or operating transmission facilities—requiring a certain percentage of the company to be owned by locals rather than foreign owners. With the vast majority of broadband subscribers accessing broadband services through DSL and cable modems, foreign ownership restrictions on the ownership and operation of telecommunication and cable TV infrastructure serve as an obstacle to greater investment in broadband networks and increased facilities-based competition in the broadband market.[4]

While traditionally grounded on national security and cultural protection concerns, onerous foreign ownership restrictions have nevertheless been rolled back in recent years—in part through the efforts of the World Trade Organization (WTO) to promote liberalization in trade in investment.[5] Furthermore, with the stock market revaluation of the telecommunication sector in the early twenty-first century, foreign funds have sometimes been required to bolster flagging competition in local markets.

5.3.4 Radio spectrum constraints

As radio spectrum is a scarce resource, lack of availability is a problem for new services such as terrestrial wireless broadband solutions. The low frequency ranges, which are robust and offer point-to-multipoint transmission are subject to congestion because they offer little bandwidth, much of which has already been allocated. Higher bandwidths are more subject to attenuation and are suitable for point-to-point transmission only, although they offer greater bandwidth. The intermediate frequency ranges, usually between the 3-30 GHz range (see Chapter two of this report for more information on frequency allocations of various services), are generally robust, offer substantial bandwidth and are suitable for both point-to-point and point-to-multipoint distribution. As a result, they are increasingly sought after for the provision of wireless broadband services.

In order to meet this growing need, an increasing number of governments have taken the step of making more frequencies available to fixed wireless broadband services. For example, frequencies previously reserved for military and government use have been released and under-utilized networks have been reallocated to other frequency bands. However, there is a limit to the amount of new frequencies governments can release while reallocation will become increasingly difficult with new frequencies having to be found for migrated users.

While technological innovation is probably the most promising long-term solution to the radio spectrum drought, as it improves the efficiency with which radio spectrum is used, significant changes to radio spectrum *management* can also help solve immediate problems. A number of governments, such as those of the United States and the United Kingdom, have for instance considered giving greater scope to market forces in determining the most productive use of radio spectrum by allowing the creation of secondary markets for radio spectrum trading among users (see Box 5.1).

Going beyond the paradigm of licensed radio spectrum, frequency bands that are exempt from licensing ("unlicensed bands") have also been increasingly exploited for the provision of broadband services. As mentioned in Chapters two and three, Wi-Fi is proving to be an increasingly popular solution to providing wireless broadband access over unlicensed spectrum.

In many economies, governments have exempted users of certain blocks of radio spectrum from individual licensing. Typically, these involve radio spectrum uses that are extremely localised and that do not interfere with other licensed radio spectrum users. While unlicensed radio spectrum is widely credited for stimulating technical innovation and increasing coverage, especially in the context of Wi-Fi's growing popularity, it is

Box 5.1: Market mechanisms for managing spectrum
Reconsidering radio spectrum management in the United Kingdom

Under a review conducted for the British Government, it was proposed that secondary markets for the trading of radio spectrum be established. The Government will initially distribute radio spectrum through auctions (the primary market). Users would then be allowed to exchange, trade or lease the radio spectrum they have purchased to others (the secondary market). This secondary market would allow new users to enter the wireless market freely and develop a service by purchasing access to the spectrum they need when they need it without waiting for scheduled government auctions of spectrum.

Being exposed to the full opportunity cost of using radio spectrum through the operation of market forces would eventually spur greater efficiency in the use of radio spectrum. The role of the regulator should be limited to defining the initial bundle of rights and interference coordination requirements that attach to the radio spectrum rights, assigning these rights and ensuring compliance with these requirements as well as preventing anti-competitive behaviour in the secondary market.

Source: Professor Martin Cave, Review of Radio Spectrum Management, An independent review for the Department of Trade and Industry and HM Treasury, United Kingdom at http://www.spectrumreview.radio.gov.uk.

difficult to draw a conclusion that would require regulatory changes aimed at increasing the proportion of unlicensed radio spectrum. This is owed in part to some of the drawbacks of unlicensed spectrum, such as the lack of quality of transmission guarantees, low transmission power limits and possible congestion. Nevertheless, given the consumer benefits demonstrated by Wi-Fi, the preservation of unlicensed blocks of spectrum and the further liberalization of the way it can be utilized, such as by opening up the use of such spectrum to a range of technologies and services, appears to be well warranted.

International decisions have in fact already been taken along these lines. In 2003, at the World Radiocommunication Conference (WRC-2003) ITU's Radiocommunication Sector (ITU-R) reached a decision to open up more spectrum for mobile wireless access systems (WAS), including radio local area networks (RLAN), in the 5 GHz frequency band. It was proposed to allocate the bands 5'150-5'350 MHz and 5'470-5'725 MHz on a primary basis to the mobile service for the implementation of WAS, including WLANs. As many of the existing licence-exempt broadband networks operate in the 2.4 GHz band, the decision means that the less-heavily used spectrum at 5 GHz will provide scope for wireless broadband networks to unleash their true potential. The lower part of the 5 GHz spectrum is predominantly to be used for indoor applications with the first 100 MHz (5'150-5'250 MHz) restricted to indoor use. Interference mitigation techniques and power limits are imposed to the WAS use to protect existing services in the whole 5 GHz WAS band.

5.4 Ensuring fair competition

Lowering barriers to market entry lays the foundation for competition in the broadband market, but it is often not enough. The new entrants that were expected to loosen the grip of established (sometimes entrenched) incumbent providers have often found competing in the market to be much more difficult than expected. In many economies today, incumbents have come to dominate the broadband market by leveraging on the market power they possess in related markets such as that for telecommunication and cable TV. Given the market imperfections that exist and the risk to competition posed by the advantages enjoyed by incumbent providers, almost all economies have put general regulatory safeguards in place. Legal and regulatory instruments provided by anti-trust or competition law, as well as sector specific regulation, are employed to guarantee access to essential facilities and networks controlled by the incumbent, to check the accumulation of excessive market power and to prevent anti-competitive behaviour.

5.4.1 Market power and dominance[6]

In a market for network services, particularly for telecommunication, the incumbent or the most established provider usually has what is known as "market power".[7] Network effects, large sunk costs and often a long operational history as a public monopoly often allow such providers to attain significant levels of market power, allowing them to dominate the market. In order to level the competitive playing field, governments in many countries have subjected such providers to asymmetric regulation vis-à-vis the new entrants into the market. In the telecommunication market, these have included mandatory interconnection conditions, local loop unbundling requirements, and the divestiture of certain assets.

In order to establish if a provider is dominant, regulators first define what is termed as the "relevant market", against which the provider's market power can be measured.[8] While markets such as that for retail and wholesale local, long-distance and international voice telecommunication services have been long established, the identification of relevant markets for broadband has been undertaken in depth only more recently (see Box 5.2).

Box 5.2: The market for wholesale broadband local access
Markets susceptible to regulation in the European Union (EU)

In a recent decision, the European Commission identified two relevant markets related to broadband services in which the regulation of dominant providers could be considered by regulators in EU member states. They include (1) the market for wholesale unbundled access (including shared access) to metallic local loops and sub-loops for the purpose of providing broadband and voice services and (2) the market for wholesale broadband access which covers "bit-stream" access that permits the transmission of broadband data in both directions over the fixed public telephone network as well as other forms of wholesale access provided over infrastructures other than the fixed public telephone network, if and when they offer facilities equivalent to bit-stream access.

Source: European Commission recommendation of 11 February 2003 on relevant product and service markets within the electronic communication sector susceptible to *ex ante* regulation (ref: C(2003) 497) at: http://europa.eu.int/information_society/topics/telecoms/regulatory/maindocs/documents/recomen.pdf.

In general, the level of market power that is necessary to attract regulatory attention is commonly referred to as "dominance" or significant market power (SMP).[9] A number of quantitative and qualitative factors are normally considered in its determination among which market share is a leading indicator. For example, in Japan, the threshold is set at 25 per cent for a determination of SMP.

It is important to note, however, that a finding of dominance does not automatically lead to the application of *ex ante* sector-specific regulation in the market. Often, *ex post* competition or anti-trust laws have been relied on to prevent anti-competitive behaviour and to maintain competition in the market. Nevertheless, in circumstances where anti-competitive behaviour on the part of the dominant provider is entrenched or where barriers to market entry are high, *ex ante* regulation may be the best solution. For example, before applying *ex ante* regulation, the European Commission recommends that regulators in EU member states first consider the following three factors in determining whether a particular market requires regulation:

- The presence of high and non-transitory entry barriers whether of structural, legal or regulatory nature;
- Whether a market's structure tended towards effective competition within a relevant time frame; and
- If application of *ex post* competition law alone would adequately address the market failure.

The Commission also notes that regulatory agencies should also take into account the fact that e-communication markets are dynamic and may be able to overcome barriers in a given time period.

5.4.2 Providing open access to networks

Encouraging facilities-based market entry into the broadband market has been the preferred way to promote long-term competition and investment in broadband infrastructure. However, infrastructure competition usually develops at a slow rate, requiring significant financial resources and time on the part of competitors. Where existing incumbent infrastructure is already in place, entry costs to service-based competition are generally considered much lower. In this respect, many policy-makers regarded service-based competition as a transitional measure that would bring about the benefits of competition while facilities-based competition develops. To this end, many governments have regulated that incumbent providers supply competitors with access to their networks and facilities that have been deemed as essential for the provision of broadband services.[10]

Local loop unbundling (LLU)

Currently, DSL services provided over the local loop are the most appropriate medium for delivering broadband services rapidly, cheaply and widely in most economies. For the most part, however, incumbent telecommunication operators control the lion's share of local-loop access to homes and businesses. With few access alternatives to the incumbent's local loop, an increasing number of countries have required incumbent telecommunication providers to provide competitors with access to the unbundled local loop on fair, reasonable and non-discriminatory terms, through which they can offer their broadband services.[11] Often, prices for these local loops are required to be transparent and cost-oriented.

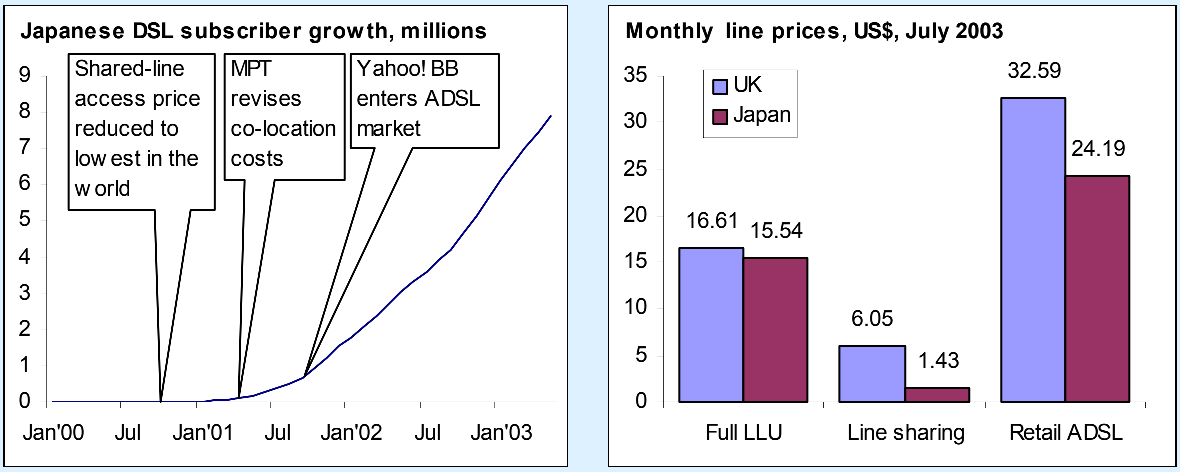
In general, the three following forms of local loop unbundling (LLU) can be placed on offer:

- Under **full local loop unbundling** (full access), the competitive provider has access to the entire line, both voice and data.
- Under **shared unbundling** (line sharing), the competitive provider has access to either the voice or data transmission portion of the line.
- Under **bit stream access**, the incumbent installs a high-speed access link to the customer and allows competitive providers access to this link. The incumbent maintains control of technical and service provision.

At the end of 2002, a total of 58 countries had mandated LLU in one form or another.[12] Overall, a greater number of higher-income economies have embraced LLU than developed ones.

The results following the implementation of LLU policies, however, have differed widely between economies. For example, the implementation of LLU in Japan has been relatively successful. Although LLU was first implemented in 1997 in Japan, resistance by the incumbents NTT East and NTT West in implementing LLU, and the Japanese Government's decision to promote DSL services, prompted regulators to revise LLU conditions in September 2000. These revised conditions lowered prices at which unbundled local loops (ULL) were made available and defined the timeframe under which incumbents were to make ULLs and collocation available to competitors. The result of this policy has been dramatic; DSL penetration in Japan has jumped from 70'655 subscribers at the end of 2000 to 6'590'000 in January 2003. By February 2003, competitors had captured 70 per cent of the ADSL market using predominantly unbundled local loops (see Figure 5.3, left chart).

Figure 5.3: Local loop unbundling and DSL growth



Source: (Left chart) ITU case study on promoting broadband in Japan at: http://www.itu.int/broadband; (Right chart) MPHPT, Japan and OFTEL, UK.

In contrast, the success of LLU in the economies of the European Union (EU) has been questionable. By end-March 2003, there were 10'653'850 DSL subscribers in the EU with incumbent operators controlling 80 per cent of the DSL market. Although EU regulation on unbundling was implemented in January 2001, competitive services provided over LLU only accounted for 4.7 per cent of all DSL lines.[13]

Although it would be impossible to attribute the growth of DSL penetration solely to LLU regulation alone, LLU pricing nevertheless appears to have a strong effect on retail DSL prices, which in turn tends to influence the level of broadband penetration in a country. The fact that Japan has the world's largest number of DSL subscribers and a DSL penetration rate of 5.51 subscribers per 100 inhabitants is not a coincidence given that line-sharing of the unbundled local loop is available at a monthly fee that is the lowest in the world (US$ 1.43). On the other end of the spectrum, the United Kingdom, where the monthly line-sharing fee is more than four times that of Japan, suffers from some of the lowest DSL penetration rates among the world's wealthiest nations at just 2.3 subscribers per 100 inhabitants at the end of 2002 (see Figure 5.3, right chart).

Cable open access

Cable open access is a term that refers to the ability for competing ISPs to offer broadband access services over cable TV networks. This enables a customer to subscribe to the ISP of their choice for broadband service regardless of which cable TV provider they are subscribed to for cable TV access.

Similar in a way to requiring unbundled local loop access to the incumbent telecommunication company's local copper plant, cable open access policies require cable access facilities to be made available to service-based providers on fair, reasonable and non-discriminatory terms.

Unlike local loop unbundling, cable open access policies have been implemented in only relatively few economies. In most economies, cable TV networks have generally been regulated under a different regime from telecommunication networks, enabling them to avoid the wave of pro-competitive telecommunication regulations that required telecommunication incumbents to open their networks to service-based competition. Without this regulatory impetus, the technology to allow the modification of cable networks to permit third-party access also developed very slowly. In general, the current process of facilitating third-party access to cable modem networks is undertaken in most economies in a monopoly environment similar to that of telecommunications in the past.

Canada, for example, was one of the first economies to take an aggressive approach to "opening-up" cable modem networks to competing providers. In 1998, the Canadian regulator, the Canadian Radio-television and Telecommunications Commission (CRTC), decided to regulate the conditions of third-party access to cable networks for the provision of Internet services. Nevertheless, due to technical delays as well as regulatory challenges by cable providers, it took more than two years for the CRTC to finalise cable open access terms and conditions.[14] Nevertheless, the debate over cable open access is far from being concluded. For example, faced with disappointing growth in competition in the telecommunication market following the implementation of local loop unbundling policies, the FCC in the United States has recently revised its regulatory position regarding the promotion of service-based competition in the broadband market (see Box 5.3).

Box 5.3: Inter-modal competition: Seeing the bigger picture
Cable open access and local loop unbundling in the United States

Until recently, the Federal Communications Commission (FCC) refrained from requiring open access to cable TV networks while requiring unbundled access to the local loop. In an effort to address the regulatory asymmetry and promote inter-modal competition between the two platforms, the FCC recently reclassified broadband services provided over both the fixed local loop and cable TV networks as "information services", in effect removing these services from access regulation.[15]

On 20 February 2003, the US Federal Communications Commission (FCC) ruled that incumbent local carriers no longer had to offer last-mile access to competitors over their networks. The ruling was an attempt to spur investment in next-generation networks such as fibre, with the reasoning that incumbent operators would be unwilling to make investments in next-generation networks if they are forced to sell unbundled access to competitors at cost-based prices.

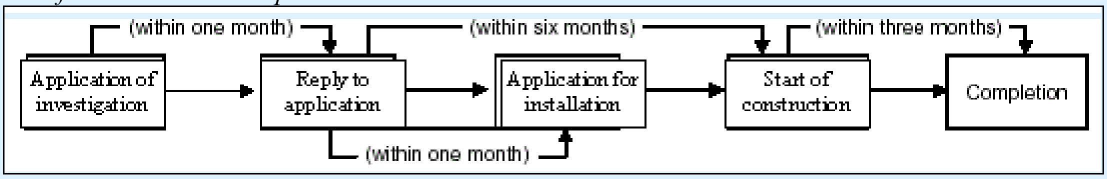
Source: FCC press release at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-231344A1.pdf.

Collocation and infrastructure sharing

A collocation regime is a necessary complement to network open access policies. Often, the process of collocating a competitor's equipment at an incumbent's exchange or main distribution frame (MDF) is a complicated and slow process that can involve considerable delaying tactics by the incumbent. As a result, most regulators have required incumbents to provide collocation to new entrants on mandatory terms and conditions and within a fixed timeframe (see Figure 5.4). In some jurisdictions, such as that of Canada, collocation disputes are resolved by industry-based committees that facilitate negotiations between providers.[16]

Figure 5.4: Regulating collocation

Procedures for collocation in Japan



Source: MPHPT, "Outline of the Telecommunications Business in Japan", October 2002.

Similarly, access to the inside wiring of multi-residence buildings has also emerged as a point of contention between incumbent and competitive providers. Some concern has been raised about the risks of access bottlenecks being created in multi-residence buildings resulting from the incumbent's exclusive ownership of inside wiring inmost buildings.

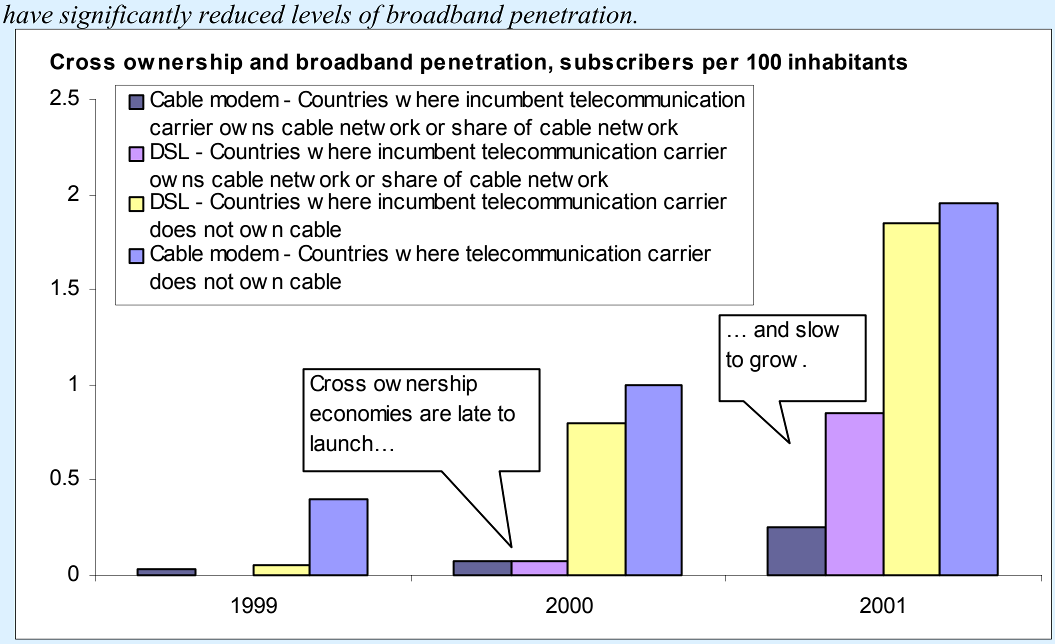
In Iceland, mechanisms for sharing infrastructure have been implemented. Since 2001, the incumbent has provided competitive providers access to in-house wiring through an arrangement which it calls "co-mingling" where it prepares a common facility such as a room in which competitive providers can install and operate their own equipment.[17]

5.4.3 Cross-ownership

Regulating broadband in a converged environment is complex because of cross-ownership issues that arise from the joint provision of telecommunication and broadcasting services. The situation is particularly acute when major telecommunication providers own cable networks or when cable providers own telecommunication networks. As a result, a provider has disincentives from rolling out both DSL and cable modem networks as the two would compete against each other. In such a situation often only one of the two technologies is introduced and prices will tend to be high (see Figure 5.5).

Figure 5.5: The corrosive nature of cross-ownership

Countries where incumbent telecommunication operators have stakes in companies offering competing broadband services have significantly reduced levels of broadband penetration.



Source: Adapted from OECD, Broadband Access for Business, 2002.

A number of Nordic countries have encountered obstacles to increased broadband penetration arising from to cross-ownership issues. In its report on Broadband Access for Business, the OECD found that while Nordic countries had high cable TV, mobile and telephone subscription rates, their broadband penetration (with the exception of Iceland) was lower than what was expected, with cable networks being under-utilized for the provision of broadband. In Sweden, for example, the incumbent Telia owns the PSTN and the largest cable TV networks. In Denmark, Telia is a competitive provider offering cable modem services over the cable TV network it owns. In Sweden, where Telia owns the PSTN network, 3.5 per cent of Telia cable TV subscribers subscribe to its cable modem service whereas in Denmark, where the Danish incumbent TDC is aggressively rolling-out DSL services, 32.4 per cent of its cable TV subscribers subscribe to cable modem services.[18]

As a result, in many economies, cross-ownership of telecommunication and cable TV providers is scrutinised by regulators with regard to its effect on competition. For example, the European Union adopted directives in 1990 and in 1999 that stipulated first the accounting separation, and then subsequently the legal separation of cable and telecommunication activities of dominant telecommunication companies.[19] As a result, a number of incumbents, such as the German company Deutsche Telekom, were required to divest their cable TV operations.

5.4.4 Anti-competitive behaviour

Beyond facilitating competitive entry into the broadband market, regulators and competition authorities are required to prevent anti-competitive market behaviour. The temptation is often great for an incumbent telecommunication or cable TV operator to leverage its market power in an adjacent market, such as that for voice services, or its control over essential facilities, such as the local loop, in order to obtain greater market share or higher profits in the market for retail broadband services. Common forms of such abuse of dominance include using revenues it receives in a market in which it is dominant to **cross-subsidize** the price of services it provides in the broadband market, the **bundling** of broadband services with other services that it provides in markets in which it is dominant and **discrimination**, in terms of differential pricing or terms, for essential input facilities or services provided to itself or its affiliate in the broadband market and its competitors.

Anti-competitive behaviour in terms of abusive pricing strategies have been common. Since broadband services have been growing in popularity, a number of operators have deliberately undercut competitors' prices for Internet access in order to entice users to convert to broadband. These and similar **predatory pricing** strategies often involve service providers incurring losses in an effort to gain market share (see Box 5.4).

5.5 Universal service

Regulations relating to universal service obligations (USO) for basic telecommunication are present in most economies. Basically, they constitute a requirement that telecommunication operators, usually the incumbent, provide basic telecommunication service to all who request it at a uniform price, regardless of the differences in the cost of supply.

Although in practice no economy has yet to include broadband services as part of a definition of universal service, an increasing number of economies have placed the matter under review usually as part of a government policy to extend broadband access to unserved rural and remote areas.[20] Nevertheless, a small number of countries, such as Australia and Iceland, have made data services part of a universal service obligation (see Box 5.5).

Box 5.4: European Union restrictions on "predatory pricing"
The European Commission fines French ISP Wanadoo Interactive for predatory pricing

With broadband increasingly seen as a key market, the European Commission has become increasingly vigilant of pricing practices designed to capture these markets. In July 2003, the Commission adopted a decision against Wanadoo Interactive, a subsidiary of France Télécom, for abuse of dominant position in the form of predatory pricing in retail ADSL broadband services. The Commission found that, from end-1999 to October 2002, the retail prices charged by Wanadoo were set below cost in order to increase their market share in the ADSL broadband market. In the Commission's view, the practice restricted market entry and the development potential for competitors to the detriment of consumers. In view of the gravity of the abuse and the length of the period over which it was committed, the Commission imposed a fine of €10,35 million (US$ 11.65 million).

In arriving at its decision, the Commission applied two tests set out in EU competition law to establish whether an abuse in the form of predatory pricing was committed: (1) where variable costs are not covered, an abuse is automatically presumed; (2) where variable costs are covered, but total costs are not, the pricing is deemed to constitute an abuse if it forms part of a plan to eliminate competitors.

These two tests were applied in the Commission's decision, for the periods before and after August 2001. From the end of 1999 to October 2002, Wanadoo, a 72 per cent owned subsidiary of France Télécom, marketed its ADSL services—known as Wanadoo ADSL and eXtense—at prices which were below their average costs. It emerged from the Commission's investigations that the prices charged by Wanadoo were well below variable costs until August 2001 and that in the subsequent period they were approximately equivalent to variable costs, but significantly below total costs. Since the mass marketing of Wanadoo's ADSL services began only in March 2001, the Commission considers that the abuse started only on that date.

Wanadoo suffered substantial losses up to the end of 2002 as a result of this practice. The practice coincided with a company plan to pre-empt the strategic market for high-speed Internet access. While Wanadoo was suffering large-scale losses on the relevant service, France Télécom, which at that time held almost 100 per cent of the market for wholesale ADSL services for Internet service providers (including Wanadoo), was anticipating considerable profits in the near future on its own wholesale ADSL products.

Wanadoo's policy was deliberate, since the company was fully aware of the level of losses which it was suffering and of the legal risks associated with the launch of its eXtense service. According to in-house company documents, the company was still expecting at the beginning of 2002 to continue selling at a loss in 2003 and 2004.

The abuse on which the Commission has taken action was designed to take the lion's share of a booming market, at the expense of other competitors. From January 2001 to September 2002, Wanadoo's market share rose from 46 per cent to 72 per cent, on a market which saw more than a five-fold increase in its size over the same period. This level of market penetration by Wanadoo is roughly what Wanadoo was expecting by 2004. The level of losses required in order to compete with Wanadoo had a dissuasive effect on competitors. At the end of the period during which the abuse was committed, no competitor held more than 10 per cent of the market, and Wanadoo's main competitor had seen its market share tumble.

Source: European Commission press release reference: IP/03/1025 at: http://www.europa.eu.int/rapid/start/cgi/guesten.ksh.

Nevertheless, there are several important considerations that have weighed against the inclusion of broadband services under a universal service obligation scheme. Firstly, broadband is still in an early stage of market development. The level of penetration of broadband in most countries has not reached a point where consumers lacking access to these services would face social and economic exclusion.[21] Furthermore, imposing USO for broadband may require significant investment in upgrading an operator's customer access network that would impact the development of services in other telecommunication areas. The delivery of broadband services on a highly cross-subsidized basis would also serve to reduce the likelihood of competitive market entry in these areas. More damagingly still, the increased reliance on an imperfect USO system may further entrench the position of incumbents, who are often the only providers that are in a position to provide universal services on a national level.

Questions also arise for policy-makers in defining what qualifies as broadband, and hence subject to USO. As pointed out in various chapters in this report, definitions of what constitute broadband—including in terms of speeds—are difficult to ascertain while the technologies are in a state of flux. This is in contrast to the PSTN, which has remained relatively stable. Government sanction of a minimum broadband delivery standard or a single technology may discourage the development of optimal tailor-made solutions for unserved areas.

Box 5.5: Universal service and broadband

Uniform broadband pricing in 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 under the Telecommunications Act, also known as the ISDN regulation, was passed by the Icelandic parliament. Under this regulation, data transmission at a minimum speed of 128 kbit/s must be guaranteed to all households in Iceland. As of February 2003, 98 per cent of Icelandic households had access to ISDN.

In 2000, the 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 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. This proposal is currently under consideration by the Minister.

Source: ITU case study on promoting broadband in Iceland at: http://www.itu.int/broadband.

Although no government has yet imposed USO for broadband services, the issue may be revisited again should broadband achieve a higher level of penetration and importance. Until then, as highlighted in Chapter three of this report, governments have been content to rely on targeted financial subsidies to providers, local governments and users as well as on the deployment of public-owned networks on a limited scale to meet the growing need to increase broadband service availability.

5.6 Conclusion

To meet the growing need for easily available and affordable broadband services, economies have increasingly turned toward market competition as a means to ensure the efficient private sector supply of such services. Effective competition, however, can be easily frustrated by the actions of incumbent telecommunication and cable TV operators who control the essential underlying infrastructure through which most broadband services are delivered. In this context, policy-makers should create flexible policy and regulatory environments in which the development of new and alternative means of broadband service delivery, such as wireless and fibre, can flourish. At the same time, policy-makers should also ensure that barriers to facilities based market entry are lowered while ensuring that existing copper networks belonging to incumbents remain open to service-based competition. Nevertheless, the experiences governments have had with the market liberalization of traditional basic telecommunication services have taught us that that of establishing effective competition in a communication market is a difficult one. The broadband market, which straddles both new services and old, will demand an even greater flexibility and adaptability on the part of policy-makers and regulators.

1 See: Trends in Telecommunication Reform, ITU, 2002, Chapter one.

2 See the ITU case study on promoting broadband in Canada at: http://www.itu.int/broadband.

3 See, for example, the resource website established by the United States National Telecommunications and Information Administration's (NTIA) to improve rights of way management among state and local governments in the context of broadband deployment at: http://www.ntia.doc.gov/ntiahome/staterow/statelocalrow.html.

4 See, for example, the considerations raised in the current review undertaken by the Government of Canada regarding its foreign ownership restrictions in the telecommunications sector at: http://www.innovationstrategy.gc.ca/cmb/innovation.nsf/MenuE/Invest00.

5 See the World Trade Organization (WTO) website at: http://www.wto.int/.

6 For more information and resources relating competition policy in telecommunications, see the website of the ITU New Initiatives Workshop on Competition Policy in Telecommunications, at: http://www.itu.int/competition.

7 Market power can be defined as "the ability of a firm to independently raise prices above market levels for a non-transitory period without loosing sales to such a degree as to make this behaviour unprofitable". Telecommunications Regulatory Handbook, World Bank/ITU, available at: http://www.itu.int/publications.

8 In general, there are usually two dimensions to the market, a product dimension and a geographic dimension. These are typically defined on the basis of demand and supply substitution possibilities. A widely accepted practice begins with the application of a "hypothetical monopolist test". Here the authority performing the analysis determines what substitution would take place if there were a small but significant non-transitory increase in the price (SSNIP) of a product or service. While the significance of the price increase depends on each individual case, price increases of between 5 to 10 per cent are normally applied. Products to which consumers would switch to in response to this increase would be included in the product market while the area over which this substitution can take place determines the geographic scope of the market.

9 The definition of "dominance" varies from jurisdiction to jurisdiction. In a number of jurisdictions, such as that of the EU and Japan, a related concept involving similar criteria is referred to as Significant Market Power (SMP).

10 With regard to telecommunication services, the World Trade Organization (WTO) Telecommunications Reference Paper defines essential facilities to mean "facilities of a public telecommunications network or service that (a) are exclusively or predominantly provided by a single or limited number of suppliers; and (b) cannot be feasibly be economically or technically substituted to provide a service".

11 In addition to local loops, regulators usually require the unbundling of a number of network elements that are considered as essential facilities for a competitor to supply telecommunications services. For example, the United States and the European Union require incumbents to unbundled (1) Local loops, including loops used to provide high-capacity and advanced telecommunications services; (2) sub-loops; (3) network interface devices (NID); (4) local circuit switching (except in some urban markets); (4) inter office transmission facilities (dedicated and shared transport); (5) signalling and call-related databases; and (6) operations support systems (OSS).

12 ITU World Telecommunication Regulatory Database.

13 See: http://www.ectaportal.com/ectauploads/dsl_apr03.xls.

14 See the ITU case study on promoting broadband in Canada at: http://www.itu.int/broadband.

15 See Federal Communications Commission (FCC), Notice of Proposed Rulemaking, Appropriate Framework for Broadband Access to the Internet over Wireline Facilities (FCC 02-42, Released: 15 February 2002), FCC Notice of Proposed Rulemaking, Review of Regulatory Requirements for Incumbent LEC Broadband Telecommunications Services (FCC 01-360, Released: 20 December 2001), and FCC, Declaratory Ruling and Notice of Proposed Rulemaking, Inquiry Concerning High-speed Access to the Internet Over Cable and Other Facilities; Internet over cable declaratory ruling; Appropriate Regulatory Treatment for Broadband Access to the Internet Over Cable facilities (FCC 02-77, Released on 15 March 2002).

16 See the ITU case study on promoting broadband in Canada at: http://www.itu.int/broadband.

17 See ITU case study on broadband in Iceland at: http://www.itu.int/osg/spu/casestudies.

18 See the OECD Broadband Access for Business Report at: http://www.olis.oecd.org/olis/2002doc.nsf/LinkTo/dsti-iccp-tisp(2002)3-final.

[19] See Directive 90/388 of 28 June 1990 on competition in the markets for telecommunications services [1990] OJ L 192/10, Art.9, as replaced by Directive 1999/65 of 23 June 1999 in order to ensure that telecommunications networks and cable TV networks owned by a single operator are separate legal entities [1999] OJ L 175/39, Art.1.

[20] See Patrick Xavier, "Should broadband be part of universal service obligations?" Info [2003] Volume 5, No. 1, 2003 at: http://www.emeraldinsight.com.

[21] See OFTEL, UK, 2001 at: http://www.oftel.gov.uk/publications/consumer/uso0801.htm.

6 Chapter Six: Promoting Broadband

6.1 Promotion and growth

Chapter one of this report described how rising broadband penetration, together with greater affordability and accessibility, has helped some world economies while leaving others lagging behind. But while penetration varies among countries, and so do user needs, almost all countries stand to benefit by participating in the birth and growth of broadband—which shows every sign of having a profound impact on ICT usage and application. If, as the title of this report—*Birth of Broadband*—suggests, we stand at the beginning of a growing trend, and if the scope for expansion is to be fulfilled, then actively driving the market and riding the crest of the broadband wave are the best ways to reap the benefits—both economic and utilitarian—of this new realm of info-communications. And while it is particularly vital for developing countries not to miss out, the signs are that much more can be done to boost growth in the developed world too.

This chapter examines the reasons for, and benefits of, promoting broadband, key factors that consistently appear to boost broadband take-up, and a breakdown of how supply and demand have and can be fostered. In particular, the creation of the right environment, pricing policies, competition, regulation and treatment of specific promotion issues facing developing countries are considered.

6.2 Why promote broadband?

In reality, there is more than one answer to the question of why it is worth promoting broadband. On a general level, analysis consistently shows that economies that actively pursue promotion of new technologies most often fare better in terms of access, economic gain and technological impact. Broadband is no exception to this. Analysis also shows that consumers often remain ignorant about the benefits they might gain by switching to broadband, and need some convincing to understand what is in it for them.

Beyond these general reasons, the reasons for promoting broadband, and thereby increasing its penetration levels, in fact depend largely on who the users are, and what they need. This differs for different segments of the population and different industry players—who can roughly be broken down into the categories of government, telecommunication operators, consumers (users) and businesses, as follows:

- For governments, broadband is a way of promoting economic development and certain social benefits. For instance, in the Republic of Korea and Hong Kong, China, which are currently the leading broadband economies, telecommunication expenditure as a percentage of GDP grew up to three times faster in the last ten years than the global average. As many countries have also experienced, broadband can also facilitate the provision of public services, such as e-learning, telemedicine and e-government.
- For telecommunication companies, broadband offers a route to offset the current slowdown in the industry. In the Republic of Korea, the average revenue per user (ARPU) for a broadband user is up to seven times higher than for a narrowband user.[1]
- For consumers, broadband makes possible a much wider and richer range of applications, especially when higher speed services are available. For instance, in a user survey in Japan, 70 per cent of users reported that broadband had increased their usage of the Internet.[2] In Iceland, some 40 foreign television channels are broadcast over the broadband network, greatly increasing the choice of services available.[3] In Estonia, the typical connectivity requirement for providing broadband to each school has risen to 100 Mbit/s, and a further rise to 1 Gbit/s is projected, but it is generally difficult to estimate future bandwidth requirements (see the example of Estonia in Box 6.1).
- For businesses, in particular small- and medium-sized enterprises, broadband brings the advantages of access to high-speed communications, and the ability to reach a worldwide audience that were previously only available to larger companies. Broadband also adds flexibility to the workplace through teleworking and remote network access at fast speeds.

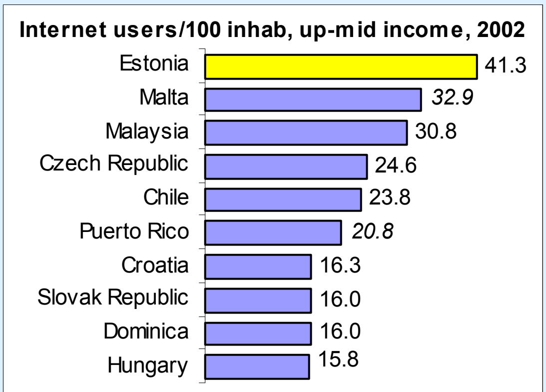
It is one thing to perceive the pressing need to promote broadband, however, and another to actively engage in its promotion. This is where the experiences of economies that have done so provide valuable keys to what works, and what doesn't. As with any new market, embarking on the promotion of a new product requires careful analysis of the factors that determine the success or failure of take-up, and solid groundwork to ensure that those factors exist or can be created.

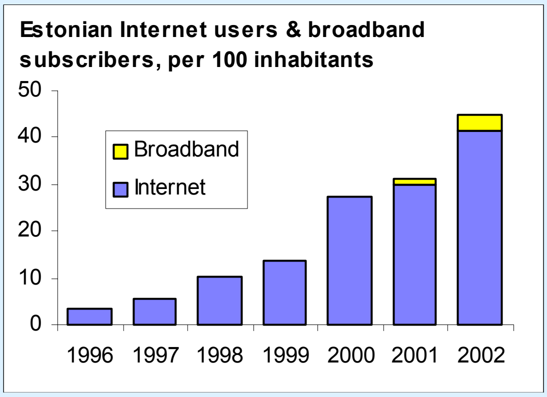
Box 6.1: Estonia: Tiger, Tiger, Burning Bright
Broadband in education: Far-reaching benefits

Estonia launched the Tiger Leap National Programme in 1996 in an effort to make a developmental leap by introducing ICTs into secondary schools. The targets were to achieve the ratio of one PC per 20 students, an Internet connection to each school, and basic computer training for all teachers. Today, the programme has accomplished most of its goals. Through Tiger Leap, 75 per cent of all Estonian schools have broadband Internet connections and the remaining schools have a dial-up option. More than 63 per cent of teachers have received training courses, acquired basic computer skills, and have been given guidance in using contemporary ICTs in teaching.

Investment in IT education and the promotion of broadband access in Estonian schools has been a significant factor in spreading the use of ICTs more broadly, beyond the boundaries of the education system. The programme has attracted considerable backing from local governments, the private sector and international investors, and has helped to shape Estonia's progressive reputation. Today, 35 per cent of the Estonian population uses the Internet, 38 per cent uses personal computers, and 18 per cent have their own home computers. Furthermore, 90 per cent of government agencies' computers are connected to the Internet. These figures place Estonia as the leader in usage of the Internet in upper-middle income countries (see left chart). Estonia's broadband penetration (at 3.4 subscribers per 100 inhabitants in 2002) also ranks it among the world leaders.

Some six years after the introduction of Tiger Leap, a new generation of Estonians, accustomed to fast information access and equipped with ICT skills, is reaching university level. As these students grow older and continue to demand fast access to information in different areas of their lives, the demand for ICT-related competence can be expected to continue its rapid growth.





Note: 2002 Internet users for Malta and Puerto Rico are estimated.

Source: International Bureau of Education (2002), at: http://www.ibe.unesco.org.; NDP Estonia (2002) at: http://www.undp.ee/tigerleap/2.html.

6.3 Success factors for broadband: what drives successful broadband take-up?

In relation to broadband growth and development, success factors vary from country to country. One thing that is clear though, is that those countries that tackle both supply and demand issues have had most success in raising availability of broadband and in the quality and choice of services. From the experience of countries worldwide, a number of common factors can be identified:

- Competition – Both inter-modal and platform-based competition (cable modem, DSL, fibre and wireless) and/or inter-operator competition help drive high broadband deployment and take-up.
- Innovation – Promotion of innovation in relation to broadband technology and applications by both government and private industry has been a key factor in the success of countries such as Japan with its rapid fibre-to-the-home (FTTH) build-out and its Ubiquitous Network Initiative, Iceland (which offers

broadband across power lines as well as via DSL and cable modem), and Korea (through the provision of converged networks).

- Applications – Development and rollout of pure-play broadband applications, such as online games in Korea, has attracted a critical mass of users and demands a high-capacity connection offered by broadband. Broadband offers users the possibility of receiving voice, data and broadcast entertainment ("triple-play") over the same connection.
- Pro-competitive regulation – A key regulatory strategy employed by a number of countries is an open access policy, which encourages shared access to networks. Canada is notable in this regard having unbundled both its copper and cable networks. Low charges for local loop unbundling and collocation are also important.
- Price – Affordable, innovative and transparent pricing schemes, such as flat-rate packages, are important to help promote user take-up.
- Speed – The existence of genuine high-speed and high-quality service offerings to consumers promote a wider range of applications.
- Marketing – Aggressive, or proactive, promotion of retail broadband services to consumers and user-friendly packages, which can be installed by the user ("plug and play") help create awareness. In Hong Kong, China, potential customers are offered competing low-priced DSL services from hawkers at street stalls.
- High ICT usage – Experience shows that those countries that already have high PC and Internet penetration have seen users embrace broadband most enthusiastically.
- Urban demographics – Broadband has tended to grow fastest in environments with highly-urbanized populations, especially where a high percentage of citizens live in apartment blocks. The young are particularly quick to adopt broadband.
- Benchmarking – Timely and reliable statistics in relation to a country's broadband penetration, coverage and usage are a valuable policy tool to allow governments to measure their progress against other countries and address bottlenecks. Competition between countries can be a spur to better performance.

The flip side of the picture shows a number of factors that can stifle broadband rollout. These include continued monopolies and low levels of competition, high or metered pricing, the imposition of caps on the volume of data that could be downloaded within a flat rate, lack of competition in the middle mile and certain State subsidies that produce market distortion. Broadband deployment has also been significantly slower in those economies where there is cross-ownership between telephone and cable television networks as this reduces the potential for inter-modal competition. Beyond the overall picture of patterns for success, a breakdown of supply and demand factors is a useful means of identifying how successful promotion can be achieved.

6.4 Promoting demand

6.4.1 Informing the public about broadband

The first striking evidence that is common to all successful broadband economies is that potential users are well informed about the benefits of broadband. This can be through the efforts of broadband companies, governments or other interested parties, and the key points that need to be made familiar to users are knowledge about what broadband is, and how it can be useful to them personally. Successful marketing and awareness campaigns therefore need to be geared towards this kind of demystification and familiarization; they need to take into account just what the user might perceive as an advantage.

One challenge is that the benefits of broadband are hard to appreciate until they have been experienced. Video game console manufacturers are very aware of this power of exposure to their products and have invested heavily in demonstration consoles in shops for people to try, hoping that a brief experience will convince consumers that they need a console at home. The unmistakable evidence is that, once users have "tasted" the experience of broadband, they are much more likely to want broadband access in their homes—this is the message that promoters of broadband need to take on board.

Schools provide an ideal environment to introduce youth to broadband, not only to realize the educational benefits of information access but from a marketing and awareness perspective. Many governments have taken the initiative by providing funding and establishing national plans to supply broadband to schools. In the United Kingdom, for example, the Government announced in November 2002 that it would provide funding for broadband connections to all schools by 2006. As seen in Box 6.1, Estonia's "Tiger Leap policy" has helped Estonia rank higher in broadband than countries with similar income levels.

In addition to supplying broadband to schools, some governments, such as the Government of Singapore, have initiated broadband promotion campaigns similar to the types of public information campaigns that promote the use of public transport or environmental recycling programmes. These campaigns generally do not promote broadband for the benefit of one provider only; rather, they highlight applications, content, and benefits of broadband through public service announcements.

While direct promotion campaigns have been highly successful in several countries, others have chosen co-branding as a method of increasing broadband awareness. Co-branding essentially involves the tying of broadband services to other products that consumers come into contact with and it can be an effective way to introduce users to broadband through companies they are already familiar with. This approach has the particular benefit of introducing broadband to users who are often daunted by the highly technical image they have of broadband, through a familiar channel. Japanese broadband providers for example, have teamed up with the producers of cartoon characters and gaming console manufacturers to sell broadband.

Bundling broadband with other similar services such as telephone or cable TV can be another effective way to promote awareness and market broadband to households. This is relatively easy with cable and DSL connections since cable TV operators and telephone companies often double-up as broadband Internet providers. However, bundling can also lead to market problems if users are forced to buy services in a package that leaves them with less choice and flexibility when they sign up for services—such as being obliged to make all calls through the incumbent's phone service.

Finally, as broadband promoters seek to introduce ways for people to first experience broadband, one aspect that is often overlooked is the potential promotional value of allowing users to network computers together and share a broadband connection, thereby pooling resources and saving on cost. The advantages of sharing a connection and paying less offer a highly persuasive incentive to potential users. Furthermore, if households are allowed to share connections or divide access among computers in one location, they are perhaps more likely to subscribe in the first place. Publicizing the ability of broadband to handle multiple users on a single connection could therefore be a highly effective way for promoters to convince users to sign up.

6.4.2 Effective use of broadband

It should not be overlooked that, as it is an enabling technology rather than a service or application *per se*, broadband is of little worth to users for its own sake. Being the owner of a broadband connection may be growing in appeal, but it does not always have the magnetism of a trendy image, so its promoters cannot rely on being able to plug the technology dissociated from the real selling points. Rather, the potential value of broadband lies in the applications it facilitates, the content it renders accessible, and how users embrace it. Broadband uses—in terms of applications and content—have already been explored in some depth in Chapter four of this report. This section therefore highlights those applications and types of content that have been particularly linked to successful broadband deployment in some markets and that warrant particular attention. In the broader context of what has already occurred in successful broadband economies, this should help broadband promoters find ways to encourage use in their own countries. Successful promotion, it should be noted, is not only advantageous in terms of making profits but makes for services and applications that better cater to users' needs, creating a positive spiral of supply and demand.

This point is corroborated by the fact that economies that have succeeded in promoting broadband haven't just promoted the technology, but have actually woven broadband technologies into their cultures. From teenagers in Seoul, Korea, who spend evenings in cybercafés chatting with friends via video, communities in rural Canada doing virtually all their shopping from home via their broadband connections, and Icelanders playing online games with users around the world; examples abound of how cultures have idiosyncratically absorbed broadband for certain uses—and where broadband has been a "hit" with certain user groups as a result.

Voice over broadband

A noteworthy example is how some economies have embraced Internet protocol (IP) telephony as a way for subscribers to save money on phone calls by making them over their broadband connections. While Internet telephony services have been available for many years, they have only recently developed into a service that works seamlessly through a broadband connection and functionally resembles the public switched telephone network (PSTN). Users are able to place and receive phone calls directly via a phone and an adapter connected directly to their broadband connection, with no need for a standard telephone line or even a computer. These calls can either be routed to other broadband subscribers or patched into the PSTN, for free or at very low tariffs. As described in Chapter four (section 4.1), Yahoo Broadband (or Yahoo BB!) in Japan for instance, offers its 1.59 million phone subscribers free calls to one another across the country. Calls outside the network in Japan are billed at a flat rate of 2 US cents a minute, as little as one-tenth the price of the same call over the incumbent telephone operator's network.

Similarly to Yahoo BB! in Japan, some US cable companies have caught onto the trend for voice services over broadband. But the similarity ends there. Rather than marketing the product as something new and different (such as voice over broadband, or voice over IP), they have passed their services off as yet another phone service under such labels as "digital phone service".[4] While they are competing with other telephone operators, they are not selling themselves as outsiders, but are approaching the broadband market under the guise of providers similar to those already in existence. It remains to be seen whether one or other of these approaches is preferable, and it may be that the US cable companies' approach better suits the US market. However, the trap may also be that users do not associate the new services with broadband or IP telephony, nor with the low prices that hold such appeal.

As regards pricing strategies for IP telephony, an important consideration for promoters is that IP telephony is particularly appealing in countries with metered local calls, although these services are also popular in areas with *unmetered local* usage but *metered long-distance* calls. Packet8 subscribers in the United States, for example, can pay a flat rate of US$ 19.95 per month for unlimited nationwide calling via their broadband connection. Companies like Packet8 and Vonage in the United States, and Yahoo Broadband Japan, are heavily promoting their services and this marketing push should help convince users that broadband can be more cost effective than they may think. Nevertheless, while IP telephony can be a driver for broadband, offering it can be a very difficult decision for incumbent operators. Promoters may do well to emphasize the enhanced service it can bring to the user.

Video over broadband

While phone services over broadband appear to hold vast potential, many predict that video services will be a key future element of broadband demand. This seems logical, given that television has become a centre-piece of information and entertainment in most cultures of the world, and the television set is a piece of equipment that already exists in a huge proportion of the world's homes. If video delivery shifts to broadband then, its popularity seems more than likely to increase. Indeed, video may yet prove to be the killer broadband application. As an example, the Now.com.hk broadband portal in Hong Kong, China delivers true video-on-demand to broadband subscribers (see Box 4.2). This has in part contributed to Hong Kong, China having the second highest per-capita broadband penetration in the world.[5]

In a related development, many users in successful broadband economies are already making heavy use of another broadband video technology—web cams—to communicate with family and friends. As mentioned above, users in Seoul, Korea, often have video chats with several users at a time. Users typically join a chat room and type their messages on a community board. Each participant's video image, or avatar, is simultaneously broadcast on the screen of other users, creating a video mosaic of all the participants. Examples like these can indicate to promoters what future trends are likely to be, and enable them to harness awakening consumer interest in a new and exciting application effectively.

Audio over broadband

The above applications are largely in the realm of the future, but another field of application: *audio* over broadband, has already proven to be a killer application capable of driving broadband adoption, especially among younger users. Users in certain successful broadband economies download music and listen to audio streams over their connections (see Box 6.1 on music over broadband in Belgium). To raise penetration levels then, broadband promoters should be able to cash in on the availability of legal music, the ability to listen to radio stations around the world, and the higher quality of music over broadband. Broadband can be pushed on the basis of the added quality it brings for music applications thanks to the higher bitstream rates it affords.

Box 6.2: Music on the cheap in Belgium

How Belgians make and share their music freely via broadband connections

The Belgian site Belgiummp3 is a forum for artists to post and share their music in MP3 and streaming audio formats. It offers lesser-known, unsigned artists a way to spread their music to a wider audience via broadband connections. The site caters to artists in Belgium and The Netherlands but accepts music submissions from around the world. Since the site only contains legal music, authorized by the artists themselves, it has been able to secure the approval of SABAM, the Belgian Society of Authors, Composers, and Publishers.

Users listening to music on the site have the option of rating the band/artist for other listeners and potential record labels. Bands and individual songs with the highest ratings are then highlighted on the site. This offers a useful way for the site's visitors to find music that others recommend without having to search through the vast number of musicians posting their music.

The Belgian example shows that broadband users are drawn to legitimate audio over broadband and many musicians are willing to make their music available online for free.

Source: Belgiummp3 at: http://www.belgiummp3.be/.

Entertainment over broadband

Online gaming has also slipped in quietly to become an important element that is already driving broadband demand. This is underscored by leading game console manufacturers such as Sony and Microsoft adding Ethernet ports and broadband capabilities to their machines.[6] Until recently, users have mostly played PC games online, but now these game console manufacturers may play a significant role in broadband promotion as their networks come online.

Even in the realm of photography, broadband promoters can highlight how fast Internet connections facilitate sharing photos at today's high-quality resolutions. As digital cameras become more sophisticated, their resolutions are approaching the quality of film. But this has also greatly increased the amount of memory required to store photos. While these larger files sizes have meant higher-quality printing, they have become somewhat problematic for many Internet users who wish to share photos online with family and friends. Downloading a 5-megapixel photo with JPEG compression over a 56K modem will take, at minimum, over two and a half minutes. Even a 1-megapixel JPEG can take around one minute to download. Broadband makes a big difference.

As well as the applications themselves, *content*, and in particular the language of content, is an underpinning feature of making broadband usage more popular. It is notable that some of the most successful broadband economies have produced content in local languages without relying on English only. Of course, content in local languages is a factor in Internet usage in general, but it has a particular relevance for broadband penetration because local language content gives users more reasons to stay online, and users who spend more time online are often the first to upgrade to faster connections. The availability of Korean content, for instance, has been an important factor in Korea's phenomenal success since all households, regardless of their ability in English, have a wealth of broadband content available to them.

Business over broadband

As well as the world of leisure, broadband can appeal greatly to the world of business for a good number of reasons, which promoters can usefully leverage. One major benefit to businesses for instance, is the ability to allow employees to telework, as a way to retain employees and minimize office costs. For example, Cisco Systems has been able to recruit engineers who weren't willing to relocate by allowing them to telecommute and the company claims the policy has enabled it to retain its best employees, boost productivity, and decrease operational costs. For teleworking purposes, faster connections help foster good productivity since they create a working environment closer to that in the physical office where download speeds and instantaneous network access are considered "normal" working conditions. Not only do employees avoid the frustrations of slow connections, but companies can make considerable efficiency gains.

6.4.3 Creating an environment that fosters broadband innovation

Broadband development is still only in its early days, and to make the most of its potential, it is essential to cultivate the right environment for its future expansion. While increasing broadband awareness and assimilating broadband applications are vital, policy-makers should create an environment that is open, innovative, and secure for fostering the content and application developments of the future. Specifically, an innovative broadband environment must address two specific issues: future content and application development, and the subsequent adoption by users.

On the development side, offering rewards and incentives for entrepreneurs has been shown to work well to encourage development of new applications and content for broadband. Strategies that have been used in various countries to promote innovation in broadband and information technology include:

- Direct public research and development (R&D) funding for local content and application creation.
- R&D tax incentives or tax deductibility for new investments, both in infrastructure and intangible assets such as software. These sorts of incentives can also take the form of cash rebates for R&D expenditures that may help spur the growth of young companies that often struggle to maintain cash flow.
- Open and thoughtful consideration of new spectrum uses. Wireless innovators thrive in an environment where open spectrum is available for development. Since one of the biggest hurdles for broadband network builders is the difficulty of upgrading or building out wired connections, governments should encourage development of wireless solutions by ensuring spectrum is available.
- Setting up and encouraging the development of technology diffusion programmes, incubators and venture capital funds. As one example, as a public/private partnership, the Canadian Network for the Advancement of Research, Industry and Education (CANARIE) helps raise and allocate funds for Internet development in Canada. One CANARIE project is the Advanced Broadband Enabled Learning project (ABEL), which will facilitate professional development for teachers via broadband.

Another method to stimulate entrepreneurial activity is to ensure that entrepreneurs are compensated for use of their creations. Intellectual property rights (IPRs) play a significant role within any innovation system, and broadband is no exception. IPR laws must strike a delicate balance between offering incentives to content and application creators, while still allowing society to benefit from the creations at large. If copyright protection is weak or non-existent, artists and producers may lose much of the financial incentive to create their works. Conversely, however, copyright protection is too strong if it limits societal use without increasing the incentives to create at the margin. Policy-makers must weigh up the benefits and costs of current levels of copyright protection, especially if "free" access to copyrighted material is a driver behind broadband take-up. This leaves governments with a thorny dilemma, but one that they should endeavour to address (see Box 6.2). IPRs are discussed in more depth in Chapter four of this report.

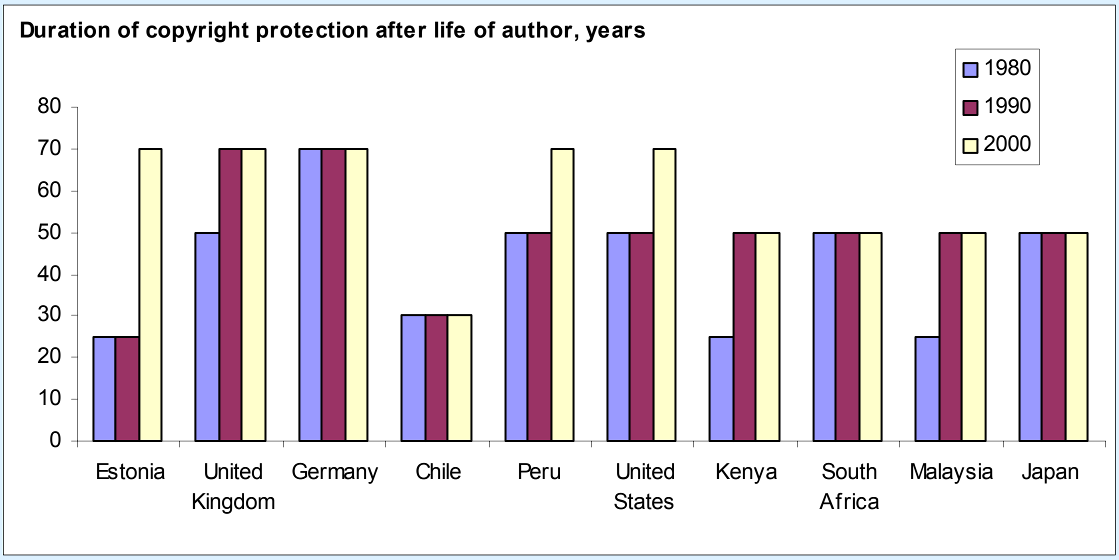
The encouragement of investment, including foreign investment, is another prime area in which governments in particular can be proactive. Many governments have adopted policies specifically targeted at securing investment for and promoting the development of ICT applications in particular regions. Striking models of such ICT regions include Silicon Valley in the United States, the Multimedia Super Corridor in Malaysia and Citywest in Ireland. Mauritius is also planning to establish "Cyber Cities" along the lines of those in other successful ICT regions around the world. There, municipalities plan to establish high-tech community areas by equipping residential, business and retail buildings with multimedia technology and advanced telecommunication facilities to enable a range of ICT related activities. Ultimately, the hope is to connect these Cyber Cities together to create a "Cyber Island".

Available evidence suggests that prices play perhaps the most important role in promoting broadband demand. Successful broadband economies are characterized by low prices—typically as a result of flourishing competition and innovative pricing schemes that attract a wide variety of customers. As price plays such a vital role in users' adoption decisions, it is vital for promoters to understand how policies that reduce prices increase broadband penetration. This section therefore focuses on affordability and pricing strategies, while the subsequent section on supply examines the effects of a competitive market structure on prices.

Box 6.3: Copyright laws have been getting stronger while illegal content flourishes

Governments are in a bind over intellectual property rights. On one hand, music downloads have spurred broadband adoption, which many governments feel is vital for their economy. On the other hand, content providers are demanding increasingly greater protection for their creations, threatening to stifle some of the incentives to adopt broadband. Large media groups have been better organized in terms of lobbying for increased protection into national legislation, but many users are crying foul.

There must be a compromise whereby content creators are compensated for their work, while at the same time, users have access to appealing content online. If economic gains attributed to broadband deployment are indeed as high as predicted, it should theoretically be possible to pass a fair share of the gains on to copyright holders. In practice, this is a much more difficult task. Until then, laws will most likely continue to get stronger while music and video files online remain underground.



Source: Reynolds, Taylor W., "Quantifying the Evolution of Copyright and Trademark Laws", 2003.

6.4.4 Prices

The rule of thumb is simple: users will only adopt broadband if its added value outweighs the material cost to them. But users do not all have the same financial threshold or needs. Before considering ways that broadband suppliers can tailor pricing plans to reflect the values of different users, it is crucial to investigate the issue of affordability. It is widely held that telecommunication services, including broadband, should be affordable. Although affordability is difficult to define, it can be said that it includes elements of:

- the ability to pay a price for a service without suffering hardship;
- the degree of need for what is purchased.

Perhaps surprisingly, affordability of broadband not only a major issue in lower-income countries, but is also one in higher-income countries. For example, research by the regulator Oftel in the United Kingdom shows that 3 per cent of the UK population, or around 1.8 million people, are "disadvantaged by the cost" of telecommunication services.

For those consumers that can theoretically afford broadband, the choice of whether to adopt typically depends on the relative pricing of narrowband (dial-up access) and broadband. Around the world, the price of broadband is usually more expensive than narrowband below a certain level of usage; however, a straight comparison is often difficult.

Broadband promoters can highlight the potential cost savings of switching to broadband for certain users. For instance, the use of broadband eliminates the cost of telephone calls to access the Internet service provider (ISP), as well as the need to rent a separate telephone line for Internet access. In addition, if broadband is also used to carry voice (e.g. voice over DSL, cable telephony, etc.), it can further result in considerable savings. For moderate to heavy Internet users, broadband often works out cheaper than narrowband. In Switzerland for example, the charges for a dial-up connection are equal to those of a

256 kbit/s ADSL connection if the user is connected for as little as 17 hours per month, just over 30 minutes a day.

While the price of dial-up Internet is often based on time spent online, the always-on nature of broadband means that the pricing model may require volume-based (or per-megabyte) charges if capacity is scarce. Accordingly, broadband suppliers in some countries set the price of broadband to consumers on the basis of volume downloaded. In some countries major broadband suppliers (e.g. Telstra in Australia) have gone as far as to place (potentially very restrictive) monthly download limits on some plans (sometimes as low as 100MB per month), with penalties for exceeding this limit. Broadband suppliers cite a desire for equitable usage of broadband networks (cable) as the reason behind these moves.

Many broadband suppliers have introduced tiered pricing plans, in recognizing that particular attributes of broadband are valued differently by different consumers. For example, consumers that make extensive use of online chat may value always-on connectivity ahead of high speed, while online gamers may insist on speed above all. Tiered pricing plans involve offering a range of connection speeds at a range of prices. For example, in Canada, a cable broadband provider scrapped its US$ 27 flat fee in 2002, instead offering a US$ 17 service that offers only 128 kbit/s downloads and 64 kbit/s uploads, and a US$ 30 service offering downloads at 1.5 Mbit/s and uploads at 192 kbit/s (the speeds of its former US$ 27 service). Tiered pricing schemes increase the options available to consumers and reflect a shift towards a consumer demand focus.

Acca Networks, an ADSL wholesaler in Japan has taken an interesting approach to tiered pricing by using an ordinary 8 Mbit line and technically limiting it to 1 Mbit download and 512 kbit upload. At US$ 11 a month, this effectively offers a lower entry point for low usage subscribers without cutting into its higher-paying subscription base.

Perhaps surprisingly, prepaid cards, which revolutionized access to mobile phones for many users owing to their financial advantages, prepaid cards for broadband have not been offered widely. This is despite the fact that prepaid cards for dial-up Internet access have proved popular in Thailand, the Philippines, Vietnam, and elsewhere. One area where prepaid *is* gaining a foothold is in the market for temporary wireless (Wi-Fi) broadband access via public hotspots, such as airports and train stations which are increasingly offering broadband access. However, the pricing plans are often prohibitive for those who are not planning on using the service for several hours. To cite one example, Swisscom introduced wireless access in train stations around Switzerland in January 2003, but with very high connection fees. Users must purchase either 2 hours at US$ 14 or 24 hours at US$ 35. Interestingly, the charge for just 24 hours of WiFi use is equivalent to a one-month Swisscom subscription to 256 kbit ADSL.

6.5 Promoting broadband supply

Fundamentally, the objective of broadband supply is to provide all those who would like broadband with the opportunity to access it. This section discusses issues, strategies and ideas for promoting the supply of broadband, while focusing on economies or regions where efforts have been particularly successful or interesting. The section also highlights possible roles for governments, regulators, telecommunication suppliers and the private sector in general.

The following factors are noteworthy examples of what successful broadband economies have put in place:

- A competitive market structure. Strong inter-modal competition as well competition among the same technologies leads to lower prices, increased feature offerings, and more extensive broadband networks. Cross-ownership by operators, however, tends to stifle broadband penetration. Competition policy authorities must continually monitor the competitive structure of the market and must be empowered to take action when necessary. Competition is discussed in greater depth in Chapter three of this report.
- Government programmes that focus on broadband. Local, regional and national initiatives have often proven successful in connecting communities to broadband. Direct infrastructure investment by governments can play a key role in developing broadband networks, especially in underserved areas. In addition, tax credits, low-interest loans, subsidies and other government programmes can also be important methods of stimulating broadband supply.
- Applying innovative ideas to expand the network. Existing networks are best utilized to their full extent alongside new network investment. Innovative broadband networks such as wireless, satellite, railway

and electrical can also be used to supply broadband where network expansion is not easy. And schools, hospitals, and community access centres can serve as initial broadband anchors in rural or remote areas in particular, eventually becoming the network access points from which future networks can expand.

6.5.1 Competition policy and regulation

It is widely held that competition in broadband supply is crucial for reducing prices, improving quality of service, and increasing customer service. Governments around the world take different approaches to managing competition, with some choosing a proactive approach to ensure competition (*ex ante*), while others remaining "reactionary"—intervening only when there appears to be an unfair use of a dominant position in the market (*ex post*).

While market prices for broadband depend on many factors, there are three elements of successful markets that are common among successful broadband economies.

- Competition via open access: Prices invariably fall when DSL and cable providers are compelled to open up their networks to competitors. This process is sometimes called unbundling the local loop (ULL).
- Strong competitive carrier: While open access is a first step, the best way for prices to fall is when there is a competitive carrier with deep pockets which is strong enough to compete effectively with the incumbent.
- Inter-modal competition: In addition to competition within a sector, prices fall when several broadband technologies compete for the same customers. The existence of strong DSL, cable, wireless and other providers in a market will ensure prices remain low.

Box 6.4: A successful recipe for broadband competition
The example of the Republic of Korea

Once again, owing to its groundbreaking position in broadband promotion and penetration, the Republic of Korea is one of the best examples of a well-functioning market, demonstrating how all three elements of competition via open access, a strong competitive carrier and inter-modal competition are in place to bring down prices. DSL suppliers all have access to Korea Telecom's (KT) local loop and have bid down DSL prices. Second, while KT remains the largest DSL provider, Hanaro Telecom was first to market with DSL and still has roughly one third of the market share. Hanaro's owners include major Korean companies such as LG, Samsung and SK Telecom. Korea also has multiple types of broadband available to most subscribers. Users can connect via DSL, Cable, LAN, satellite or WLAN. The combination of market dynamics has helped Korea develop a subscriber base per capita that is nearly twice the level of the next leading country in the world. This strong competition on all fronts has given Korea some of the lowest broadband prices in the world. Entry-level plans start at US$ 22.84 (KRW 30'000) and faster connections are closer to US$ 30 a month.

Source: ITU research (see also case study on promoting broadband in the Republic of Korea at: http://www.itu.int/osg/spu/casestudies/).

In addition to Korea (see Box 6.3), Japan's immensely competitive market is also characterized by all three elements and has quickly become one of the world's leaders, boasting the lowest broadband prices in the world. Japan reached this milestone after Yahoo BB entered the market and pushed ADSL market prices down 50 per cent on the local loop from US$ 40 (JPY4'800) to US$ 20 (JPY2'400). Yahoo BB!'s low prices and innovative services have increased its market share to 33 per cent, just slighting lower than NTT, making it a very strong competitive carrier. In addition to having open access and a strong competitor to match NTT, Japan has inter-modal competition from a wide group of technologies including cable, DSL, fibre, and wireless services. The interaction of these three factors has had an astounding effect on broadband in Japan. In the year following Yahoo BB!'s entry in the ADSL market, the number of ADSL subscribers increased five hundred per cent (from 922'000 in Oct 2001 to 4'640'000 in Oct 2002). Not only did the number of subscribers increase, fierce competition led to faster broadband speeds, with ADSL speeds jumping from 1.5 Mbit/s in 2001 to 12 Mbit/s, and to 26 Mbit/s by mid-2003, and fibre speeds reaching 100 Mbit/s.[7]

Competition has had profound effects on broadband markets, specifically in Korea and Japan and policy-makers around the world can use competition regulation to help foster other successful broadband markets. While extremely important, this is not a simple task.

This approach first requires an understanding of what the broadband market actually is. One common way to define a market is by the cross-price elasticity between goods. If a change in price in one of the goods significantly alters the quantity demanded of another good, both goods may be said to be in the same market. When viewed in this way, the market definition of broadband likely includes all high-speed Internet access, even though technologies, data transmission speeds, and providers may vary. However, it is worth noting that a broad market definition based on the number of potential providers does not imply that the market is truly competitive.

So, while different types of broadband (e.g. DSL, cable model, WLAN, etc) may be considered to be in the same market, governments often have regulations that do not apply evenly, or in a technologically-neutral manner. This is most evident with regulations imposed on incumbent telephone operators, who are often seen as dominant players. For example, some governments have mandated that incumbent telephone operators open up the local loop to competitors, in an effort to reduce the power of the incumbent and facilitate competition in the DSL market (unbundling the local loop). The view was that the cost of duplicating local loop investment could be considered to be a major barrier for companies seeking to provide services over a twisted pair telecommunication network. These moves have unsurprisingly met with great opposition from incumbent operators. While admitting they have control over the local loop, they insist the broadband market is much broader and that, in fact, they are not a dominant operator when other broadband options are taken into consideration. They point to cable and wireless providers as competitors in the full broadband market and argue that forcing them to sell access to competitors at regulated rates will reduce their incentive to invest. Specific regulatory issues surrounding broadband are explored in greater depth in Chapter five of this report, but a number of points are worth highlighting in the context of broadband promotion.

For instance, while governments and policy-makers need to consider what the broadband market is, and to define some form of competition policy that is conducive to broadband penetration, regulation of licensing, allocation of spectrum and so on needs to be ensured to foster a fair and competitive environment to stimulate supply at affordable costs and that meets consumer needs.

Appropriate regulation is particularly relevant in developing countries where a single telecommunication supplier is often dominant. In South Africa, as one example, the monopoly of the incumbent operator, Telkom, officially ended in May 2002, but as of the start of 2003, there was still effectively no competition in the telephone market. A second national operator was only scheduled to be licensed by March 2003. In such cases, it would seem prudent for governments to consider alternative measures to introduce competition into the market.

In the broadband market, if there are no cable, fibre, or wireless networks in place to compete with DSL, there may be a lack of inter-modal competition. In such cases, governments may choose to encourage the development of alternative broadband infrastructure. Governments could, for example, issue licences for alternative networks such as wireless LAN (WLAN) or fixed wireless and permit self-provision of these services. The development of wireless broadband technologies may gain further importance if laying cable or fibre networks is not feasible. Governments can aid this process through streamlining processes of allocating spectrum for wireless broadband.

Several broadband markets around the world have struggled with broadband rollout because of cross-ownership issues. This is a situation where major telecommunication operators also own portions of a cable company or cable operators own telephone networks. The result is a provider that has disincentives to roll out both DSL and cable modem technologies since the two would compete against each other. In this situation, often only one of the two technologies is introduced and prices tend to be high. As has been seen elsewhere in this report, several Nordic countries have had a particularly difficult time with cross-ownership issues and the effects are evident in their lower-than-predicted broadband penetration rates.

6.5.2 Governments and broadband

Governments' role in broadband promotion has already been identified as a key factor for success. And their role ideally extends even beyond that of ensuring a competitive market structure: they can also play a key role in developing various policies to help accelerate network rollout. The following sections examine the different frameworks for broadband supply and how governments can use tax credits, low-interest loans, government subsidies, and certification programmes to strategically expand broadband networks.

It should be noted that while the categories above refer only to national government initiatives, municipal and local governments can also use policy initiatives to promote private investment in broadband infrastructure. These include providing incentives, such as tax credits or low-interest loans with a view to developing and rolling out broadband technology. One such example is the State of Michigan in the United States, where legislation passed in March 2002 created a new “Broadband Development Authority” that is empowered to issue State-backed bonds and offer very attractive 20-year loans to public and private entities for fibre build-out. Michigan also provides tax credits to telecommunication providers who invest in new broadband infrastructure.

Some governments go so far as to subsidize broadband by reducing the price of broadband to selected consumers. In the United Kingdom, for example, several regional development agencies and devolved administrations have created the Remote Area Broadband Inclusion Trial (RABBIT). Their goal is to subsidize broadband connections for small businesses in remote areas not reached by DSL or cable. Qualifying companies can receive up to US$ 1’100 (GBP 700) towards one year of satellite broadband service. It is typical for these subsidies to be in the form of a one-time payment, the idea being that once users become accustomed to broadband connections they will not give them up when the subsidy ends.

Governments (particularly local governments) can also play a role in promoting broadband supply by certifying the broadband speeds of neighbourhoods and apartment buildings. By publishing this extra information, they may provide incentives to building developers to wire their buildings with the fastest connections available in order to lure tenants. Correspondingly, potential tenants can then use the connectivity of the building as a criterion when deciding whether to rent / buy an apartment. This has been very successful in Korea where the Government certifies new apartment buildings with 1st, 2nd, or 3rd class certificates on the building’s broadband network infrastructure depending on whether it provides over 100 Mbit, 10-100 Mbit or 10 Mbit Internet connections. Certification programmes such as these can jointly stimulate broadband supply and raise broadband awareness amongst consumers.

6.5.3 Innovative broadband roll-outs

Conventionally, broadband rollout strategies have been aimed at establishing infrastructure to enable supply of broadband to individual consumers. This typically involves telecommunication suppliers laying cable (either copper or fibre optic) and installing equipment to enable the supply of broadband over the telephone or cable network. However, some countries have adopted more innovative approaches to broadband rollout as a way to overcome the prohibitive costs of wiring remote areas. These ideas are discussed in this section.

Where network rollout is concerned, it is important to realize differences between countries and regions: while some economies are involved in debating competition law for broadband, others are still struggling to connect areas with basic telecommunication infrastructure. Despite the hurdles, there are ways that economies can develop their networks that minimize cost and provide flexibility for future growth. One concept, called “expanding point of profitability” or (EPOP), proposes the build-out of a network incrementally as each new node becomes profitable or feasible.

But there are also many less conventional ways to expand networks. Numerous countries have made use of existing infrastructure for broadband supply. The most obvious example is in the use of existing cable-television infrastructure to supply broadband Internet directly to the home. India is proving resourceful in making use of the existing signalling cables in its vast rail network to extend broadband access to rural areas, and although the sophistication of India’s rail network is exceptional amongst developing countries, some other countries might usefully follow India’s lead.

Countries are also starting to make use of electrical power lines to provide broadband access. Power line communication (PLC) works by transmitting high frequency data signals through electrical power lines to businesses and residences. A special modem filters the data signal out of the electrical current while providing speeds up to 3 Mbit/s. Iceland and Japan are just two countries making use of the power grid to deliver broadband and PLC could help expand broadband access in developing economies too (see also Chapter two).

As mentioned above, most countries have tended to focus their attention on the supply of broadband to individual users and businesses. An alternative that might be particularly attractive for developing economies is to promote the development and use of community centres offering broadband access, particularly in areas where it is not feasible and expensive (due to a lack of infrastructure and resources) to bring broadband to households. The approach taken by Mexico, for example, appears to be a highly successful strategy for extending broadband access to the population. There, the establishment of digital community centres has served to help extend broadband to rural and remote communities.

One alternative to the expense and difficulty of expanding landline networks is to focus on wireless broadband, a growing technology. Wireless broadband technology has the particular potential to overcome the difficulties in supplying broadband over the last kilometre, or "last mile" to consumers, or reaching areas out of the reach of traditional landline networks. It is also particularly appropriate for community access schemes. However, despite the tremendous hype, some telecommunication suppliers have found investment in wireless broadband to be unprofitable. One exceptional example is Lanka Bell, in Sri Lanka, which achieved success in 2002 by offering broadband over their fixed wireless local loop. In this way, Lanka Bell has offered broadband to businesses and households that do not have access to other types of broadband due to geographical difficulties and a general lack of other infrastructure. Lanka Bell's BellBurst service offers speeds from 64 kbit/s to 2 Mbit/s. Still small-scale, in October 2002, Lanka Bell had 40 subscribers, and a plan to reach 100 by the end of 2002. Spain and Hong Kong, China, have also made extensive use of wireless technologies to increase the size of their broadband networks.

6.5.4 Developing country experiences

While developed economies contain the majority of broadband subscribers in the world, developing economies are nevertheless beginning to provide and promote broadband, and promotion techniques can be usefully shared between countries. Experiences in these economies vary depending on various factors, such as geography and population. Many developing economies fall into a vicious cycle of high prices and low take up, where users cannot afford the initial prices, preventing providers from being able to negotiate better rates for higher bandwidth and curtailing any economy of scale.

In such economies, two particularly viable methods for promoting broadband include connecting schools and using community access centres to give users access to broadband without the vast fixed costs of wiring to homes. Developing economies must also make best use of the existing networks since they usually don't have the financial resources to build new networks. The COMPARTEL programme in Colombia provides a good example of extending access through community access centres.

Other countries, such as Jordan, have addressed broadband through government initiatives including e-government, e-health, and e-learning. Projects include initiatives that focus on teaching teachers how to interact and deliver material via computers and broadband connections.

6.6 Conclusion

Although not exhaustive, this chapter has sought to highlight some of the most salient reasons and strategies for promoting broadband technology. One of the main points to emerge from studies is that successful strategies and policies to promote broadband have typically sought to raise user knowledge of the advantages of broadband, and by combining the attraction of high-speed connections with applications and content that users really want.

To foster demand, promoters do best by informing users about broadband through schools, government programmes, and through intelligent marketing. They can also usefully adopt the approaches seen in successful broadband economies of merging new broadband technologies such as IP telephony, multimedia over broadband, online gaming, and various business applications into their cultures. It is important for governments and regulators to create an environment that fosters broadband innovation through attempts to spur innovation, careful management of intellectual property rights, varied distribution channels and by providing security to users. Countries that have successfully promoted broadband have competitive market structures and innovative pricing schemes that keep prices low.

The interest and utility of broadband for leisure, work, society and the economy are strikingly evident as broadband is now starting to take off in a few of the world's economies: it is up to the promoters heed the lessons as early as possible, so that broadband's potential can grow elsewhere.

[1] See the ITU case study on promoting broadband in the Republic of Korea at: http://www.itu.int/osg/spu/casestudies/.

[2] See the ITU case study on promoting broadband in Japan at: http://www.itu.int/osg/spu/casestudies/.

[3] See the ITU case study on promoting Iceland at: http://www.itu.int/osg/spu/casestudies/.

[4] Comcast, the cable provider in Utah in the United States is one such example. See the website at: http://www.comcast.com/Products/Telephony/LocalPhoneService.ashx?LocResult&Zip=84106.

[5] See the ITU case study on Hong Kong, China at: http://www.itu.int/osg/spu/casestudies/.

[6] See the ITU case study on promoting broadband in Japan at: http://www.itu.int/osg/spu/casestudies/.

[7] For more information see the ITU case study on promoting broadband in Japan at: http://www.itu.int/osg/spu/casestudies/.

7 CHAPTER SEVEN: BROADBAND AND THE INFORMATION SOCIETY

7.1 Technology and information for a knowledge-based society

The everyday lives of people throughout the world have already been radically changed by the impact of information and communication technologies (ICT). The world economy has "gone global", and since the late 1990s, the concept of the "information society" has become increasingly familiar. It is clear that these changes are the "tip of the iceberg" and that there is much more to come. But it is also becoming clear that the impact of technology on society has far-reaching effects: what are the real implications of this transformation? Greater security risks? Will access to information for everyone, everywhere really be achieved? Notions of the "information society" are both commonplace in their vaguest forms, and difficult to define in any detail, and are hence the subject of much debate and analysis. Some of the most recent attempts to integrate an understanding of the information society are discussed in Box 7.1.

The weaving together of digital networks and information with the social networks of the twenty-first century has significant implications for everyone. No matter how we choose to define the "information society", there are many unanswered questions about how, and the extent to which, we should promote developments that give an increasingly central place to the use of information and communication technologies in our lives. Regardless of whether we believe that today's information societies are fundamentally new, or that they are simply an extension of certain features of existing societies, the global spread of networks means that there are major implications for those who can participate easily and effectively and for those who cannot.

As this report has shown, among ICTs, broadband is not only a technology that is showing signs of seriously taking off, but it is one that, under the right conditions, has the particular promise of extending greater access to information, at lower cost, to more people worldwide. It is important then to look at broadband in the wider context of the emerging information society in which we will all participate. It is also important to look at the issues that may influence how broadband might be successfully promoted, and what the strengths of broadband are for achieving the goal of extending access to information and knowledge to all in the digital age.

In the industrialized countries, distinctive patterns are emerging for the way businesses, governments and citizens are using new ICTs, and it is important to understand the forces at play in the interests of economic growth and social development. Also highly pressing though, is the need to address the persistent exclusion of people in some geographical areas and as a result of under-investment in an appropriate skills base, those who are already marginalized, and in particular the populations of the least developed countries (LDC). In recognition of this, there has been a growing understanding for some time now that technological innovation alone is not enough to ensure a sustainable, growth-oriented "information society". Current thinking advocates rather the fostering of "knowledge-driven economies"—laying the emphasis not only on technology, but on all the prerequisites for equitable access to knowledge. As is discussed in this chapter, broadband is a unique tool in this regard, enabling multiple applications across a single network, and bringing down prices.

7.2 The impact of broadband

A schematic representation of the technological landscape that underpins today's vision of information societies is depicted in Figure 7.1. The emphasis on the components of this landscape varies from country to country, but the components are mostly all in place. The emphasis of policy is on promoting their widest possible diffusion.

Box 7.1: From ICTs to an information society—building technology, building knowledge

As well as numerous initiatives to set out "visions" for the information society, an emphasis on the need to foster "knowledge-driven economies" to underpin inclusive information societies began to gain currency in policy circles in the late 1990s. The European Union set targets for becoming the most competitive and dynamic knowledge-driven region in the world. In the United Kingdom, the Department of Trade and Industry (DTI) gave priority to building the knowledge-driven economy in a White Paper published towards the end of the decade. In the United States, there were strong hopes that investment in "new economy" services would continue to boom and that there would be substantial economic benefits from investment in digital technologies. The World Bank's 1998/99 Development Report made a strong case for greater investment in knowledge as a means of tackling poverty and a range of persistent development problems.

Discussions about the growing importance of knowledge accumulation and absorption were often accompanied by assertions about the impact of rapid innovations in ICTs and of increasing investment in digital networks and their applications. Many acknowledged that the new technological "tools" could have both positive and negative social and economic consequences. It was also recognized that there might not be a straightforward relationship between investment in digital technologies and services and positive gains for economies or social welfare. Nevertheless, the mobilization of concerned stakeholders around the problems posed by knowledge-driven growth continues to emphasize the technical and economic features of these developments over the social and cultural features.

The rush to develop information society visions and knowledge-driven economy strategies has not been limited to the industrialized countries. For instance, the United Nations Economic Commission for Africa developed the Africa Information Society Initiative (AISI); Singapore developed its "Intelligent Island" vision and others such as South Africa also developed their own visions and strategies. In the "hope department", many experts have argued that ICTs would provide the opportunity for the developing world to "leapfrog" over generations of technology and catch-up with—or occasionally even surpass—wealthy countries in the industrialized world. Just as the end of the *dot.com* boom abruptly curtailed many utopian dreams, contemporary economic realities have tempered idealism. More positively perhaps, visions are now more inclusive of progressive patterns of technological development and of local adaptation of ICTs into individual cultures.

The creation of the G8 Digital Opportunities Task (DOT) Force and the decision to hold a United Nations World Summit on the Information Society (WSIS), under the leadership of ITU, are indicators of the significance of these developments at the highest levels. Most participants in these, and many related forums admit today that social considerations are as important as the economic and technological dynamics of emerging information societies.

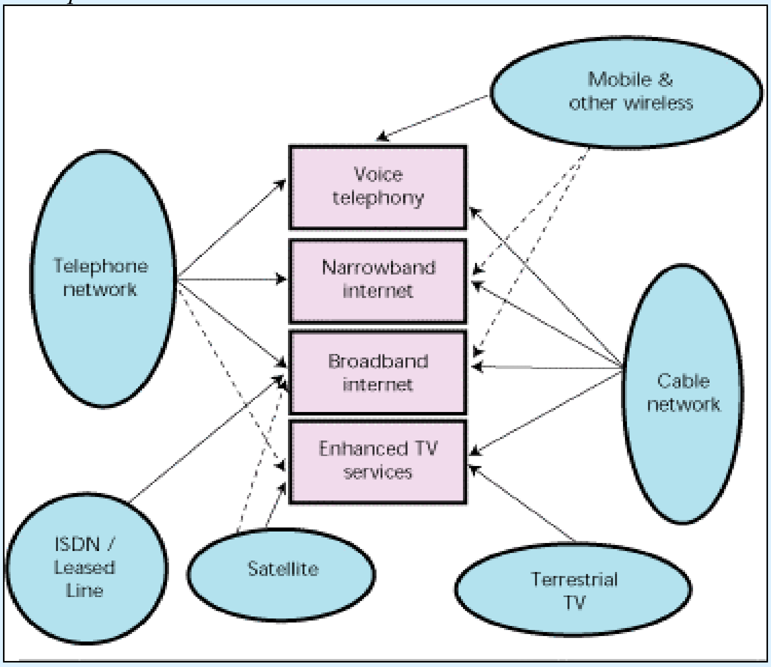
More information on the World Summit on the Information Society (WSIS), to be held in two phases in Geneva in 2003, and in Tunis in 2005, can be found at the website: http://www.itu.int/wsis. In addition to full information on the Summit and its working documents, the site also offers background resources; research papers; links to worldwide information society initiatives, ICT success stories, interest groups and organizations, press materials, and specialized documentation on specific subject areas.

Source: Adapted from R. Mansell, "The nature of the information society: An industrialized world perspective", in *Visions of the Information Society*, ITU, 2003. More information can be found at http://www.itu.int/visions.

While broadband is one among many technologies present on the scene, its particular promise—viewed through the information society "lens"—lies in two areas: first, its capacity to enable multiple applications (voice communications—for example using IP telephony, Internet applications, and television/video and audio applications) over a *single* network. Second, the related economic gains, which also translate into lower costs for consumers. Add to this the increased data transfer and drastically reduced delays in waiting for downloads, as well as the effects of competition among service providers, and it is clear that the potential to bring prices down is strong. The ultimate impact is that information can be diffused to more people, for less money. In other words, affordability and accessibility can be improved, although the stakes are not the same in developed and developing economies—as will be discussed later in this chapter.

Figure 7.1: The ICT landscape

How broadband fits into the picture



Source: Adapted from "Electronic Networks: Challenges for the Next Decade", Prime Minister's Strategy Unit, (United Kingdom) at: http://www.strategy.gov.uk/2002/electronic/report/02.htm.

The advantages of broadband have already been described in depth in previous chapters of this report, but it is useful to identify the primary ways in which broadband is having, or is likely to have, an impact on societies globally. Some of these can be summarized as follows:

- Sharing of knowledge can be enhanced by ensuring equitable access to the Internet, which is considered as a source of information for educational, scientific, economic, social, political and cultural activities.[1]
- Broadband enables people to conduct two-way communications at high speed over the Internet, exchange vast amounts of content and data, and benefit from an "always-on" mode of communication.[2]
- In the information society, many types of face-to-face contact, for instance, the provision of education and medical information, as well as administrative and government procedures, could be replaced by two-way communication over the Internet. At the same time, a tremendous body of knowledge and information is being created in an attractive and accessible format. By enabling the exchange of large amounts of content over the Internet, broadband is also helping to attract further investment in Internet software and network deployment.[3]
- Broadband is becoming a more significant tool that is accessible to all for the attainment of truly pervasive communications. This goes some way towards the fulfilment of access to knowledge for all as a basic human right—a goal that has been evoked in a number of regional and international declarations and that forms one of the main tenets of the Principles developed as part of the United Nations World Summit on the Information Society (WSIS).[4]
- Broadband contributes to building public awareness of the capabilities of ICTs to improve quality of life by circumventing traditional constraints like distance and time. It can also contribute to economic revitalization.[5]
- There is also widespread understanding that the active introduction of broadband Internet and other ICTs has contributed to the economic development of many countries, including most of the OECD countries.[6]

- Conversely, the economic impact on developing countries has not been clearly proven owing to the limited application of the newly emerging ICTs and a relative lack of reliable analytical studies and data. Generally speaking though, broadband Internet is widely recognized as a catalyst for the economic development of a country, whether developed or developing, in the long run.
- The development of broadband is also bringing about a paradigm shift in levels of informatization, and therefore in accountability, particularly in government processes. Wider public access to government information, and the opening up of information on public networks, underscores a commitment to democracy and good governance. Furthermore, depending on the legal system of each country, independent, pluralistic and free mass media and other communication media are expanding as an important means of fostering public information, societal development and social cohesion.
- Broadband not only makes possible "always-on"[7] communications, but will in the future enable the interconnection of online and off-line appliances that are integrated not only at the network level, but also at the content level. The ease with which information can be passed from one context, system or appliance to another will introduce a whole new dimension to information flows.
- Broadband development is also already increasing the urgency with which a host of issues need to be addressed concerning intellectual property rights, personal privacy, freedom of information, regulation and governance at the national level (with the associated issues of sovereignty and national law), and security at all levels from personal, to corporate, to international—in turn raising technological standards issues (see Chapter four).

The major challenges raised here relate primarily to overcoming the digital divide between developed and developing economies, in particular by the extension of universal access to encompass Internet access, and to ensuring a strong legal, social and regulatory framework for broadband applications to flourish in the best interests of all. While some of the issues are global in nature, others are currently affecting only those societies where communication technologies already have a strong foothold.

7.3 Developmental perspectives—accessibility, affordability and universal service

The path to the information society typically passes via extensive infrastructure development. In developed countries, the basic telephone infrastructure is already largely in place, but in the developing world the technology has a different starting point. In order to grow telephone networks, the impetus has historically come from the concept of universal service, that is, extending basic telephone access to all. One of the major questions under debate in current thinking on the information society is whether, and how, the universal service concept might be extended to include other ICTs, making access to Internet content and applications a basic right for all and a recognized tool for economic growth. As discussed in Chapter four of this report, some governments are actively considering extending the universal service concept in this way. The stakes are however, not the same for developed and developing economies.

But would it be meaningful to include broadband access under a universal service-oriented approach? There is now wide acceptance that broadband network investment contributes to economic growth in countries that have already attained a certain degree of development—i.e. primarily developed countries. But even among developed economies there is a reasonably long diffusion period before gains to the economy can be observed. As discussed in previous chapters, this is because broadband network investment has to be complemented by appropriate changes in the regulatory, policy-making, marketing and promotion and social architecture.[8]

For developing economies, the path is not so clear. According to some researchers[9], ICT networks only have a positive impact on wealth measured by gross domestic product (GDP) once a country has hit a certain level of development. This means that, contrary to the expectations of some, ICTs may have no special, or immediate, economic effects (in particular on GDP growth) in the developing world.

This is partly because the level of dependence on information of countries differs according to the development stage they are currently in. In some developing countries, the contribution to GDP from the agricultural and manufacturing sectors of the economy outweighs the contribution from service sectors. It is worth bearing in mind though, that the current lack of resources and dependable and consistent statistics make reliable information about impact on developing economies difficult to come by, and the longer-term picture may change as the truer patterns emerge.

Furthermore, as these societies gain further access to education and information, information-based industries are likely to take on a greater economic role. In the long term then, ICT-enhanced social and economic structures are likely to attract new investment, create jobs, and increase productivity through infrastructure build-up and access to new or improved services, even in the developing world.

In view of this, it is hardly surprising that although a number of countries can be seen to be applying policies that treat access to broadband Internet as a universal service, in most developing countries governments are unlikely to set a clear Internet policy from a regulatory point of view because the Internet has as yet a highly limited effect on their economies.

In sum, there is still a long way to go to fully extend the concept of universal service, as it is currently understood to apply to basic telephone services, to the Internet on a worldwide basis. Indeed, the inclusion of broadband under the concept of universal service would require that most households in a country be connected to the Internet and include a significant proportion of broadband users. However, including even the Internet, let alone broadband, under the concept of universal service is still some way off. Access to and affordability of Internet services are not yet considered as prerequisites for social development and equality of opportunity.

Finally, if the road to broadband-enhanced universal Internet access is to be taken in earnest, it is not only essential to build infrastructure and expand and promote broadband Internet access, but it is also necessary to develop content and human resources.[10] Through e-learning, for example, education and information can be provided to the information "have-nots". This will in turn create the necessary environment for broadband to take off once the requisite technology is in place.

7.3.1 Broadband in developed societies

In the sobering aftermath of the telecommunication boom of the late 1990s, perhaps one positive lesson being drawn by the industry and governments is that both sectors have a responsibility to ensure that the benefits of ICTs are social, as well as economic, and that they are sustainable.[11] Indeed, the harsh dose of "reality" is widely recognized as an opportunity to create a longer-term curve of economic growth. It may not have the "get rich quick" appeal of the mobile boom, but this approach could be the wisest one in the long-term interests of all. It is clear too, that the "digital divide" takes many forms, even within developed economies—and the gap is not only a question of access, but one of quality too (see Box 7.2).

The broadband success stories of economies featured in this report—like Canada, Estonia, Iceland, Japan, the Republic of Korea, and Hong Kong, China—show beyond doubt that a proactive, planned approach to broadband deployment by governments and policy-makers stimulates competition, raises penetration and boosts the market. But this proactive approach is not only desirable for promotion and development. By the same token, regulations and laws that safeguard users, both commercial and residential, and the legal framework of society as a whole, need to be established at the national level, and coordinated at the international level.

For those societies where modern appliances, computers and mobile phones are a part of daily life, and beyond the commercial aspects of promotion and development of applications, the policy focus should now be on the establishment of an adequate framework to contain and manage such open information exchange in what are highly liberalized markets. As has been mentioned in earlier chapters, clear regulatory guidelines can help promote broadband through competition and targeted development. But regulation and legislation are also required to tackle the numerous legal aspects of consumer protection and privacy, data protection, etc. (see Box 7.3). These areas broadly break down into security, ethical issues, and intellectual property rights (IPR) management. Standardization also forms an essential part of the framework, and is part of the core work of ITU's Standardization (ITU-T) Sector.[12] IPR issues have been discussed in Chapter four of this report, but security and ethical issues warrant a brief mention here.

Box 7.2: Measuring the digital divide in Internet capacity

We are familiar with measures of the digital divide that show differences in the level of access to ICTs (as measured, for instance by telephone lines, mobile phones or Internet users per 100 inhabitants), or differences in price, in different countries of the world. These differences have narrowed over time, but are still significant. But is this way of measuring the digital divide sufficient to show the real scale of the problem?

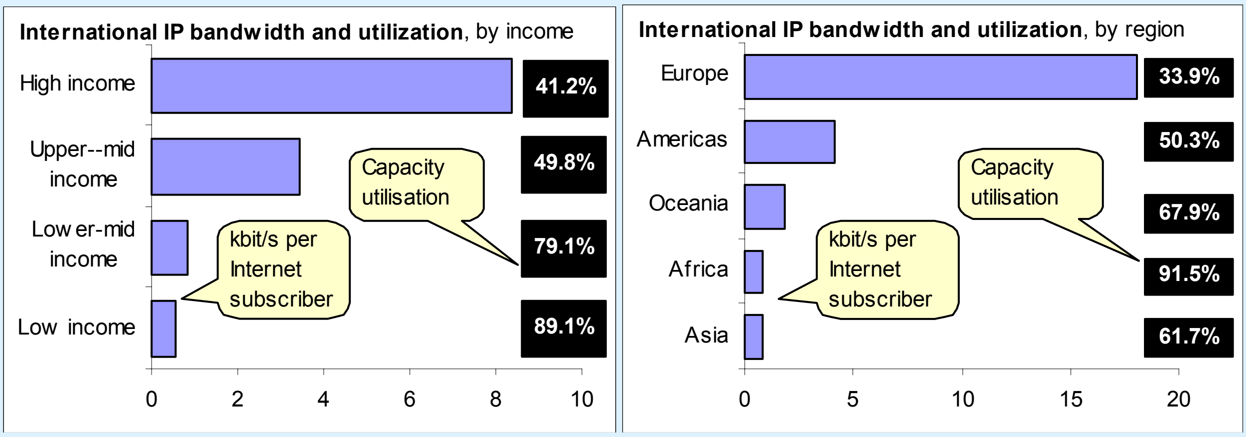
If ICT access were like a fizzy soft drink, then measuring the divide between countries in terms of availability and price would be adequate. One could say, for instance, that ICT access, like *Coca-Cola*, is harder to find in Africa than in Europe, and that the price varies between countries. But there is a third dimension to the problem—quality—that does not really apply to soft drinks, where a can of *Coca-Cola* in one country tastes pretty much the same as in any other. As the ICT revolution has progressed from simple telephone access to Internet access and now to broadband, the differences in quality have become more significant. How can quality of ICT access be measured objectively, and compared between countries?

One way of measuring the difference in quality is by looking at the availability of international IP bandwidth, which is one of the determining factors of the quality of access, for instance for web-browsing or e-mail file transfer (see Table 9 in the statistical annex). Differences are generally much wider than for simple access. In 2001, there was, for instance, more international IP bandwidth (1.3 Gbit/s) available to the 450'000 citizens of Luxembourg than the 820 million Africans (1.2 Gbit/s). European users have around 18 kbit/s per user of dedicated IP bandwidth, compared with just 0.8 kbit/s in Africa. To extend the *Coca-cola* analogy, not only would it be harder to find and more expensive in Africa, but a 1 litre bottle sold in Europe would only contain 50 millilitres if sold in Africa!

International IP bandwidth is not a totally reliable measure of an individual user's experience of using the Internet. Differences in international bandwidth are usually compounded by differences in the quality of the local access network. Furthermore, countries with a large domestic market, like the United States, Korea or Japan, may not necessarily make much use of international IP bandwidth, but instead rely on domestic capacity and peering. This may explain, for instance, why the level of bandwidth per subscriber in broadband-rich Asia, or in the Americas, appears to be much lower than in Europe. Nevertheless, the differences between countries and regions are sufficiently large to show that the digital divide in quality of ICT access is real.

If international bandwidth markets functioned seamlessly, like that for soft drinks, then more capacity would be made available in areas where it is in short supply so that, ultimately, the main difference between countries would be just in the ability of the local population to afford the service. But the available evidence suggests that the market is not working well. Figures on international circuit capacity of carriers regulated by the US regulator, the FCC, show that, although Africa's international private lines to the United States increased ten-fold between 1998 and 2001, they still constitute only 0.5 per cent of the global total (see Table 9 in the Statistical Annex). Furthermore, while the available circuits are running at only one third of capacity in Europe (the remaining two-thirds are idle), capacity utilization is over 90 per cent in Africa. This suggests that the problem is not going to get better soon, and may never do so if left purely to market forces.

The digital divide in Internet capacity and utilization, 2001



Note: Capacity (in kbit/s) is measured by International IP bandwidth divided by estimated Internet users (September 2001). Capacity utilization (in per cent) is measured by percentage of available international circuits to United States that are in commercial use, i.e. not idle, (December 2001).

Source: ITU adapted from TeleGeography Inc. (www.telegeography.com) and FCC (www.fcc.gov).

Security

The explosion of spamming, hoaxes and cyber attacks has highlighted how vulnerable users are to security breaches and the steps they need to take to protect themselves. The always-on nature of a broadband connection means that attacks and hacking can happen around the clock, raising the stakes by comparison with a computer that is only on for short periods. Most broadband users are residential consumers, and few have awareness, let alone expert knowledge, of security risks. As broadband gets a reputation for enabling easier and freer access to information, it may also gain a reputation for being vulnerable to security loopholes if precautions don't exist or are not sufficiently advertised. Indeed, potential broadband users may hesitate to adopt the technology if it means an increased risk to personal or commercial data. Governments and ISPs can take steps to increase awareness and include measures for increased security, while producers of technology standards are partly responsible for ensuring an acceptable degree of network security.[13]

Viruses and spyware (described below) can be introduced into computer systems connected to the Internet, without the knowledge or consent of the system owner, and are commonplace and well documented. Viruses can automatically corrupt and delete files on a computer and spyware can increase pop-up adverts and capture personal information and web surfing habits to send out secretly about users. Another concern is the increasing use of "scanners" that run through vast numbers of IP addresses, scanning for any open ports on the attached computers that can be used to gain access to personal files. While being scanned is not necessarily a problem for a protected computer, it causes huge concerns when computers are either poorly configured or have security flaws.

While both dial-up and broadband connections can be affected by such security breaches, an always-on broadband connection is undoubtedly an easier target (see Box 7.3). As a result, broadband connections require greater attention to security. Luckily, there are many tools available to make broadband connections secure and thus attractive to potential users and broadband providers, governments and others can help educate users of the risks and safeguards they can take.

One effective way to prevent unauthorized access to personal resources on a computer with broadband access is a firewall. This is a piece of software or hardware that acts as a gatekeeper for any communications leaving or entering the computer (or network). Firewalls can be configured to allow only certain applications to access the broadband connection and to reject certain types of requests from the outside (such as scans). Many firewall providers offer free versions of their software for download on the Web, such as Tinysoftware.com[14] and Zonelabs.com[15]. However, the configuration of these products is often difficult for users. Some broadband providers, for example Earthlink in the United States, have taken the initiative to help consumers with security by including firewalls for free as part of their home networking packages, and partnering with firewall producers to make installation procedures more standardized.

Other kinds of software have also been developed to combat one of the most common problems broadband users face, i.e. spyware. Spyware is usually introduced to a computer via another downloaded program from the Internet. File-sharing programs such as Kazaa are infamous for installing several other spyware applications on the computer during installation. However, free programs such as Adaware from Lavasoft[16] and SpyBot can search for these files and eliminate them from the computer.

While firewalls help deny unwanted communications, encryption offers an even better way to protect sensitive data as they sit on the computer or pass over the Internet. Broadband connections can make use of various encryption technologies to help ensure the data stays private and unaltered as it travels over the Internet, and can easily support encrypted communications—which usually require 10 to 20 per cent more bandwidth than the transmission of non-encrypted information.

The implementation of enhanced security systems, and the existence of appropriate laws and regulation dealing with this problem, will be of fundamental importance for the development of commercial and public applications, such as e-government, e-health or e-commerce. To carry out these services online, in fact, users should be guaranteed that their data will be accessed and manipulated only by those authorized to do so, that their electronic mailbox will not be the object of undesired bulk e-mails ("spam"), or that information given by certain services can be trusted, etc. Security is also important for home users, who usually do not benefit from the controls and technical assistance usually provided in companies or government offices. Having a computer connected to the Internet 24 hours a day can be likened to having a window open: anybody can enter. Security is therefore necessary to build confidence, so that technologies like broadband can be exploited to their fullest potential and to help build an environment of trust in the global information society.

Box 7.3: Longer Internet connection times spell greater vulnerability for broadband users
The importance of firewalls highlighted by the Internet worm "MSBlast"

In August 2003, the particular vulnerability of broadband Internet users was highlighted by the propagation of the Internet worm, "MSBlast". MSBlast finds its way into users' computers by exploiting a flaw in several of Microsoft's operating systems, scanning for certain open ports on computers connected to the Internet. Once a susceptible computer is located, the worm establishes a connection and downloads itself onto the vulnerable computer. Once on the new host computer, it again scans the Internet for open ports on other computers around the Internet in an attempt to infect them via the compromised host. The striking factor about this particular worm, is that it acts without any interaction from users: in other words, an always-on broadband Internet connection that is left on for long periods is by nature more vulnerable to such infiltration, even though computers with all types of connections can be hit.

While the worm had infected 180'000 computers around the world within just a few days, computers with properly installed firewalls remained unaffected. This example highlights how much more important security measures such as firewalls are when making use of broadband connections. While broadband users may learn their lesson "the hard way", when they actually suffer an attack, governments and ISPs can do a lot to increase awareness, and can take certain concrete measures, for example by making pre-installed security programs standard.

Source: ITU research and article at: http://www.msnbc.com/news/951168.asp?cp1=1.

Social impact

There is a general "feeling" that ICTs bring benefits to society, but just how much do individuals perceive these benefits in their day-to-day lives? An annual survey of Computer and Internet Use, carried out by the Korean National Statistical Office, reveals a generally very positive view of the information society's effects on lifestyles, with 78 per cent of respondents saying that they expected their lives to become more convenient as a result of the information society. Men (81 per cent) were, however, more confident on this point that women (75 per cent). The views expressed also vary with age—teenagers were the most confident, with around 88 per cent (10 per cent higher than the national average) sure that the information society will have a beneficial effect. Not surprisingly perhaps, this level of confidence tapers off as respondents get older with only just over half of the over 60 year olds feeling that the information society will be beneficial. Interestingly, among older age groups, there is not necessarily any great feeling that the information society will lead to drawbacks, but rather a high level of uncertainty, with just under a third of over 60s responding that they did not know what the effects of the information society would be on their lifestyles, suggesting perhaps that they had not had much exposure to it (see Figure 7.2, left chart).

Box 7.4: Keeping kids out of the cookie jar

A prominent cookie company in the United States closed its popular online "cookie club" for children after a complaint by the US Federal Trade Commission (FTC). Mrs Fields Cookies, (at: http://www.mrsfields.com), took the form of a club where children could register for free treats on their birthday. Three years after going online, the site had signed up 84'000 children aged 12 and under, often without the consent of their parents.

The FTC alleged that Mrs Fields had failed to give sufficient notice on its website or to parents about what information it collected, did not ensure that children had their parents' permission before signing up, and did not offer a way for parents to review or delete information their children had submitted. As a result of the complaint, Mrs Fields Cookies was required to delete the database and pay a fine of US$ 100'000, without admitting any wrongdoing. The Mrs Fields action was part of the FTC's implementation of the Children's Online Privacy Protection Act, passed in 1998, to protect the safety and privacy of children online by prohibiting the unauthorized or unnecessary collection of children's personal information by website operators.

Source: http://www.sltrib.com/2003/Feb/02272003/business/33260.asp and http://www.ftc.gov/os/2003/02/mrsfieldscmp.htm.

On a wider social level, the ICT revolution that has already occurred in developed economies also brings with it a number of hazards, which, although usually outweighed by the social and economic advantages of such technological progress, should not be overlooked.

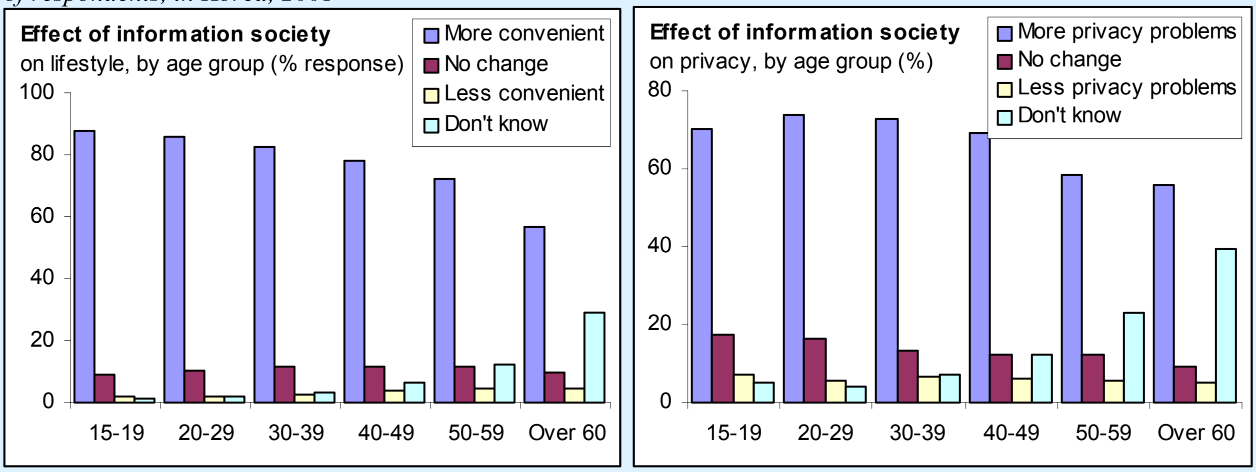
Despite strong Internet and broadband growth, many developed countries face growing concerns about Internet addiction, proliferation of indecent material and cybercrime. Among other countries, the United States has seen numerous cases where the social impact of Internet content has been the central cause for concern (see Box 7.4).

Privacy concerns

Taking again the example of the Republic of Korea, while there is general agreement that the information society will make life easier and more convenient, there are concerns that it will invade personal privacy. Overall, two-thirds of Koreans believe that the information society will be more invasive of personal privacy, while only 7.6 per cent believe that the new ICT tools will make it easier to guard privacy. Korean men are more concerned about the loss or privacy than Korean women. Youngsters and older people seem to have fewer concerns about loss of privacy than those in the prime of their lives, but older people are ten times more willing to admit that they do not really know the effect it will have on privacy than teenagers. Those with a university level of education are almost twice as concerned about the potential loss of privacy as those with only a primary education (see Figure 7.2, right chart).

Figure 7.2: Information society: hopes and fears

Perceived effects of the information society on personal lifestyles and personal privacy, by age group, as percentage of respondents, in Korea, 2001



Source: Korea National Statistical Office, Report on Computer and Internet Use Survey, 2001.

The Republic of Korea has also already been grappling with some of the adverse effects of intensive ICT penetration, particularly among the younger members of its population, and has already mounted measures to counteract these and help those affected (see Box 7.5). The steps taken in Korea may give others the lead in minimizing adverse affects in their own societies.

Such social hazards do not, however, appear to be major deterrents to potential consumers: other factors such as cost or lack of useful applications would seem to feature more strongly in some users' priorities. In one United States survey for example, only 1 per cent of households nationwide that had never had an Internet subscription cited "concerns about how children use it" as a reason, compared to 53.6 per cent that cited "don't want it" and 23.8 per cent that cited "too expensive".[17]

Box 7.5: The "dark side" of the information revolution
Positive reactions to a new social phenomenon in the Republic of Korea

While the Republic of Korea's ICT developments have brought economic and social progress, there are thorns among the roses. One example is online game addiction, which has become a major problem. The excessive use of online games is particularly noticeable among teenagers and young adults, who play at home or at one of the 25'000 or so personal computer (PC) "bangs" (online game rooms). One user died in a PC bang after three days of continuous games playing, so engrossed in the game that he forgot to eat, drink, or sleep. This illustrates how cyberlife can sometimes be more gripping than real life, and that even when surrounded by other people isolation and vulnerability present real risks. In recognition of this kind of problem, the Korean Education Research and Information Service (KERIS) has launched a research study into the problem of alienation among young people. In addition, the Ministry of Information and Communication (MIC) has established a "Center of Internet Addiction Prevention and Counseling" (http://www.internetaddiction.or.kr) to help combat the problem. The Center is equipped with group and individual counselling rooms and provides free advice to addicts. It also has plans to focus its programme on the prevention of addiction. Parents and teenagers alike will be addressed and will be able to attend lectures on the topic.

While this example may be an extreme one, the cybercafé and games culture has other less flagrant, but potentially harmful consequences for children. Who knows how healthy it is for young people to spend several hours a day in front of a PC screen? The strain put on the eyes, the brain and ears have not yet been fully studied. And the growing propensity for young people to remain sedentary for long periods of time may entail long-term health risks, the repercussions of which may become more apparent in the future. Is cyberculture sowing the seeds of a society in which people may become detached from their psychological and physical well-being, or may become socially dysfunctional?

The signs are that PC bangs and online games are indeed modifying social interaction. As one observer says "[PC bangs are] ...rabbit warrens of high-bandwidth connectivity ...where young adults gather to play games, video-chat, hang out and hook up". They allow people to pretend to be someone completely different. Avatars, personalized online personas, allow internauts to assume new personalities. How much will real life become a pale shadow of the exciting virtual world? In such cases, the temptation to escape into another world is not helping young people adapt to their real-life circumstances.

Content-related problems are not a uniquely Korean phenomenon. Stories about paedophile or racist sites have appeared in many countries. But a country like Korea, with ubiquitous access, is probably even more vulnerable to harmful sites. A Korean children's portal carried out a survey and found that more and more youngsters were affected by adult content websites. The survey (which addressed children under 13 years of age) revealed that 28 per cent of the respondents had access to adult websites. Some 53 per cent accidentally came across these sites and 32 per cent accessed them through spam or unsolicited e-mails. Some 85 per cent of those youngsters surveyed said that spam was a serious problem. New problems need new solutions, and government intervention in this field includes the declaration on "The Principle of Netizen Ethics", issued in June 2000. The Korean Government has also organized several campaigns on ethical awareness.

Source: ITU case study on promoting broadband in the Republic of Korea at: http://www.itu.int/broadband.

7.3.2 The developing world and broadband

In developing countries, the barriers to equitable access to information and communication result from a variety of factors, including: differences in education and literacy levels, gender, age, income and connectivity, as well as from a lack of user training and particular conditions of access to relevant technologies. To overcome these barriers, government initiatives can help increase penetration by encouraging network development. As mentioned previously, while there is some debate as to the immediate impact of ICTs on economic prosperity in such economies, it does seem that, in the longer term, some broader development objectives can be enhanced by the integration of ICTs into developing communities. Insofar as the Internet can help provide distance education, cheap communications, and medical know-how, etc., broadband has the potential to make these benefits even more achievable by bringing down costs and increasing the quantities of information exchanged.

But broadband is not going to arrive overnight; it is already a challenge for many developed countries to upgrade, or roll out, backbone networks capable of transmission speeds of several Gbit/s in order to enable high-speed Internet connections and seamless services. In stark contrast, most developing countries are still struggling to provide dial-up Internet services—often through public access points like cybercafés—even in their capital cities.

Nevertheless, by starting out with communal access points, developing countries can go a long way towards familiarizing their populations with broadband Internet. Just as in developed societies, where Internet in schools has substantially narrowed the computer-literacy gap between children from high and low-income families, in developing communities a “group” approach to learning or to obtaining information can be the most cost-effective way of helping achieve development goals. The case of fishermen in southern India, described in Box 7.6, provides a good example.

In developing economies, public access from community centres such as telecentres, post offices, libraries, and schools, provides a particularly appropriate and effective means of fostering universal access, especially in rural and remote areas and poor urban areas. Increasing Internet access is already a clear policy goal in some countries. Eventually, with broadband, low-cost long-distance and international voice services can be easily added to e-mail and web services at community telecentres. If these development “seeds” can result in a significantly large number of subscribers in the societies of the future, there may be some hope of reducing the digital gap.[18]

Box 7.6: Southern India: Information shops

In Southern India, four Village Knowledge Centres (VKC) have now been set up by The MS Swaminathan Research Foundation (MSSRF), in collaboration with the International Development Research Centre (IDRC) of Canada. Obtaining current price information for fish or farm products was one of the initial benefits being advertised. A fisherman can, for example, go to the VKC to obtain a 24-hour forecast of the likely height of the waves at sea. The information is downloaded from a United States Navy website. Information pertaining to safety at sea, fish/shoal occurrence near the seashore and post-harvesting techniques can likewise be obtained, enabling fishermen to optimize their productivity and reduce risk to life.

From the VKCs, villagers can also access information on grain and agricultural input prices, integrated pest management and pest management in rice and sugarcane crops. Important public events and government announcements that are relevant to the villagers are also flashed through the VKCs. Locale-specific information has also been compiled—a detailed account on sugarcane cultivation, a guidebook on the application of bio-fertilizers in rice cultivation, a how-to-style document on herbal remedies for disorders among children and one on local religious festivals. There is also a provision for exchanging information on the availability of labour and materials in the region. Bus and train timetables and opinions of medical practitioners are also available at the click of a mouse.

Source: MS Swaminathan Research Foundation. Website at: http://www.mssrf.org/informationvillage/ivrppapers.html.

From the international perspective, developing and least developed countries (LDC), economies in transition and post-conflict countries need to be considered taking into account the hugely diverse factors at play among them. Such regions require special measures to catch up with countries that already benefit from broadband Internet.

Generally, in terms of broadband development, the situation of developing countries is widely varied and it is hard to define common emerging patterns. For instance, although growth can be linked to the diffusion of new technologies, progress in other areas, such as skills, is barely detectible. Neglecting the evident need to link technology development with skills and capacity building is therefore likely to seriously hamper broadband penetration in these economies. Not only do they have a great distance to cover before they start to look like the developed countries, but they also have a long way to go before they achieve more balance within their countries.[19]

7.3.3 Can wireless reach where cables don’t?

As has been discussed, the lack of wireline infrastructure in developing parts of the world, and in rural and remote areas, is the most fundamental and critical factor preventing greater telephone penetration on the one hand, and Internet penetration on the other. Even where telephone lines exist, upgrading them to support high-speed Internet connections is costly and impractical. The proliferation of wireless Internet (e.g. Wi-Fi) services in many developed countries begs the question of whether wireless can provide the miracle solution for countries with insufficient telephone infrastructures.

The different wireless technologies available today have been discussed in depth elsewhere in this report, and it is clear that we are witnessing a take-off of initiatives to create wireless areas in public places (such as “hotspots” in airports and hotels). As has been seen, these are now being expanded to create whole urban areas in cities with wireless access. Although these initiatives are to date only in their incipient—and often experimental—phases, development organizations such as the United Nations have already begun to grow wise to the potential that wireless technologies may hold for developing countries. As pointed out by the United Nations Secretary-General, Kofi Annan, "it is precisely in places where no infrastructure exists that Wi-Fi can be particularly effective, helping countries to leapfrog generations of telecommunication technology and infrastructure and empower their people".[20]

It has also been argued that Wi-Fi-type wireless technologies are cost-effective and particularly appropriate for developing nations because they are not government-regulated or licensed and are built using global industry-wide standards.[21]

However exciting the prospect of a wireless revolution in developing economies may seem, some realism is still required regarding the immediate viability of delivering Internet connectivity across what are often large geographical areas. Current technological standards are still limited in terms of the number of kilometres that can be covered. While the currently most widespread standard, Wi-Fi (802.11b), is typically used to deliver broadband over about 100 metres, it will not solve the problem in the developing world or in rural and remote areas where there is usually no connection to the Internet for hundreds of kilometres.

There is however, a new standard called 802.16 (WiMAX), that may offer a future solution to the problem. WiMAX is a long-range connection (not really suitable for ISP access networks) that can be used to form the backbone path to the Internet. It has a range of 50 km with data rates up to 70 Mbit/s (theoretically enough for 130 or so 512 kbit/s broadband users on the receiving end). WiMAX effectively enables a single long-distance Internet connection to a central point, such as a telecentre in a city or village, from where coverage can be extended to the local area. While this offers a great spark of hope for bypassing the problems of infrastructure development and cost, it will be some time before technology and market forces combine to make such projects viable on a large scale. In the meantime, the work of establishing relevant content, increasing education levels and human resources development still remains to be done.

Another alternative for broadband Internet access in regions where most households are not able to connect for geographical or financial reasons is convergence networks. To facilitate an appropriate way of promoting broadband to areas where broadband penetration is low, the OECD has proposed several models.[22] At the community level, a similar environment to the wireless local loop (WLL) could be realized by bringing in an "entrance gateway" to the local community centres, perhaps also introducing mobile equipment enabling connection for individual households. This model implies that each local inhabitant would be able to access content provided by fixed networks. However, under this type of model, affordability of terminals would be essential, and they would need to be compatible with both fixed and mobile technologies.

7.4 International cooperation to make it happen?

Throughout this report, examples have shown how cooperation and coordination are necessary in order to prepare for a global information, or "knowledge-based", society. Cooperation should cover every aspect, from legal coordination on copyright and content issues, to technical standardization and harmonization and to the development of an overarching set of humanitarian principles and objectives, as aimed at by numerous initiatives—in particular the World Summit on the Information Society (WSIS).[23]

As has been seen, broadband brings with it numerous benefits, including the potential to expand the concept of universal service to cover Internet access, particularly in developing economies. International cooperation is, *inter alia*, an important factor in increasing awareness of how broadband Internet can contribute to economic development in a country.[24]

Standardization efforts are an example of the need for international cooperation to harmonize interfaces and protocols between broadband networks, software sharing, and to ensure secure infrastructure and data flow. Governments and industry are already actively involved in developing international standards, in particular those defined by ITU and the International Organization for Standardization (ISO). The ITU Standardization Sector (ITU-T) also hosts and organizes various international workshops for standardization, bringing together industry and governments to define new standards, or to refine existing ones.

Coordination of the radio frequency spectrum is also an area where strong international cooperation is required. The radio spectrum is already considered a scarce resource, and with the plethora of new technologies vying for frequencies, competition for allocations is growing. ITU's Radiocommunication Sector is responsible for managing this resource, and brings together the international community to negotiate the rules that govern frequency management, as well as studying various areas of standardization pertaining to radio technologies.

Another important area for cooperation is research and development (R&D), which is the cornerstone of future technological development, training and education, computer literacy, and exchanges of information. Many governments have already earmarked resources for R&D activities specifically related to ICTs and are encouraging joint projects and initiatives at the national, regional and international levels. A particular advantage for developing economies is the spill-over effect of technology and know-how from co-research partnerships. Again, international cooperation in development projects is vital to the enabling of autonomous learning and education.

Finally, the gathering of authoritative, independent data and information about broadband and the wider ICT environment is an essential tool for all players (from private users, to business strategists, to national regulators and governments) to understand their relative performances in ICT development and to appreciate global and national market trends, including possible adverse effects or social hazards. For worldwide studies and statistics on individual countries for example, the collaboration and readiness of government ministries and private enterprises is essential in producing reliable and up-to-date information. On pricing for instance, some governments collect pricing data for services offered in their countries, while others do not. More coordination among statistical agencies would be useful to enable like-for-like comparisons to be made.

Among other organizations, ITU produces indicators, country case studies and other such research. It also holds regular international meetings of indicator experts.[25] Thanks to ITU's position as an independent, intergovernmental organization driven by its membership (including governments, international bodies, private enterprises, research institutions, etc.), the international community can benefit from a large amount of information on the world as a whole and on individual regions and countries. As national boundaries are challenged by the free flow of information, it is likely that the role of independent, international bodies such as ITU will have to grow further still to accommodate the need for global dialogue and coordination of all aspects of the information society.[26]

7.5 Conclusion

As has been seen in this report, broadband technologies have arrived in an era of rapid change—and a radically altered global landscape where access to knowledge is becoming the major driver of growth and development. Broadband, with its potential to make access to information and communication cheaper and easier than ever before, is set to accelerate this process. The information society is intrinsically global in nature and policy dialogue based on global trends should take place on global, regional, national and local levels to facilitate the provision of technical assistance aimed at national and capacity building; technology appropriation; the sharing of knowledge, and the development of compatible regulations and standards that respect national characteristics and concerns.[27] International debate on the information society is rallying around the call that cyberspace should be subject to universally held ethical values such as truth, justice, solidarity, tolerance, human dignity, shared responsibility and accountability. Indeed, broadband is another tool for use in achieving the broader goals of humanity, such as those expressed in the UN Millennium Declaration.

Insofar as broadband appears to move us one step closer to an inclusive information society, policies should reflect the wider need to establish a framework that is both enabling and equitable. The image of an information society in which all persons, without distinction of any kind, are empowered freely to create, receive, share and utilize information and knowledge, in any media and regardless of frontiers may seem a far-off dream, but realistic thinking is already called for about the impact and implications of broadband technologies.

Finally, while individual developed and developing economies have different points of departure, broadband can represent an undeniable tool for the extension of better and faster communications. If the right environment is fostered, broadband perhaps has the potential to extend access to more of the world's information "have-nots", contributing to the creation of a healthier information society.

1 See: http://www.itu.int/osg/spu/ni/promotebroadband/PB03-PromotingBroadband.doc.

2 The definition of 'always-on' is basically when a user has continuous access to the Internet. This can be contrasted with standard dial-up Internet connections with which it is necessary to engage a new connection each time access is required. See: http://www.itu.int/osg/spu/ni/promotebroadband/PB03-PromotingBroadband.doc and http://earthlink.net/home/broadband/homenetwork/gettingstarted/firewall/.

3 Clearly, the changing framework of the ICT industry has a major impact as a ripple effect throughout the economy as businesses gain access to capital and technology to upgrade productivity and efficiency. The government is aware of the huge impact that managing information effectively, reducing transaction costs, and upgrading productivity using technology, can have on performance and productivity. See: Bruno Lanvin, Pamela C.M. Mar, Christine Zhen-Wei Qiang, Frank-Jurgen Richter, Born Global: The Impact of the WTO Process on China's ICT Competitiveness (Oxford, pp.171-173.)

4 See the work on the WSIS Declaration of Principles at: www.itu.int/wsis.

5 For many, broadband has been viewed as having a significant impact on economic activity, and is considered by some as being an accelerator for economic development. See: the OECD paper: Broadband Infrastructure Deployment: The Role of Government Assistance, at: http://www.olis.oecd.org/olis/2002doc.nsf/linkto/dsti-doc(2002)15, p. 9.

6 See synoptical table on "How ICTs can help achieve broader development objectives such as the Millenium Declaration Goals" at: http://www.itu.int/osg/spu/wsisthemes/UNMDG/How%20ICTS%20achieve%20Mill%20Goals%202.pdf. The OECD report on Broadband Infrastructure Deployment: The Role of Government Assistance (at: http://www.olis.oecd.org/olis/2002doc.nsf/linkto/dsti-doc(2002)15) states that over the past two decades, ICT contributed 0.2 and 0.5 percentage points per year to economic growth.

7 In technology point of view, one of the preconditions of "always-on" is to roll out a flawless mobile network which minimizes shaded areas and guarantees soft hand-over in move.

8 Various studies basically confirm the contribution to GDP by the ICT producing sectors. Although the benefits to economy are not limited to ICT producing countries but also to countries that can effectively use ICTs.

9 See for example: Roller, L.-H. and L. Waverman. Telecommunications Infrastructure and Economic Development: A Simultaneous Approach, *American Economic Review*, Vol 91:4, 2001, pp. 909-923.

10 As one commentator states: Internet users should have access to networks that are capable of supporting the broadest range of offerings. It is critical, therefore, that the underlying network supports advanced communications, which tap the potential of multimedia applications involving voice, data, and video that need bandwidth. See: William E. Kennard, Connecting the Globe: A Regulator's Guide to building a global Information Community, pp. IX6-IX7.

11 This awareness is reflected in numerous initiatives being taken across the globe at all levels—most of which aim to positively drive ICT growth and aid development. See for example the ICT Success Stories series published on the ITU website at: www.itu.int/osg/spu/wsis-themes/ict_stories/index.html.

12 For more information on standardization work being carried out at the international level, see for example the ITU website at: http://www.itu.int/ITU-T/news/index.html and http://www.itu.int/osg/spu/enum/index.html.

13 For further research, information, country case studies and web resources on network security, see the ITU website on Creating Trust in Critical Network Infrastructures at: http://www.itu.int/osg/spu/ni/security/index.html.

14 At: http://www.tinysoftware.com/.

15 At: http://www.zonelabs.com/.

16 At: http://www.lavasoft.de/.

17 See: US Department of Commerce, Economics and Statistics Administration, National Telecommunications and Information Administration, *A Nation Online: How Americans Are Expanding Their Use of the Internet*, at: http://www.ntia.doc.gov/ntiahome/dn/anationonline2.doc.

18 For more on Internet access and services for development, see the ITU Internet Reports: IP Telephony, ITU, 2001. Further information can be found at: http://www.itu.int/osg/spu/publications/index.html#intrep.

[19] See for example: Gorge Sciadas, Monitoring the Digital Divide, Orbicom, 2002.

[20] See the speech given by Kofi Annan, Secretary-General of the United Nations, on 26 June 2003, published on the UNICT Task Force website at: http://www.unicttaskforce.org/wifi/sg_msg.asp.

[21] Comments of Pat Gelsinger, chief technology officer for Intel Corp, the world's biggest computer chip maker, reported at: http://sg.news.yahoo.com/030626/3/3c4u8.html.

[22] The OECD models consist of: A. The demand aggregated model which emphasizes the collective purchasing of broadband services. B. Open access/network model under which the localities themselves build their own broadband networks and own them. C. Community-owned networks plus telecommunications service provision model where broadband network operators owned by the localities provide Internet services taking into consideration local needs and continually reinvesting in service and network upgrades. See Sangjin Lee, DSTI/ICCP/TISP(2002)12.

[23] See: http://www.itu.int/wsis.

[24] See for example: ITU, *Visions of the Information Society*, available at: http://www.itu.int/osg/spu/visions/.

[25] See for instance the proceedings of the 3rd World Telecommunication Indicators Meeting, held in Geneva in January 2003, at: http://www.itu.int/ITU-D/ict/WICT02/conclusions/.

[26] For technical information see the websites of the ITU Development Sector: http://www.itu.int/itu-d/; the ITU Standardization Sector: http://www.itu.int/itu-t; and the ITU Radiocommunication Sector: http://www.itu.int/itu-r/. For studies, reports and statistics, country case studies and workshops of a cross-sectoral nature see: http://www.itu.int/osg/spu.

[27] Soumitra Dutta, Bruno Lanvin, Fiona Paua (Ed.), The Global Information Technology Report 2002-2003: Readiness for the Networked World, Oxford University Press, 2003, pp. 11-12.

Birth of Broadband

Statistical Annex

September 2003

International
Telecommunication
Union

CONTENTS

INTRODUCTION

Data are presented for 206 economies with populations greater than 40'000 and where sufficient data are available.

Economies are grouped by 2001 United States dollar (US$) income levels:

Gross National Income (GNI) per capita of:

Low Income	US$ 745 or less
Lower middle	US$ 746–2'975
Upper middle	US$ 2'976–9'205
High	US$ 9'206 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 telecommunication 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, 1975-2002 is contained in a CD-ROM version available separately.

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 annual questionnaire sent to telecommunication authorities and operating companies. These data are supplemented by annual reports and statistical yearbooks of telecommunication ministries, regulators, operators and industry associations. In some cases, estimates are derived from ITU background documents or other references; estimates are shown in italic. Broadcasting data are supplied by annual questionnaire sent to national broadcasting authorities or industry associations. Demographic and macro-economic data are provided by the relevant international organizations identified in the *Technical notes*.

The following signs and symbols are used in the tables:

italic	Year other than that specified or estimate.
k	Thousands (i.e., 1'000).
M	Millions (i.e., 1'000'000).
B	Billions (i.e., 1'000'000'000).
US$	United States dollars. See the *Technical notes* for how US$ figures are obtained.
%	Per cent.
_	Zero or a quantity less than half the unit shown. Also used for data items that are not applicable.
...	Data not available.
CAGR	Compound Annual Growth Rate. See the *Technical notes* for how this is computed.

The absence of any sign or symbol indicates that data are in units.

Comments and suggestions relating to the World Telecommunication Indicators should be addressed to:

Market, Economics and Finance Unit
Telecommunication Development Bureau
International Telecommunication Union
Place des Nations
CH-1211 Geneva 20, Switzerland

Fax: +41 22 730 6449
E-mail: indicators@itu.int

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	66	Ending 31.12	Europe
Algeria	67	Ending 31.12	Africa
Andorra	154	Ending 31.12	Europe
Angola	2	Ending 31.12	Africa
Antigua & Barbuda	118	Beginning 01.04	Americas
Argentina	119	Ending 30.09	Americas
Armenia	3	Ending 31.12	Asia
Aruba	155	Ending 31.12	Americas
Australia	156	Ending 30.06	Oceania
Austria	157	Ending 31.12	Europe
Azerbaijan	4	Ending 31.12	Asia
Bahamas	158	Ending 31.12	Americas
Bahrain	159	Ending 31.12	Asia
Bangladesh	5	Ending 30.06	Asia
Barbados	120	Beginning 01.04	Americas
Belarus	68	Ending 31.12	Europe
Belgium	160	Ending 31.12	Europe
Belize	69	Beginning 01.04	Americas
Benin	6	Ending 31.12	Africa
Bermuda	161	Beginning 01.04	Americas
Bhutan	7	Ending 31.12	Asia
Bolivia	70	Ending 31.12	Americas
Bosnia	71	Ending 31.12.	Europe
Botswana	121	Beginning 01.04	Africa
Brazil	122	Ending 31.12	Americas
Brunei Darussalam	162	Ending 31.12	Asia
Bulgaria	72	Ending 31.12	Europe
Burkina Faso	8	Ending 31.12	Africa
Burundi	9	Ending 31.12	Africa
Cambodia	10	Ending 31.12	Asia
Cameroon	11	Ending 31.12	Africa
Canada	163	Ending 31.12	Americas
Cape Verde	73	Ending 31.12	Africa
Central African Rep.	12	Ending 31.12	Africa
Chad	13	Ending 31.12	Africa
Chile	123	Ending 31.12	Americas
China	74	Ending 31.12	Asia
Colombia	75	Ending 31.12.	Americas
Comoros	14	Ending 31.12.	Africa
Congo	15	Ending 31.12	Africa
Costa Rica	124	Ending 31.12	Americas
Côte d'Ivoire	16	Ending 31.12	Africa
Croatia	125	Ending 31.12	Europe
Cuba	76	Ending 31.12	Americas
Cyprus	164	Ending 31.12	Europe
Czech Republic	126	Ending 31.12	Europe
D. R. of Congo	18	Ending 31.12	Africa
Denmark	165	Ending 31.12	Europe
Djibouti	77	Ending 31.12	Africa
Dominica	127	Beginning 01.04	Americas
Dominican Rep.	78	Ending 31.12	Americas
Ecuador	79	Ending 31.12	Americas
Egypt	80	Ending 30.06	Africa
El Salvador	81	Ending 31.12	Americas
Equatorial Guinea	19	Ending 31.12	Africa
Eritrea	20	Ending 31.12	Africa
Estonia	128	Ending 31.12	Europe
Ethiopia	21	Ending 31.12	Africa
Faroe Islands	166	Ending 31.12	Europe
Fiji	82	Ending 31.12	Oceania
Finland	167	Ending 31.12	Europe
France	168	Ending 31.12	Europe
French Guiana	169	Ending 31.12	Americas
French Polynesia	170	Ending 31.12	Oceania
Gabon	129	Ending 31.12	Africa
Gambia	22	Beginning 01.04	Africa
Georgia	23	Ending 31.12	Asia
Germany	171	Ending 31.12	Europe
Ghana	24	Ending 31.12	Africa
Greece	172	Ending 31.12	Europe
Greenland	173	Ending 31.12	Europe
Grenada	130	Ending 31.12	Americas
Guadeloupe	131	Ending 31.12	Americas
Guam	174	Ending 31.12	Oceania
Guatemala	83	Ending 31.12	Americas
Guernsey	175	Ending 31.12	Europe
Guinea	25	Ending 31.12	Africa
Guinea-Bissau	26	Ending 31.12	Africa
Guyana	84	Ending 31.12	Americas
Haiti	27	Ending 31.12	Americas
Honduras	85	Ending 31.12	Americas
Hong Kong, China	176	Beginning 01.04	Asia
Hungary	132	Ending 31.12	Europe
Iceland	177	Ending 31.12	Europe
India	28	Beginning 01.04	Asia
Indonesia	29	Ending 31.12	Asia
Iran (I.R.)	86	Beginning 22.03	Asia
Iraq	87	Ending 30.06	Asia
Ireland	178	Beginning 01.04	Europe
Israel	179	Ending 31.12	Asia
Italy	180	Ending 31.12	Europe
Jamaica	88	Beginning 01.04	Americas
Japan	181	Beginning 01.04	Asia
Jersey	182	Ending 31.12	Europe
Jordan	89	Ending 31.12	Asia
Kazakhstan	90	Ending 31.12	Asia
Kenya	30	Ending 30.06	Africa
Kiribati	91	Ending 31.12	Oceania
Korea (Rep.)	183	Ending 31.12	Asia
Kuwait	184	Ending 31.12	Asia
Kyrgyzstan	31	Ending 31.12	Asia
Lao P.D.R.	32	Ending 31.12	Asia
Latvia	133	Ending 31.12	Europe
Lebanon	134	Ending 31.12	Asia
Lesotho	33	Beginning 01.04	Africa
Liberia	34	Ending 31.12	Africa
Libya	135	Ending 31.12	Africa
Lithuania	136	Ending 31.12	Europe
Luxembourg	185	Ending 31.12	Europe
Macao, China	186	Ending 31.12	Asia
Madagascar	35	Ending 31.12	Africa
Malawi	36	Ending 31.12	Africa
Malaysia	137	Ending 31.12	Asia
Maldives	92	Ending 31.12	Asia
Mali	37	Ending 31.12	Africa
Malta	138	Ending 31.12	Europe
Marshall Islands	93	Ending 31.12	Oceania
Martinique	187	Ending 31.12	Americas
Mauritania	38	Ending 31.12	Africa
Mauritius	139	Ending 31.12	Africa
Mayotte	140	Ending 31.12	Africa

Economy	*Location*	*Fiscal year*	*Region*
Mexico	141	Ending 31.12	Americas
Micronesia	94	Ending 31.12	Oceania
Moldova	39	Ending 31.12	Europe
Mongolia	40	Ending 31.12	Asia
Morocco	95	Ending 31.12	Africa
Mozambique	41	Ending 31.12	Africa
Myanmar	42	Ending 31.12	Asia
Namibia	96	Ending 30.09	Africa
Nepal	43	Ending 15.07	Asia
Netherlands Antilles	188	Ending 31.12	Americas
Netherlands	189	Ending 31.12	Europe
New Caledonia	190	Ending 31.12	Oceania
New Zealand	191	Beginning 01.04	Oceania
Nicaragua	44	Ending 31.12	Americas
Niger	45	Ending 31.12	Africa
Nigeria	46	Ending 31.12	Africa
Northern Marianas	192	Ending 31.12	Asia
Norway	193	Ending 31.12	Europe
Oman	142	Ending 31.12	Asia
Pakistan	47	Ending 30.06	Asia
Palestine	97	Ending 31.12	Asia
Panama	143	Ending 31.12	Americas
Papua New Guinea	48	Ending 31.12	Oceania
Paraguay	98	Ending 31.12	Americas
Peru	99	Ending 31.12	Americas
Philippines	100	Ending 31.12	Asia
Poland	144	Ending 31.12	Europe
Portugal	194	Ending 31.12	Europe
Puerto Rico	145	Ending 31.12.	Americas
Qatar	195	Ending 31.12	Asia
Réunion	196	Ending 31.12	Africa
Romania	101	Ending 31.12	Europe
Russia	102	Ending 31.12	Europe
Rwanda	49	Ending 31.12	Africa
S. Tomé & Principe	50	Ending 31.12	Africa
Samoa	103	Ending 31.12	Oceania
Saudi Arabia	146	Ending 31.12	Asia
Senegal	51	Ending 31.12	Africa
Serbia & Montenegro	104	Ending 31.12	Europe
Seychelles	147	Beginning 01.04	Africa
Sierra Leone	52	Ending 31.12	Africa
Singapore	197	Beginning 01.04	Asia

Economy	*Location*	*Fiscal year*	*Region*
Slovak Republic	148	Ending 31.12	Europe
Slovenia	198	Ending 31.12	Europe
Solomon Islands	53	Beginning 01.04	Oceania
Somalia	54	Ending 31.12	Africa
South Africa	105	Beginning 01.04	Africa
Spain	199	Ending 31.12	Europe
Sri Lanka	106	Ending 31.12	Asia
St. Kitts and Nevis	149	Beginning 01.04	Americas
St. Lucia	150	Beginning 01.04	Americas
St. Vincent	107	Beginning 01.04	Americas
Sudan	55	Ending 31.12	Africa
Suriname	108	Ending 31.12	Americas
Swaziland	109	Beginning 01.04	Africa
Sweden	200	Ending 31.12	Europe
Switzerland	201	Ending 31.12	Europe
Syria	110	Ending 31.12	Asia
Taiwan-China	202	Ending 31.12	Asia
Tajikistan	56	Ending 31.12	Asia
Tanzania	57	Ending 31.12	Africa
TFYR Macedonia	111	Ending 31.12	Europe
Thailand	112	Ending 30.09	Asia
Togo	58	Ending 31.12	Africa
Tonga	113	Ending 31.12	Oceania
Trinidad & Tobago	151	Beginning 01.04	Americas
Tunisia	114	Ending 31.12	Africa
Turkey	115	Ending 31.12	Europe
Turkmenistan	116	Ending 31.12	Asia
Uganda	59	Ending 30.06	Africa
Ukraine	60	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	152	Ending 31.12	Americas
Uzbekistan	61	Ending 31.12	Asia
Vanuatu	111	Ending 31.12	Oceania
Venezuela	153	Ending 31.12	Americas
Viet Nam	62	Ending 31.12	Asia
Virgin Islands (US)	206	Ending 31.12	Americas
Yemen	63	Ending 31.12	Asia
Zambia	64	Beginning 01.04	Africa
Zimbabwe	65	Ending 30.06	Africa

1. Basic indicators

		Population		GDP		Total telephone subscribers	
		Total (M) 2002	*Density (per km²) 2002*	*Total (B US$) 2001*	*per capita (US$) 2001*	*Total (k) 2002*	*per 100 inhabitants 2002*
1	Afghanistan	23.29	36	20.7	919	45.0	0.19
2	Angola	13.94	11	9.0	664	215.0	1.54
3	Azerbaijan	8.14	94	*4.0*	507	1'859.2	22.84
4	Bangladesh	133.13	925	45.4	346	1'757.0	1.32
5	Benin	6.59	59	*2.3*	370	*184.3*	*2.86*
6	Bhutan	0.69	15	*0.5*	734	19.6	2.84
7	Burkina Faso	11.96	44	2.3	200	151.8	1.27
8	Burundi	6.99	251	0.7	96	74.1	1.06
9	Cambodia	13.79	76	3.4	254	*257.0*	*1.91*
10	Cameroon	15.75	33	*9.3*	615	*411.4*	*2.67*
11	Central African Rep.	3.96	6	1.0	265	*19.9*	*0.53*
12	Chad	7.87	6	1.5	194	46.0	0.58
13	Comoros	0.76	409	0.2	303	10.3	1.35
14	Congo	3.29	10	2.8	887	243.8	7.41
15	Côte d'Ivoire	16.49	51	9.2	563	1'363.2	8.27
16	D.P.R. Korea	23.67	193	15.7	670	*500.0*	*2.13*
17	D.R. Congo	52.65	22	*15.3*	297	*170.0*	*0.32*
18	Equatorial Guinea	0.49	17	*1.3*	2'765	35.8	7.34
19	Eritrea	3.98	42	*0.7*	196	35.9	0.90
20	Ethiopia	67.35	55	*6.3*	106	418.6	0.62
21	Gambia	1.37	128	*0.4*	333	138.3	10.08
22	Georgia	4.93	71	3.2	643	1'152.1	23.35
23	Ghana	21.67	91	4.4	209	*435.9*	*2.08*
24	Guinea	7.67	31	2.9	381	116.8	1.52
25	Guinea-Bissau	1.25	35	*0.2*	179	11.2	0.89
26	Haiti	8.30	299	3.5	423	270.0	3.25
27	India	1'041.85	329	*464.6*	459	54'107.6	5.19
28	Indonesia	212.11	111	145.3	695	19'450.0	9.17
29	Kenya	31.93	55	*10.4*	338	1'653.3	5.18
30	Kyrgyzstan	5.09	26	1.5	306	447.9	8.79
31	Lao P.D.R.	5.53	23	1.7	324	117.1	2.12
32	Lesotho	2.17	71	0.8	377	126.0	5.82
33	Liberia	3.24	29	...	...	*8.8*	*0.28*
34	Madagascar	15.91	27	4.5	292	222.5	1.40
35	Malawi	10.44	111	*1.6*	158	159.1	1.52
36	Mali	10.63	9	2.5	236	102.4	0.96
37	Mauritania	2.68	3	0.9	360	277.7	10.35
38	Moldova	4.40	131	1.5	337	*864.2*	*19.68*
39	Mongolia	2.43	2	1.1	439	344.0	14.16
40	Mozambique	18.23	23	3.6	202	*242.1*	*1.37*
41	Myanmar	48.98	72	*7.1*	148	*309.0*	*0.64*
42	Nepal	23.20	164	5.5	241	349.6	1.51
43	Nicaragua	5.37	44	2.6	490	411.6	7.66
44	Niger	11.75	10	*1.8*	170	*23.8*	*0.21*
45	Nigeria	120.08	130	51.3	438	2'335.1	1.94
46	Pakistan	145.96	182	55.2	387	4'909.0	3.36
47	Papua New Guinea	5.46	12	*4.0*	777	*72.7*	*1.37*
48	Rwanda	8.17	310	1.7	208	*86.5*	*1.09*
49	S. Tomé & Principe	0.15	157	...	...	*5.4*	*3.63*
50	Senegal	9.80	50	*4.4*	458	778.0	7.94
51	Sierra Leone	4.95	68	0.7	152	*49.6*	*1.01*
52	Solomon Islands	0.44	15	0.3	611	7.6	1.71
53	Somalia	10.16	16	...	...	135.0	1.33
54	Sudan	32.54	13	12.6	396	862.6	2.65
55	Tajikistan	6.38	45	0.8	129	245.9	3.86
56	Tanzania	34.57	37	9.1	271	*575.4*	*1.71*
57	Togo	4.68	83	*1.2*	269	211.2	4.51
58	Uganda	24.70	102	5.3	224	448.3	1.81
59	Uzbekistan	25.29	57	11.6	463	1'856.9	7.34
60	Viet Nam	81.25	247	32.9	406	5'567.1	6.85
61	Yemen	19.39	102	*6.7*	384	1'010.0	5.21
62	Zambia	10.70	14	*3.2*	312	227.6	2.13
63	Zimbabwe	11.63	30	*7.4*	654	640.9	5.51
	Low Income	**2'472.23**	**75**	**1'031.4**	**431**	**109'183.7**	**4.43**

1. Basic indicators

		Population		*GDP*		*Total telephone subscribers*	
		Total (M) 2002	*Density (per km²) 2002*	*Total (B US$) 2001*	*per capita (US$) 2001*	*Total (k) 2002*	*per 100 inhabitants 2002*
64	Albania	4.03	140	*3.7*	940	1'020.0	25.30
65	Algeria	31.29	13	*54.2*	1'784	2'308.0	7.38
66	Armenia	3.80	127	2.1	558	575.6	15.14
67	Belarus	9.91	48	12.2	1'223	3'432.4	34.63
68	Belize	0.25	11	0.8	3'264	84.1	33.26
69	Bolivia	8.34	8	8.0	963	1'436.6	17.22
70	Bosnia	4.10	80	*4.4*	1'120	1'239.0	30.22
71	Bulgaria	7.80	70	13.6	1'672	*4'463.9*	*55.06*
72	Cape Verde	0.44	109	*0.6*	1'286	113.1	25.77
73	China	1'284.53	134	1'191.0	907	421'040.0	32.78
74	Colombia	43.29	38	82.4	1'925	12'363.0	28.56
75	Cuba	11.28	98	17.1	1'518	*583.0*	*5.19*
76	Djibouti	0.66	30	0.6	894	25.1	3.83
77	Dominican Rep.	8.71	180	21.2	2'447	*2'225.2*	*25.67*
78	Ecuador	12.94	28	*13.6*	1'076	2'987.0	23.08
79	Egypt	65.64	66	91.1	1'412	11'924.7	18.17
80	El Salvador	6.46	302	13.7	2'147	1'556.5	24.10
81	Fiji	0.83	45	1.7	2'049	187.4	22.47
82	Guatemala	12.00	110	20.5	1'757	2'423.1	20.20
83	Guyana	0.88	4	*0.7*	828	167.7	19.08
84	Honduras	6.71	60	6.4	980	649.0	9.67
85	Iran (I.R.)	65.55	40	379.6	5'876	15'394.6	23.49
86	Iraq	24.24	55	...	...	695.0	2.87
87	Jamaica	2.62	229	7.8	2'994	1'850.0	70.66
88	Jordan	5.33	56	8.8	1'701	1'907.2	35.79
89	Kazakhstan	15.97	6	22.1	1'370	3'109.3	19.47
90	Kiribati	0.09	128	-	464	*4.1*	*4.79*
91	Maldives	0.28	943	0.6	2'258	70.5	25.11
92	Marshall Islands	0.06	31	0.1	1'817	4.9	8.72
93	Micronesia	0.12	85	0.2	2'064	*10.1*	*8.67*
94	Morocco	29.64	45	33.9	1'162	7'326.1	24.71
95	Namibia	1.88	2	3.1	1'697	*217.4*	*11.90*
96	Palestine	3.46	574	...	...	618.5	17.90
97	Paraguay	5.78	14	6.8	1'215	1'940.2	33.56
98	Peru	26.75	21	54.0	2'071	*3'567.3*	*13.67*
99	Philippines	79.98	267	71.4	913	17'555.2	21.95
100	Romania	22.33	94	39.7	1'774	*7'961.1*	*35.56*
101	Russia	146.59	9	*251.1*	1'709	53'168.1	36.27
102	Samoa	0.18	63	0.3	1'428	13.0	7.20
103	Serbia and Montenegro	10.72	105	*11.3*	1'067	5'243.4	48.91
104	South Africa	45.45	38	113.3	2'542	16'976.0	37.35
105	Sri Lanka	18.95	289	15.7	836	1'814.7	9.58
106	St. Vincent	0.12	301	*0.3*	3'015	37.3	31.88
107	Suriname	0.45	3	*0.8*	1'921	*164.4*	*37.36*
108	Swaziland	1.03	59	*1.3*	1'332	98.1	9.50
109	Syria	17.04	92	*19.2*	1'185	2'499.3	14.67
110	TFYR Macedonia	2.06	80	*3.4*	1'705	*761.8*	*37.27*
111	Thailand	61.89	120	114.8	1'874	22'616.8	36.55
112	Tonga	0.10	142	0.1	1'322	14.6	14.70
113	Tunisia	9.81	60	20.0	2'064	1'651.9	16.83
114	Turkey	67.27	86	145.2	2'191	42'289.2	62.86
115	Turkmenistan	4.85	10	*4.4*	988	*395.8*	*8.19*
116	Ukraine	50.14	83	*30.8*	608	*12'894.2*	*25.64*
117	Vanuatu	0.20	14	0.2	1'090	11.5	5.62
	Lower Middle Income	**2'244.81**	**48**	**2'920.2**	**1'307**	**693'686.2**	**30.91**

1. Basic indicators

		Population		GDP		Total telephone subscribers	
		Total (M) 2002	*Density (per km²) 2002*	*Total (B US$) 2001*	*per capita (US$) 2001*	*Total (k) 2002*	*per 100 inhabitants 2002*
118	Antigua & Barbuda	0.08	176	*0.7*	8'629	*62.3*	*80.42*
119	Argentina	36.60	13	268.7	7'418	14'509.4	39.64
120	Barbados	0.27	626	2.5	9'500	*182.1*	*67.86*
121	Botswana	1.72	3	4.9	2'921	*458.6*	*27.28*
122	Brazil	173.88	20	508.5	2'959	73'691.0	42.38
123	Chile	15.05	20	66.5	4'314	9'912.9	65.86
124	Costa Rica	4.14	81	*4.6*	1'148	1'566.0	37.80
125	Croatia	4.84	86	20.3	4'352	4'157.0	85.82
126	Czech Republic	10.14	129	57.2	5'593	*10'808.0*	*105.71*
127	Dominica	0.08	104	*0.3*	3'478	34.8	44.57
128	Estonia	1.36	30	5.4	3'794	1'356.0	100.07
129	Gabon	1.30	5	*5.1*	4'136	312.7	24.07
130	Grenada	0.11	307	*0.4*	4'348	41.1	38.77
131	Guadeloupe	0.46	272	...	...	*502.5*	*109.24*
132	Hungary	10.15	109	51.9	5'207	10'228.4	100.75
133	Latvia	2.33	37	7.6	3'249	1'618.4	69.49
134	Lebanon	3.42	328	16.7	4'988	1'453.9	42.58
135	Libya	5.55	3	*34.8*	6'207	*710.0*	*12.72*
136	Lithuania	3.46	53	12.0	3'257	2'567.5	74.20
137	Malaysia	24.53	74	88.0	3'684	13'915.0	56.73
138	Malta	0.40	1'253	3.6	9'226	484.1	122.25
139	Mauritius	1.21	649	4.5	3'771	677.2	55.95
140	Mayotte	0.15	394	...	...	*10.0*	*6.98*
141	Mexico	101.88	52	*574.2*	5'807	40'869.9	40.12
142	Oman	2.71	10	20.2	7'693	708.0	26.12
143	Panama	2.96	38	*10.0*	3'529	*851.9*	*29.38*
144	Poland	38.61	123	176.6	4'572	*21'404.7*	*55.41*
145	Puerto Rico	3.86	431	44.2	11'519	*2'540.6*	*66.20*
146	Saudi Arabia	23.06	10	186.2	8'343	8'325.5	36.10
147	Seychelles	0.08	205	0.6	7'571	*65.5*	*79.97*
148	Slovak Republic	5.38	110	20.5	3'804	4'326.1	80.44
149	St. Kitts and Nevis	0.05	180	*0.3*	7'282	28.5	60.64
150	St. Lucia	0.16	260	*0.7*	4'521	*52.7*	*33.40*
151	Trinidad & Tobago	1.30	254	*7.7*	5'951	687.0	52.78
152	Uruguay	3.38	18	18.7	5'554	1'598.5	47.22
153	Venezuela	25.30	28	*121.3*	5'017	9'305.3	36.78
	Upper Middle Income	**509.95**	**24**	**2'345.5**	**4'679**	**240'023.2**	**47.07**

1. Basic indicators

		Population		GDP		Total telephone subscribers	
		Total (M) 2002	*Density (per km²) 2002*	*Total (B US$) 2001*	*per capita (US$) 2001*	*Total (k) 2002*	*per 100 inhabitants 2002*
154	Andorra	0.08	176	1.2	16'990	*57.8*	*74.05*
155	Aruba	0.11	570	1.5	17'109	*90.1*	*85.03*
156	Australia	19.66	3	358.3	18'481	23'169.0	117.83
157	Austria	8.16	97	189.2	23'243	10'403.0	127.50
158	Bahamas	0.31	23	...	...	248.3	79.59
159	Bahrain	0.67	941	7.9	12'068	564.4	84.64
160	Belgium	10.35	338	227.0	22'022	13'267.9	128.24
161	Bermuda	0.07	1'204	2.1	33'469	*69.5*	*107.56*
162	Brunei Darussalam	0.35	61	4.3	12'447	*225.4*	*65.92*
163	Canada	31.41	3	704.7	23'484	31'811.1	101.26
164	Cyprus	0.70	76	9.2	13'290	845.4	120.77
165	Denmark	5.37	125	159.3	29'745	8'217.4	152.90
166	Faroe Islands	*0.05*	32	*1.1*	24'102	*41.9*	*93.16*
167	Finland	5.21	14	*120.8*	23'338	7'250.0	139.24
168	France	59.64	110	*1'280.2*	21'737	72'514.0	121.59
169	French Guiana	0.18	2	...	...	*126.3*	*66.48*
170	French Polynesia	0.24	61	3.9	16'613	142.5	59.37
171	Germany	82.60	231	1'835.5	22'267	112'920.0	136.71
172	Greece	11.02	83	116.9	11'033	*13'569.7*	*128.06*
173	Greenland	*0.06*	-	...	...	*43.0*	*76.60*
174	Guam	0.16	356	*3.4*	22'086	*112.6*	*71.63*
175	Guernsey	*0.06*	966	*1.8*	29'574	*86.5*	*137.72*
176	Hong Kong, China	6.77	6'378	164.0	24'383	10'140.5	149.72
177	Iceland	0.29	3	7.6	26'617	436.7	151.63
178	Ireland	3.93	57	103.0	26'829	4'944.0	125.77
179	Israel	6.64	300	111.7	17'160	9'434.0	142.17
180	Italy	56.46	187	*1'070.8*	18'689	79'767.9	141.27
181	Japan	127.53	338	4'143.8	32'554	152'267.0	119.40
182	Jersey	*0.09*	752	...	...	*135.3*	*155.24*
183	Korea (Rep.)	47.60	484	422.2	9'023	55'599.0	116.80
184	Kuwait	2.36	97	32.4	14'260	1'708.9	72.29
185	Luxembourg	0.45	174	19.2	43'193	*755.8*	*169.99*
186	Macao, China	0.44	18'391	6.2	13'838	452.2	103.32
187	Martinique	0.41	368	*0.9*	2'296	*458.1*	*114.53*
188	Neth. Antilles	0.22	275	...	...	*94.0*	*44.16*
189	Netherlands	16.20	393	383.2	23'793	22'100.0	136.46
190	New Caledonia	0.22	12	3.1	13'940	*118.6*	*54.09*
191	New Zealand	3.94	15	50.4	13'197	4'201.0	106.65
192	Northern Marianas	0.05	105	...	...	*24.0*	*45.25*
193	Norway	4.56	14	168.1	37'116	7'167.0	157.31
194	Portugal	10.41	113	109.7	10'651	12'889.9	123.83
195	Qatar	0.61	53	16.2	26'479	443.2	72.66
196	Réunion	0.74	296	*1.3*	1'893	*721.1*	*98.65*
197	Singapore	4.16	6'099	85.7	20'752	5'225.3	125.50
198	Slovenia	2.00	99	19.5	9'790	2'478.4	124.17
199	Spain	40.68	81	*556.2*	13'863	52'180.6	128.26
200	Sweden	8.94	20	219.4	24'626	14'356.0	160.53
201	Switzerland	7.28	176	245.5	33'884	11'069.0	152.02
202	Taiwan, China	22.46	624	281.3	12'553	37'004.8	164.78
203	United Arab Emirates	3.20	38	*46.5*	19'750	3'521.7	110.05
204	United Kingdom	59.09	241	*1'416.1*	23'694	85'066.0	143.96
205	United States	288.37	31	10'208.1	35'843	330'766.8	114.70
206	Virgin Islands (US)	0.11	319	...	...	*110.4*	*101.01*
	High Income	**962.65**	**28**	**24'920.2**	**26'150**	**1'201'413.5**	**124.86**
	WORLD	**6'189.64**	**46**	**31'217.3**	**5'135**	**2'244'306.5**	**36.29**
	Africa	**819.75**	**27**	**562.1**	**722**	**56'849.3**	**6.97**
	Americas	**850.97**	**21**	**12'806.9**	**15'326**	**552'927.3**	**65.04**
	Asia	**3'687.48**	**119**	**8'289.6**	**2'280**	**883'585.5**	**23.97**
	Europe	**799.68**	**31**	**9'132.6**	**11'436**	**722'850.8**	**90.37**
	Oceania	**31.76**	**4**	**426.0**	**13'771**	**28'093.6**	**88.94**

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. Broadband subscribers

		DSL subscribers		Cable modem subscribers		Total Broadband subscribers	
		Total	as % of residential telephone	Total	as % of cable TV subscribers	Total	per 100 inhabitants
		2002	2002	2002	2002	2002	2002
1	Afghanistan	-	-	-	-	-	-
2	Angola	-	-	-	-	-	-
3	Armenia	…	…	…	…	…	…
4	Azerbaijan	…	…	-	-	…	…
5	Bangladesh	-	-	-	-	-	-
6	Benin	…	…	…	…	…	…
7	Bhutan	-	-	-	-	-	-
8	Burkina Faso	-	-	-	-	-	-
9	Burundi	…	…	-	-	…	…
10	Cambodia	-	-	-	-	-	-
11	Cameroon	…	…	…	…	…	…
12	Central African Rep.	…	…	…	…	…	…
13	Chad	-	-	-	-	-	-
14	Comoros	-	-	-	-	-	-
15	Congo	-	-	-	-	-	-
16	Côte d'Ivoire	…	…	…	…	…	…
17	D.P.R. Korea	-	-	-	-	-	-
18	D.R. Congo	…	…	…	…	…	…
19	Equatorial Guinea	-	-	…	…	…	…
20	Eritrea	-	-	-	-	-	-
21	Ethiopia	…	…	…	…	…	…
22	Gambia	…	…	…	…	…	…
23	Georgia	200	…	720	1.2	920	0.02
24	Ghana	…	…	…	…	…	…
25	Guinea	…	…	…	…	…	…
26	Guinea-Bissau	-	-	-	-	-	-
27	Haiti	-	-	-	-	-	-
28	India	*20'000*	…	*30'000*	*0.1*	*50'000*	*0.005*
29	Indonesia	*10'000*	*0.2*	*5'000*	*7.1*	*15'000*	*0.007*
30	Kenya	…	…	…	…	…	…
31	Kyrgyzstan	…	…	…	…	…	…
32	Lao P.D.R.	-	-	-	-	-	-
33	Lesotho	…	…	…	…	…	…
34	Liberia	…	…	…	…	…	…
35	Madagascar	…	…	…	…	…	…
36	Malawi	-	-	-	-	-	-
37	Mali	21	-	22	…	43	0.0004
38	Mauritania	…	…	…	…	…	…
39	Moldova	…	…	…	…	…	…
40	Mongolia	-	-	-	-	-	-
41	Mozambique	…	…	…	…	…	…
42	Myanmar	-	-	-	-	-	-
43	Nepal	-	-	-	-	-	-
44	Nicaragua	-	-	2'319	…	2'319	0.043
45	Niger	-	-	-	-	-	-
46	Nigeria	…	…	…	…	…	…
47	Pakistan	-	-	-	-	-	-
48	Papua New Guinea	-	-	-	-	-	-
49	Rwanda	-	-	-	-	-	-
50	S. Tomé & Principe	-	-	-	-	-	-
51	Senegal	-	-	-	-	-	-
52	Sierra Leone	…	…	…	…	…	…
53	Solomon Islands	108	…	116	…	224	0.1
54	Somalia	…	…	…	…	…	…
55	Sudan	-	-	-	-	-	-
56	Tajikistan	-	-	-	-	-	-
57	Tanzania	…	…	…	…	…	…
58	Togo	…	…	…	…	…	…
59	Uganda	…	…	…	…	…	…
60	Ukraine	…	…	…	…	…	…
61	Uzbekistan	…	…	…	…	…	…
62	Viet Nam	-	-	-	-	-	-
63	Yemen	…	…	…	…	…	…
64	Zambia	-	-	-	-	-	-
65	Zimbabwe	-	-	-	-	-	-
	Low Income	**30'329**	**0.2**	**38'177**	**0.1**	**68'506**	**0.003**

2. Broadband subscribers

		DSL subscribers		Cable modem subscribers		Total Broadband subscribers	
		Total	as % of residential telephone	Total	as % of cable TV subscribers	Total	per 100 inhabitants
		2002	2002	2002	2002	2002	2002
66	Albania	…	…	…	…	…	…
67	Algeria	…	…	…	…	…	…
68	Belarus	20	…	-	-	20	0.0002
69	Belize	-	-	-	-	-	-
70	Bolivia	…	…	…	…	…	…
71	Bosnia	-	-	-	-	-	-
72	Bulgaria	…	…	…	…	…	…
73	Cape Verde	-	-	-	-	-	-
74	China	2'220'000	0.2	…	…	2'260'000	0.2
75	Colombia	2'000	…	18'400	…	20'400	0.05
76	Cuba	…	…	…	…	…	…
77	Djibouti	-	-	-	-	-	-
78	Dominican Rep.	…	…	…	…	…	…
79	Ecuador	…	…	…	…	…	…
80	Egypt	…	…	-	-	…	…
81	El Salvador	…	…	…	…	…	…
82	Fiji	-	-	-	-	-	-
83	Guatemala	…	…	…	…	…	…
84	Guyana	…	…	…	…	…	…
85	Honduras	…	…	…	…	…	…
86	Iran (I.R.)	*661*	*0.007*	-	-	*661*	*0.001*
87	Iraq	…	…	…	…	…	…
88	Jamaica	…	…	…	…	…	…
89	Jordan	1'900	0.1	-	-	1'900	0.04
90	Kazakhstan	…	…	…	…	…	…
91	Kiribati	-	-	-	-	-	-
92	Maldives	190	-	-	-	190	0.1
93	Marshall Islands	…	…	6	…	…	…
94	Micronesia	-	…	-	-	-	-
95	Morocco	-	…	-	-	-	-
96	Namibia	…	…	…	…	…	…
97	Palestine	…	…	…	…	…	…
98	Paraguay	-	-	500	0.3	500	0.01
99	Peru	*1'875*	…	*5'362*	…	*34'282*	*0.1*
100	Philippines	21'000	0.4	-	-	21'000	0.03
101	Romania	*4'000*	*0.1*	*1'200*	*0.04*	*6'000*	*0.03*
102	Russia	-	-	-	-	-	-
103	Samoa	-	-	-	-	-	-
104	Serbia and Montenegro	…	…	…	…	…	…
105	South Africa	-	-	-	-	-	-
106	Sri Lanka	-	-	-	-	-	-
107	St. Vincent	782	…	304	…	1'086	0.9
108	Suriname	…	…	…	…	…	…
109	Swaziland	-	-	-	-	-	-
110	Syria	…	…	…	…	…	…
111	TFYR Macedonia	…	…	…	…	…	…
112	Thailand	*700*	*0.02*	*900*	*0.6*	*1'613*	*0.003*
113	Tonga	11	-	-	-	11	0.01
114	Tunisia	…	…	…	…	…	…
115	Turkey	2'999	0.02	18'206	1.9	21'205	0.03
116	Turkmenistan	…	…	…	…	…	…
117	Vanuatu	-	-	-	-	-	-
	Lower Middle Income	**2'256'138**	**0.87**	**44'878**	**0.04**	**2'328'868**	**0.11**

2. Broadband subscribers

		DSL subscribers		*Cable modem subscribers*		*Total Broadband subscribers*	
		Total	*as % of residential telephone*	*Total*	*as % of cable TV subscribers*	*Total*	*per 100 inhabitants*
		2002	*2002*	*2002*	*2002*	*2002*	*2002*
118	Antigua & Barbuda	…	…	…	…	…	…
119	Argentina	64'400	0.7	46'000	0.8	115'000	0.3
120	Barbados	…	…	…	…	…	…
121	Botswana	…	…	…	…	…	…
122	Brazil	600'000	0.9	131'000	3.8	731'000	0.4
123	Chile	45'457	1.0	59'012	6.8	104'469	0.69
124	Costa Rica	363	-	-	-	363	0.0
125	Croatia	12'000	…	-	-	12'000	0.2
126	Czech Republic	-	-	*6'200*	*0.6*	*6'200*	*0.1*
127	Dominica	170	…	150	…	320	0.4
128	Estonia	33'000	4.1	12'700	8.8	45'700	3.4
129	Gabon	…	…	1'000	6.7	1'000	0.1
130	Grenada	563	-	-	-	563	0.5
131	Guadeloupe	…	…	…	…	…	…
132	Hungary	32'054	0.2	31'190	1.1	63'244	0.6
133	Latvia	3'235	0.6	…	…	3'235	-
134	Lebanon	-	-	35'000	…	35'000	1.0
135	Libya	…	…	…	…	…	…
136	Lithuania	20'000	0.3	-	-	20'000	0.6
137	Malaysia	*4'000*	*0.1*	-	-	*4'000*	*0.0*
138	Malta	11'505	3.9	6'174	3.3	17'679	4.5
139	Mauritius	…	…	…	…	…	…
140	Mayotte	…	…	…	…	…	…
141	Mexico	*29'854*	*0.3*	*20'000*	*0.8*	*50'000*	*0.05*
142	Oman	…	…	-	-	…	…
143	Panama	…	…	…	…	…	…
144	Poland	*2'000*	*0.02*	*10'000*	*0.3*	*12'000*	*0.03*
145	Puerto Rico	…	…	…	…	…	…
146	Saudi Arabia	2'287	0.05	-	-	2'287	0.01
147	Seychelles	…	…	…	…	…	…
148	Slovak Republic	-	-	-	-	-	-
149	St. Kitts and Nevis	500	…	1'200	…	1'700	3.6
150	St. Lucia	…	…	…	…	…	…
151	Trinidad & Tobago	176	-	-	-	176	0.01
152	Uruguay	…	…	…	…	*1'371*	*0.0*
153	Venezuela	46'870	2.5	67'402	…	114'272	0.5
	Upper Middle Income	**908'434**	**0.91**	**427'028**	**2.1**	**1'341'579**	**0.26**

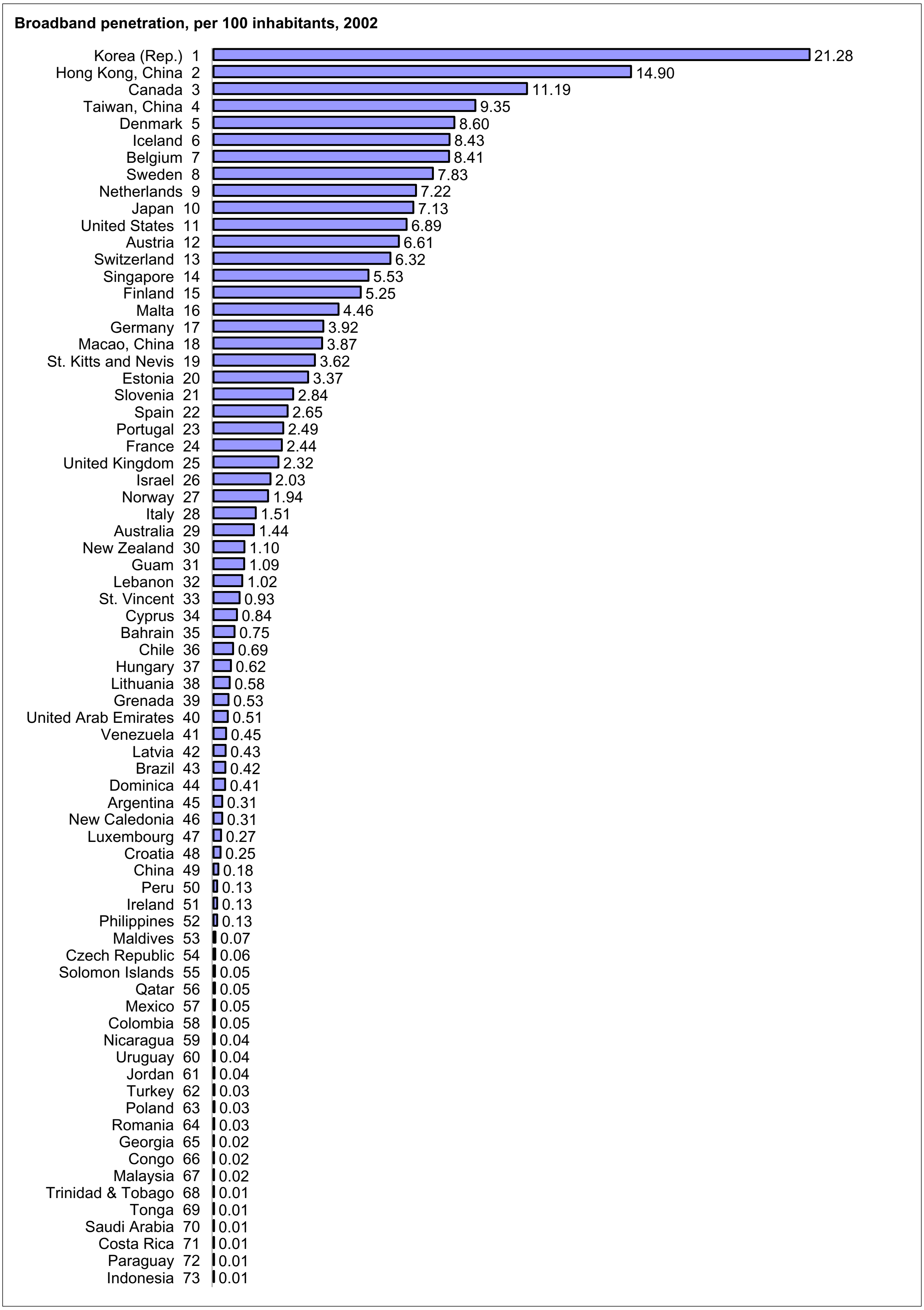
2. Broadband subscribers

		DSL subscribers		Cable modem subscribers		Total Broadband subscribers	
		Total	as % of residential telephone	Total	as % of cable TV subscribers	Total	per 100 inhabitants
		2002	2002	2002	2002	2002	2002
154	Andorra	…	…	…	…	…	…
155	Aruba	…	…	…	…	…	…
156	Australia	134'200	0.5	140'900	6.6	283'600	1.4
157	Austria	151'600	6.0	255'000	15.7	539'500	6.6
158	Bahamas	-	-	-	-	-	-
159	Bahrain	4'980	1.0	-	-	4'980	0.7
160	Belgium	518'919	…	359'114	5.3	870'000	8.4
161	Bermuda	…	…	…	…	…	…
162	Brunei Darussalam	-	-	-	-	-	-
163	Canada	1'086'049	8.5	1'624'456	20.6	3'515'000	11.2
164	Cyprus	5'879	0.7	-	-	5'879	0.8
165	Denmark	307'055	…	154'830	8.1	462'000	8.6
166	Faroe Islands	…	…	…	…	…	…
167	Finland	*32'500*	*1.7*	*19'668*	*2.0*	273'500	5.3
168	France	1'277'000	5.4	239'896	5.8	1'456'000	2.4
169	French Guiana	…	…	…	…	…	…
170	French Polynesia	-	-	-	-	-	-
171	Germany	3'195'000	…	45'000	0.1	3'240'000	3.9
172	Greece	-	-	-	-	-	-
173	Greenland	…	…	…	…	…	…
174	Guam	*1'050*	…	*700*	…	*1'750*	*1.1*
175	Guernsey	…	…	…	…	…	…
176	Hong Kong, China	559'000	26.2	225'000	28.4	1'009'426	14.9
177	Iceland	24'270	7.2	-	-	24'270	8.4
178	Ireland	2'654	…	2'300	-	4'954	0.1
179	Israel	120'000	1.9	15'000	1.2	135'000	2.0
180	Italy	850'000	1.8	-	-	850'000	1.5
181	Japan	7'023'039	4.3	2'069'000	6.6	9'092'039	7.1
182	Jersey	…	…	…	…	…	…
183	Korea (Rep.)	6'386'646	26.2	3'701'708	…	10'128'000	21.3
184	Kuwait	…	…	…	…	…	…
185	Luxembourg	*1'215*	*0.5*	-	-	*1'215*	*0.3*
186	Macao, China	16'954	7.3	-	-	16'954	3.9
187	Martinique	…	…	…	…	…	…
188	Neth. Antilles	…	…	…	…	…	…
189	Netherlands	370'000	2.2	800'000	12.3	1'170'000	7.2
190	New Caledonia	700	…	-	…	700	0.3
191	New Zealand	39'000	2.8	4'500	4.6	43'500	1.1
192	Northern Marianas	…	…	…	…	…	…
193	Norway	*24'000*	…	*45'339*	*5.4*	*88'541*	*1.96*
194	Portugal	52'005	…	207'486	8.4	259'491	2.5
195	Qatar	300	-	-	-	300	0.05
196	Réunion	…	…	…	…	…	…
197	Singapore	162'000	*6.3*	*78'000*	*25.8*	230'357	5.5
198	Slovenia	16'735	0.5	40'000	12.5	56'735	2.8
199	Spain	*392'900*	*2.7*	*37'155*	*6.3*	*430'055*	*1.1*
200	Sweden	*241'000*	*6.1*	*115'500*	*5.8*	700'000	7.8
201	Switzerland	195'220	…	260'000	2.9	460'000	6.3
202	Taiwan, China	1'820'000	9.6	280'000	6.0	2'100'000	9.4
203	United Arab Emirates	16'177	1.5	-	-	16'177	0.5
204	United Kingdom	587'000	0.8	783'000	8.0	1'370'000	2.3
205	United States	6'471'716	3.1	11'369'087	9.7	19'881'549	6.9
206	Virgin Islands (US)	…	…	…	…	…	…
	High Income	**32'086'763**	**6.7**	**22'872'639**	**14.1**	**58'721'472**	**6.1**
	WORLD	**35'281'664**	**7.6**	**23'382'722**	**7.0**	**62'500'425**	**1.0**
	Africa	**21**	**0.0**	**1'022**	**0.7**	**1'043**	**0.0**
	Americas	**8'350'775**	**15.8**	**13'345'192**	**14.1**	**24'574'370**	**2.9**
	Asia	**18'390'034**	**6.4**	**6'440'328**	**3.7**	**25'125'804**	**0.7**
	Europe	**8'365'765**	**7.8**	**3'449'958**	**5.4**	**12'469'423**	**1.6**
	Oceania	**175'069**	**2.9**	**146'222**	**10.1**	**329'785**	**1.0**

Note: For data comparability and coverage, see the technical notes.
Data in italics refer to 2001.

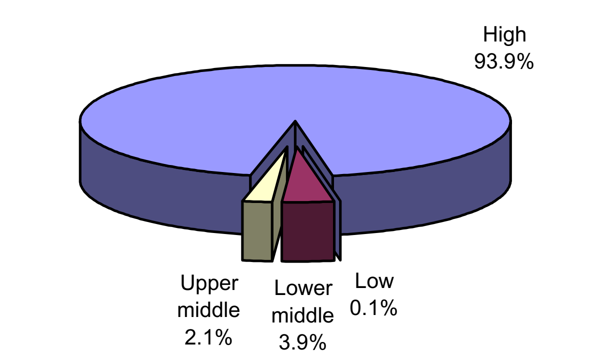
Source: ITU.

2. Broadband subscribers

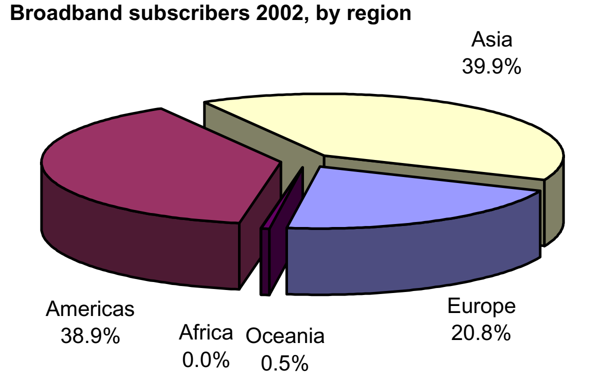


2. Broadband subscribers

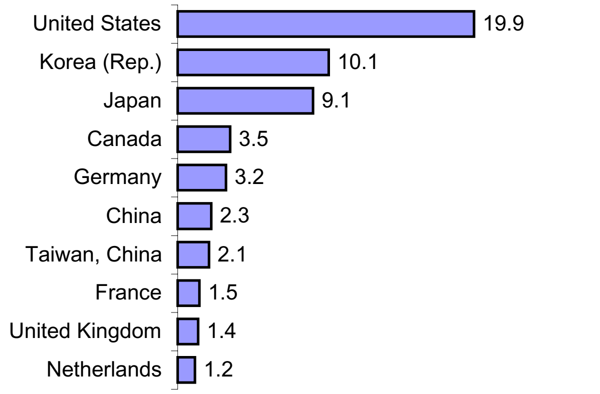
Broadband subscribers, by income, 2002



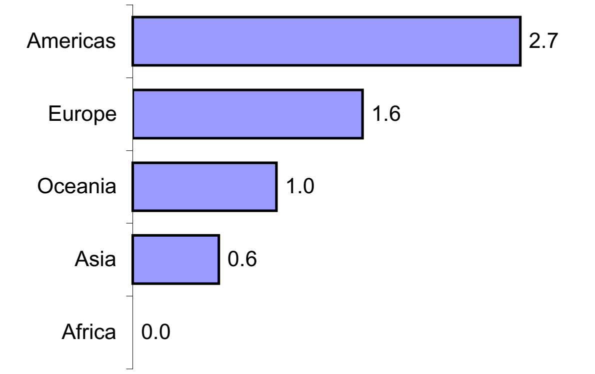
Broadband subscribers 2002, by region



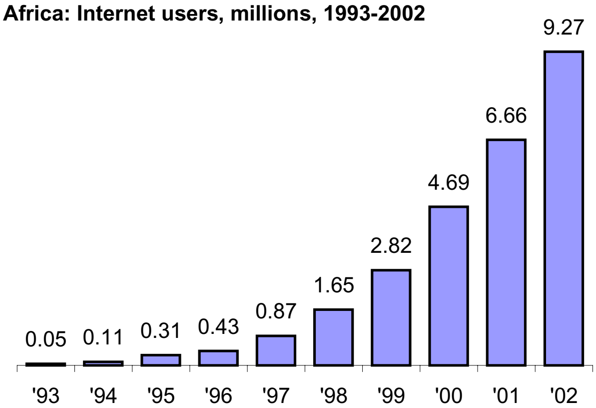
Total broadband subs, top 10, 2002, millions



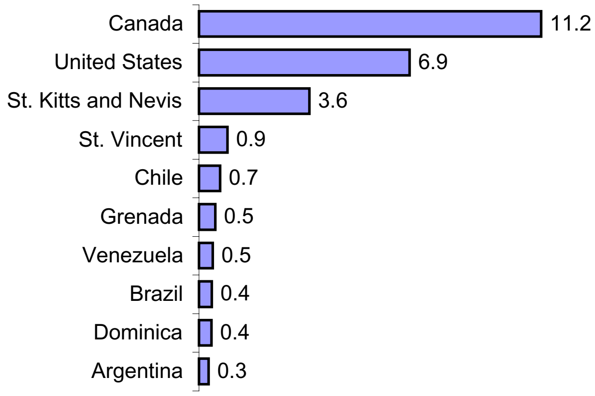
Broadband penetration*, by region, 2002



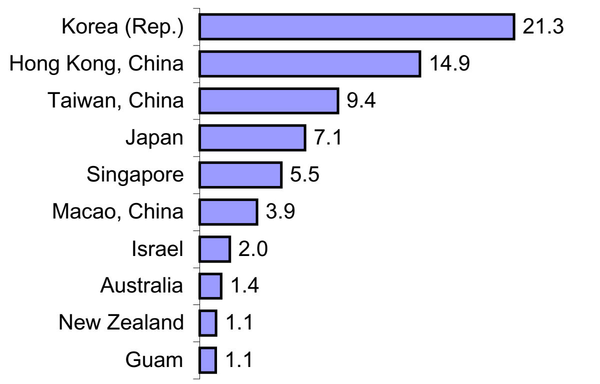
Africa: Internet users, millions, 1993-2002



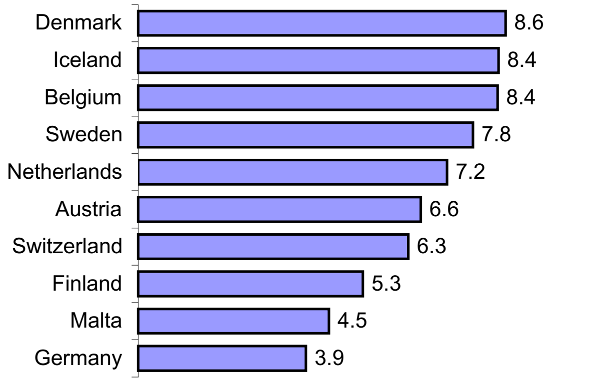
Americas: Broadband penetration, top 10, 2002



Asia/Pacific: Broadband penetration, top 10, 2002



Europe: Broadband penetration, top 10, 2002



* Penetration = subscribers per 100 inhabitants

3. Information technology

		Internet				Estimated PCs	
		Hosts Total 2002	Hosts per 10'000 inhab. 2002	Users (k) 2002	Users per 10'000 inhab. 2002	Total (k) 2002	Per 100 inhab. 2002
1	Afghanistan	*4*	-	...	...	...	...
2	Angola	*8*	*0.01*	41.0	29.42	27	0.19
3	Azerbaijan	1'139	1.40	300.0	368.51	...	...
4	Bangladesh	2	-	204.0	15.32	450	0.34
5	Benin	574	0.87	*25.0*	*38.78*	*11*	*0.17*
6	Bhutan	1'242	17.98	10.0	144.75	10	1.45
7	Burkina Faso	409	0.34	25.0	20.90	19	0.16
8	Burundi	3	-	8.4	12.02	5	0.07
9	Cambodia	*623*	*0.46*	30.0	21.76	*20*	*0.15*
10	Cameroon	439	0.28	*45.0*	*29.19*	*60*	*0.39*
11	Central African Rep.	6	0.02	*3.0*	*7.93*	*7*	*0.19*
12	Chad	11	0.01	15.0	19.06	*12*	*0.16*
13	Comoros	*11*	*0.15*	3.2	41.99	4	0.55
14	Congo	36	0.11	5.0	15.20	*12*	*0.39*
15	Côte d'Ivoire	4'397	2.67	90.0	54.58	*118*	*0.72*
16	D.P.R. Korea	...	...	-	-	...	...
17	D.R. Congo	134	0.03	*6.0*	*1.14*	...	...
18	Equatorial Guinea	3	0.06	1.7	34.84	4	0.72
19	Eritrea	859	2.16	9.0	22.61	10	0.25
20	Ethiopia	*43*	*0.01*	50.0	7.42	100	0.15
21	Gambia	568	4.14	*18.0*	*134.63*	*17*	*1.27*
22	Georgia	3'032	6.15	73.5	148.97	156	3.16
23	Ghana	313	0.14	*40.5*	*19.36*	*70*	*0.33*
24	Guinea	251	0.33	35.0	45.66	42	0.55
25	Guinea-Bissau	20	0.16	5.0	39.90	...	...
26	Haiti	-	-	80.0	96.41	...	...
27	India	*82'979*	*0.81*	16'580.0	159.14	*6'000*	*0.58*
28	Indonesia	*45'660*	*2.18*	8'000.0	377.16	*2'300*	*1.10*
29	Kenya	2'963	0.93	*500.0*	*159.78*	*175*	*0.56*
30	Kyrgyzstan	5'930	11.64	152.0	298.33	65	1.27
31	Lao P.D.R.	*165*	*0.31*	15.0	27.11	18	0.33
32	Lesotho	*60*	*0.28*	21.0	96.91	...	...
33	Liberia	11	0.03	*1.0*	*3.22*	...	...
34	Madagascar	*234*	*0.15*	55.0	34.57	*40*	*0.26*
35	Malawi	*22*	*0.02*	27.0	25.87	*13*	*0.13*
36	Mali	158	0.15	32.0	30.11	*14*	*0.13*
37	Mauritania	79	0.29	10.0	37.28	*27*	*1.03*
38	Moldova	*1'756*	*4.00*	*60.0*	*136.67*	*70*	*1.59*
39	Mongolia	*151*	*0.63*	50.0	205.85	50	2.06
40	Mozambique	*16*	*0.01*	*30.0*	*16.99*	*70*	*0.40*
41	Myanmar	*2*	-	*10.0*	*2.07*	*55*	*0.11*
42	Nepal	*1'513*	*0.67*	*60.0*	*26.39*	*80*	*0.35*
43	Nicaragua	*2'194*	*4.20*	90.0	167.60	150	2.79
44	Niger	119	0.10	*12.0*	*10.69*	*6*	*0.05*
45	Nigeria	1'030	0.09	200.0	16.66	*800*	*0.68*
46	Pakistan	*11'319*	*0.78*	1'500.0	100.82	*600*	*0.41*
47	Papua New Guinea	517	0.95	*50.0*	*94.44*	*300*	*5.67*
48	Rwanda	1'233	1.51	*20.0*	*25.16*	...	...
49	S. Tomé & Principe	*927*	*61.80*	*9.0*	*600.00*	...	...
50	Senegal	761	0.78	105.0	107.12	200	2.04
51	Sierra Leone	277	0.56	*7.0*	*14.19*	...	...
52	Solomon Islands	470	10.58	2.2	49.51	18	4.05
53	Somalia	4	-	89.0	87.58	...	...
54	Sudan	-	-	84.0	25.82	200	0.61
55	Tajikistan	302	0.47	3.5	5.49	...	...
56	Tanzania	*1'478*	*0.44*	*100.0*	*29.77*	*120*	*0.36*
57	Togo	80	0.17	200.0	426.89	150	3.20
58	Uganda	2'242	0.91	*60.0*	*25.18*	*70*	*0.29*
59	Uzbekistan	*213*	*0.09*	275.0	108.74	...	...
60	Viet Nam	*487*	*0.06*	1'500.0	184.62	800	0.98
61	Yemen	113	0.06	40.0	20.63	145	0.75
62	Zambia	*1'095*	*1.03*	52.4	49.01	80	0.75
63	Zimbabwe	*3'494*	*3.04*	500.0	429.75	600	5.16
	Low Income	**184'181**	**0.76**	**31'625.4**	**129.36**	**14'369**	**0.63**

3. Information technology

		Internet				Estimated PCs	
		Hosts Total 2002	*Hosts per 10'000 inhab. 2002*	*Users (k) 2002*	*Users per 10'000 inhab. 2002*	*Total (k) 2002*	*Per 100 inhab. 2002*
64	Albania	172	0.43	*10.0*	*25.19*	*30*	*0.76*
65	Algeria	821	0.26	500.0	159.78	*220*	*0.71*
66	Armenia	2'850	7.50	*70.0*	*184.12*	*35*	*0.92*
67	Belarus	4'025	4.06	808.7	815.84	...	...
68	Belize	*333*	*13.50*	22.0	869.57	35	13.83
69	Bolivia	*1'522*	*1.84*	270.0	323.70	190	2.28
70	Bosnia	5'702	13.91	100.0	243.90	...	...
71	Bulgaria	32'986	42.28	700.0	897.32	405	5.19
72	Cape Verde	48	1.09	16.0	364.46	35	7.97
73	China	*89'357*	*0.68*	59'100.0	460.09	*25'000*	*1.90*
74	Colombia	*57'419*	*13.41*	1'982.0	457.84	2'133	4.93
75	Cuba	*878*	*0.78*	*120.0*	*106.79*	*220*	*1.96*
76	Djibouti	498	7.59	4.5	68.60	10	1.52
77	Dominican Rep.	*41'761*	*48.17*	*186.0*	*214.53*	...	...
78	Ecuador	*3'383*	*2.63*	503.3	388.92	403	3.11
79	Egypt	3'061	0.47	1'500.0	228.51	1'120	1.71
80	El Salvador	*510*	*0.80*	300.0	464.58	*140*	*2.19*
81	Fiji	785	9.41	22.0	263.79	40	4.80
82	Guatemala	*6'630*	*5.67*	400.0	333.42	*150*	*1.28*
83	Guyana	*20*	*0.23*	*95.0*	*1'091.95*	*23*	*2.64*
84	Honduras	*322*	*0.49*	200.0	297.97	*80*	*1.22*
85	Iran (I.R.)	3'491	0.53	3'168.0	483.30	*4'500*	*6.97*
86	Iraq	-	-	25.0	10.31	200	0.83
87	Jamaica	*1'436*	*5.52*	*100.0*	*384.71*	*130*	*5.00*
88	Jordan	4'116	7.72	307.0	576.09	200	3.75
89	Kazakhstan	16'562	10.37	*150.0*	*93.20*	...	...
90	Kiribati	35	4.00	*2.0*	*232.24*	*1*	*1.05*
91	Maldives	*265*	*9.81*	15.0	533.81	20	7.12
92	Marshall Islands	*3*	*0.55*	1.3	220.97	3	5.30
93	Micronesia	636	53.94	*5.0*	*429.97*	...	...
94	Morocco	2'680	0.90	500.0	168.67	*400*	*1.37*
95	Namibia	*4'632*	*25.36*	*45.0*	*246.33*	*100*	*5.47*
96	Palestine	...	...	105.0	303.91	125	3.62
97	Paraguay	*2'704*	*4.80*	100.0	172.95	200	3.46
98	Peru	*13'504*	*5.18*	*2'000.0*	*766.49*	*1'250*	*4.79*
99	Philippines	*30'851*	*3.94*	3'500.0	437.60	2'200	2.75
100	Romania	40'971	18.35	1'800.0	806.09	*800*	*3.57*
101	Russia	409'229	27.92	6'000.0	409.32	13'000	8.87
102	Samoa	5'705	316.94	4.0	222.22	1	0.67
103	Serbia and Montenegro	16'972	15.83	640.0	597.01	290	2.71
104	South Africa	*238'462*	*53.51*	3'100.0	682.01	3'300	7.26
105	Sri Lanka	*2'286*	*1.22*	200.0	105.56	250	1.32
106	St. Vincent	*3*	*0.26*	7.0	598.29	14	11.97
107	Suriname	*59*	*1.34*	*14.5*	*330.00*	*20*	*4.55*
108	Swaziland	*1'142*	*11.20*	20.0	193.80	25	2.42
109	Syria	11	0.01	220.0	129.11	330	1.94
110	TFYR Macedonia	*2'594*	*12.69*	*70.0*	*342.47*	...	...
111	Thailand	*71'995*	*11.75*	4'800.0	775.61	2'461	3.98
112	Tonga	19'485	1'968.18	2.9	292.93	*1*	*1.42*
113	Tunisia	341	0.35	505.5	515.03	300	3.06
114	Turkey	154'585	22.98	4'900.0	728.39	*2'700*	*4.07*
115	Turkmenistan	2'020	4.16	*8.0*	*16.55*	...	...
116	Ukraine	71'691	14.30	*600.0*	*119.29*	*920*	*1.83*
117	Vanuatu	*358*	*17.81*	7.0	341.46	3	1.46
	Lower Middle Income	**1'371'907**	**6.06**	**99'831.6**	**444.85**	**64'013**	**2.88**

3. Information technology

		Internet				Estimated PCs	
		Hosts Total 2002	Hosts per 10'000 inhab. 2002	Users (k) 2002	Users per 10'000 inhab. 2002	Total (k) 2002	Per 100 inhab. 2002
118	Antigua & Barbuda	*786*	*101.52*	*7.0*	*904.09*	...	...
119	Argentina	*465'359*	*128.47*	4'100.0	1'120.22	3'000	8.20
120	Barbados	*130*	*4.85*	*15.0*	*559.08*	*25*	*9.32*
121	Botswana	*1'273*	*7.57*	*50.0*	*297.47*	*65*	*3.87*
122	Brazil	*1'644'575*	*95.71*	14'300.0	822.41	13'000	7.48
123	Chile	*122'727*	*79.68*	3'575.0	2'375.36	1'796	11.93
124	Costa Rica	*8'551*	*20.79*	*384.0*	*933.63*	*700*	*17.02*
125	Croatia	29'644	61.20	789.0	1'628.82	760	15.69
126	Czech Republic	226'429	223.21	2'500.0	2'464.51	*1'500*	*14.67*
127	Dominica	*223*	*28.66*	12.5	1'602.56	*6*	*7.71*
128	Estonia	63'364	467.63	560.0	4'132.84	285	21.03
129	Gabon	79	0.61	25.0	192.46	25	1.92
130	Grenada	*12*	*1.20*	6.5	613.21	*13*	*13.00*
131	Guadeloupe	*461*	*10.02*	*20.0*	*434.78*	*100*	*21.74*
132	Hungary	194'503	191.59	1'600.0	1'576.04	1'100	10.84
133	Latvia	35'492	152.39	310.0	1'331.04	400	17.17
134	Lebanon	7'199	21.08	400.0	1'171.30	275	8.05
135	Libya	*70*	*0.13*	125.0	225.02	130	2.34
136	Lithuania	54'605	157.82	500.0	1'445.09	380	10.98
137	Malaysia	*74'007*	*31.10*	7'500.0	3'077.55	3'600	14.77
138	Malta	7'355	185.73	*99.0*	*2'525.51*	*90*	*22.96*
139	Mauritius	3'462	28.60	180.0	1'487.00	*130*	*10.83*
140	Mayotte	-	-	...	...	...	...
141	Mexico	*918'288*	*91.49*	4'663.4	457.74	*6'900*	*6.87*
142	Oman	*4'678*	*17.83*	180.0	663.96	95	3.50
143	Panama	*7'825*	*26.99*	*120.0*	*413.94*	*110*	*3.79*
144	Poland	657'495	170.30	*3'800.0*	*983.72*	*3'300*	*8.54*
145	Puerto Rico	*1'584*	*4.13*	*600.0*	*1'563.31*	...	...
146	Saudi Arabia	14'788	6.41	1'600.0	693.84	3'003	13.02
147	Seychelles	*262*	*31.99*	*9.0*	*1'098.90*	*12*	*14.65*
148	Slovak Republic	85'998	159.91	862.8	1'604.38	970	18.04
149	St. Kitts and Nevis	*3*	*0.65*	5.0	1'063.83	9	19.15
150	St. Lucia	*17*	*1.08*	*13.0*	*823.96*	*23*	*14.58*
151	Trinidad & Tobago	*6'872*	*52.86*	138.0	1'060.32	104	7.95
152	Uruguay	*70'892*	*210.93*	*400.0*	*1'190.12*	*370*	*11.01*
153	Venezuela	*22'614*	*9.18*	1'274.4	503.73	*1'300*	*5.28*
	Upper Middle Income	**4'731'622**	**93.75**	**50'723.6**	**995.60**	**43'575**	**8.66**

3. Information technology

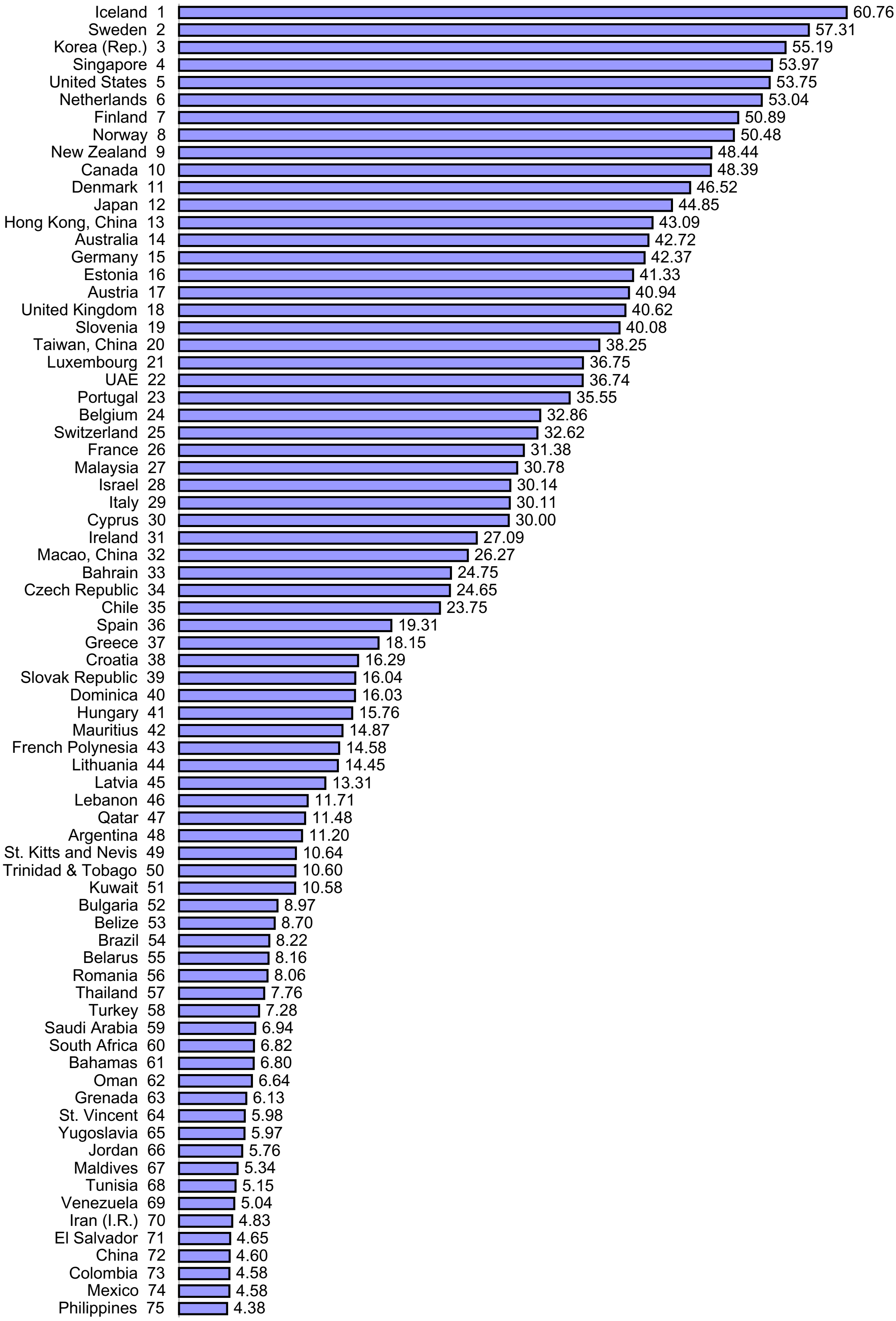
		Internet				Estimated PCs	
		Hosts Total 2002	Hosts per 10'000 inhab. 2002	Users (k) 2002	Users per 10'000 inhab. 2002	Total (k) 2002	Per 100 inhab. 2002
154	Andorra	2'778	338.78	*7.0*	*897.44*	...	...
155	Aruba	*923*	*87.08*	*24.0*	*2'264.15*	...	...
156	Australia	2'564'339	1'304.16	8'400.0	4'272.03	*10'000*	*51.58*
157	Austria	367'933	450.95	3'340.0	4'093.64	3'013	36.93
158	Bahamas	*28*	*0.91*	21.2	679.74	...	...
159	Bahrain	*1'718*	*26.41*	165.0	2'474.66	107	16.04
160	Belgium	336'604	325.35	3'400.0	3'286.29	2'500	24.16
161	Bermuda	*5'161*	*798.92*	*30.0*	*4'643.96*	*32*	*49.54*
162	Brunei Darussalam	*8'707*	*254.59*	*35.0*	*1'023.39*	*25*	*7.31*
163	Canada	*2'890'273*	*963.20*	15'200.0	4'838.61	15'300	48.70
164	Cyprus	2'692	38.46	210.0	3'000.00	*170*	*24.65*
165	Denmark	836'631	1'556.74	2'500.0	4'651.81	3'100	57.68
166	Faroe Islands	*1'614*	*358.23*	...	...	...	...
167	Finland	1'220'062	2'343.12	2'650.0	5'089.30	2'300	44.17
168	France	1'388'681	232.86	18'716.0	3'138.32	20'700	34.71
169	French Guiana	2	0.11	*3.2*	*168.42*	*27*	*14.21*
170	French Polynesia	3'661	152.51	35.0	1'458.08	*66*	*28.00*
171	Germany	2'594'323	314.08	35'000.0	4'237.29	35'921	43.49
172	Greece	160'829	145.97	1'704.9	1'547.41	*860*	*8.12*
173	Greenland	2'914	519.52	*20.0*	*3'565.70*	...	...
174	Guam	129	8.06	*48.0*	*3'053.44*	...	...
175	Guernsey	1'634	260.19	*20.0*	*3'189.79*	...	...
176	Hong Kong, China	*387'672*	*576.47*	2'918.8	4'309.46	*2'600*	*38.66*
177	Iceland	68'261	2'370.17	175.0	6'076.39	130	45.14
178	Ireland	136'487	347.21	1'065.0	2'709.23	*1'500*	*39.07*
179	Israel	146'791	221.22	2'000.0	3'014.05	*1'600*	*24.59*
180	Italy	672'638	119.13	17'000.0	3'010.77	13'025	23.07
181	Japan	*7'118'333*	*559.22*	57'200.0	4'485.22	48'700	38.19
182	Jersey	1'712	196.36	*8.0*	*921.87*	...	...
183	Korea (Rep.)	*694'206*	*148.37*	26'270.0	5'518.91	26'458	55.58
184	Kuwait	*3'437*	*15.11*	250.0	1'057.53	285	12.06
185	Luxembourg	*13'965*	*314.08*	165.0	3'674.83	*230*	*51.73*
186	Macao, China	*189*	*4.22*	115.0	2'627.37	92	21.02
187	Martinique	319	7.88	*40.0*	*1'000.00*	*52*	*13.00*
188	Neth. Antilles	*119*	*5.47*	...	...	...	...
189	Netherlands	3'137'203	1'937.14	8'590.0	5'304.11	*6'900*	*42.84*
190	New Caledonia	5'915	264.06	30.0	1'339.29	...	...
191	New Zealand	432'957	1'099.13	1'908.0	4'843.75	*1'500*	*39.26*
192	Northern Marianas	*13*	*2.60*	...	...	...	...
193	Norway	255'742	561.33	2'300.0	5'048.29	*2'300*	*50.80*
194	Portugal	164'711	158.24	3'700.0	3'554.62	*1'210*	*11.74*
195	Qatar	171	2.80	70.0	1'147.54	110	18.03
196	Réunion	1	0.01	*150.0*	*2'051.98*	*43*	*5.88*
197	Singapore	*197'959*	*479.18*	2'247.0	5'396.64	*2'100*	*50.83*
198	Slovenia	35'791	179.31	800.0	4'008.02	600	30.06
199	Spain	589'979	145.02	7'856.0	1'931.03	*6'800*	*16.82*
200	Sweden	849'174	949.54	5'125.0	5'730.74	*5'000*	*56.12*
201	Switzerland	560'902	770.34	2'375.0	3'261.79	*3'900*	*53.83*
202	Taiwan, China	*1'712'539*	*764.34*	8'590.0	3'825.09	8'887	39.57
203	United Arab Emirates	52'332	163.54	1'175.6	3'673.80	450	14.06
204	United Kingdom	2'865'930	485.03	24'000.0	4'061.74	*22'000*	*36.62*
205	United States	*106'193'339*	*3'728.74*	155'000.0	5'375.06	*178'000*	*62.50*
206	Virgin Islands (US)	*2'468*	*225.80*	*17.0*	*1'555.35*	...	...
	High Income	**138'692'891**	**1'450.21**	**422'669.8**	**4'392.26**	**428'593**	**44.79**
	WORLD	**144'980'601**	**235.91**	**604'850.5**	**981.79**	**550'551**	**9.26**
	Africa	**281'200**	**3.46**	**9'270.2**	**113.89**	**8'997**	**1.24**
	Americas	**112'496'229**	**1'340.28**	**206'439.0**	**2'429.13**	**226'004**	**27.49**
	Asia	**10'803'406**	**29.51**	**211'187.5**	**576.13**	**144'457**	**4.03**
	Europe	**18'364'758**	**229.66**	**167'436.4**	**2'093.71**	**159'159**	**20.34**
	Oceania	**3'035'008**	**955.66**	**10'517.4**	**3'334.71**	**11'934**	**38.94**

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).

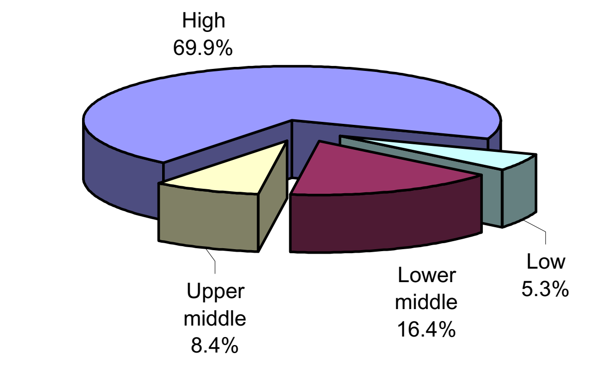
3. Information technology: Internet users

Estimated internet users per 100 inhabitants, top 75, 2002

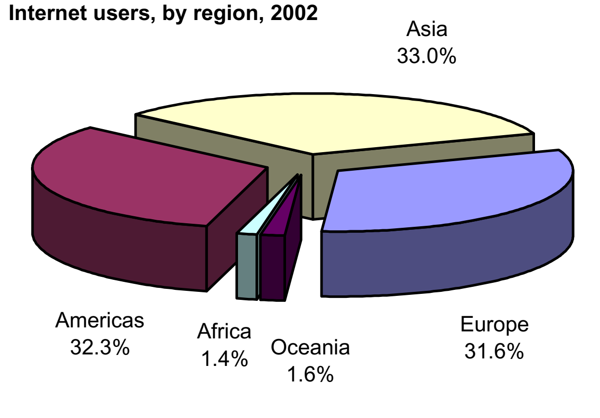


3. Information technology: Internet users

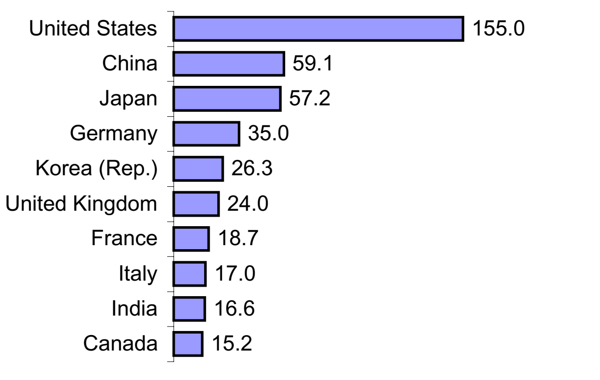
Internet users, by income, 2002



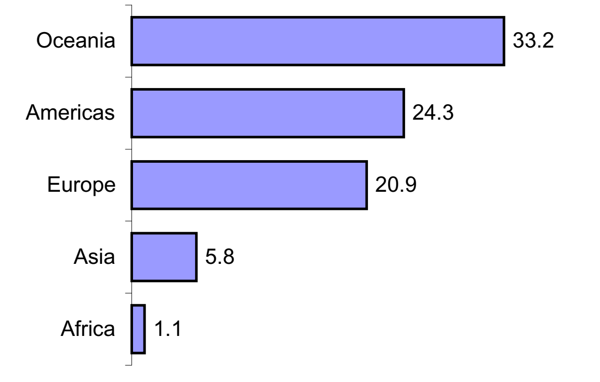
Internet users, by region, 2002



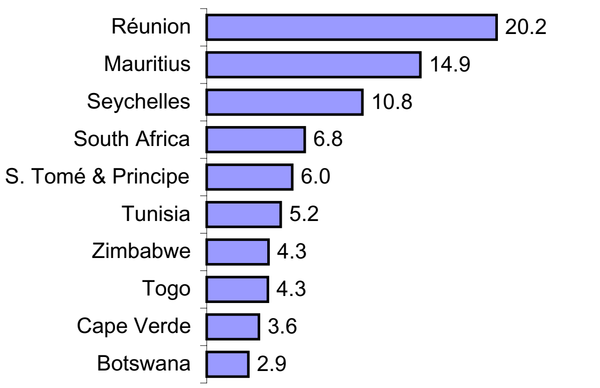
Total Internet users, top 10, 2002, millions



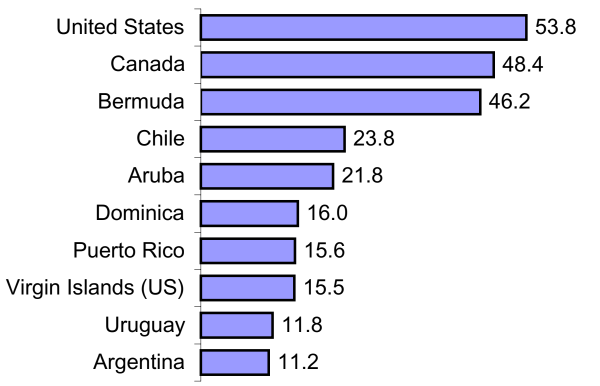
World: Internet users/100 inhab, by region, 2002



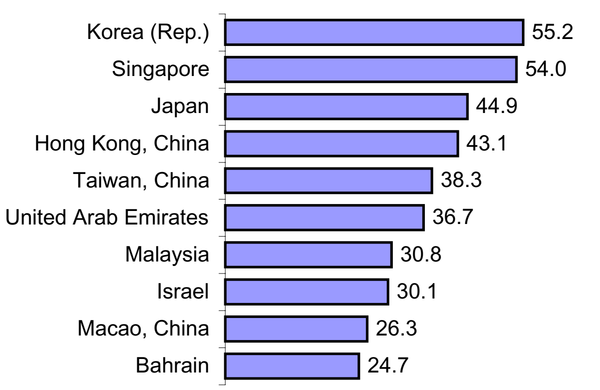
Africa: Internet users/100 inhab, top 10, 2002



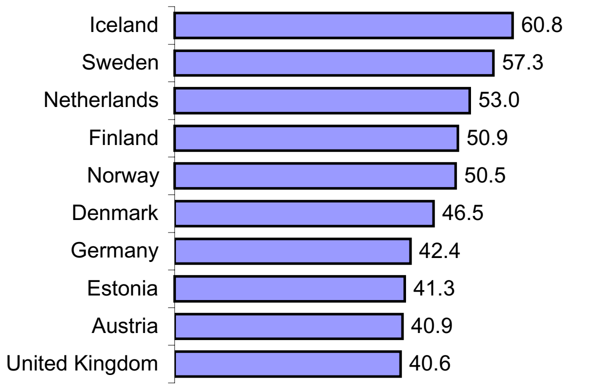
Americas: Internet users/100 inhab, top 10, 2002



Asia/Pacific: Internet users/100 inhab, top 10, 2002



Europe: Internet users/100 inhab, top 10, 2002



4. Internet subscribers

		Internet subscribers		*CAGR*	*Dial-up*		*Broadband*
		Total	*per 100 inhabitants*	*%*	*Total*	*as % of total subscribers*	*subscribers*
		2002	*2002*	*2000-02*	*2002*	*2'002*	*2002*
1	Afghanistan	…	…	…	…	…	-
2	Angola	…	…	…	…	…	-
3	Armenia	*20'000*	*0.53*	…	…	…	…
4	Azerbaijan	*12'000*	*0.15*	…	…	…	…
5	Bangladesh	68'000	0.05	6.5	…	…	-
6	Benin	*3'949*	*0.06*	…	*2'482*	*62.9*	…
7	Bhutan	1'600	0.23	46.5	1'584	99.0	-
8	Burkina Faso	8'000	0.07	58.4	*5'455*	*100.0*	-
9	Burundi	1'400	0.02	19.5	…	…	…
10	Cambodia	12'000	0.09	68.5	…	…	-
11	Cameroon	*4'400*	*0.03*	…	…	…	…
12	Central African Rep.	*982*	*0.03*	…	…	…	…
13	Chad	1'802	0.02	34.3	*1'517*	*100.0*	-
14	Comoros	896	0.12	35.1	896	100.0	-
15	Congo	600	0.02	144.9	…	…	-
16	Côte d'Ivoire	*13'721*	*0.08*	…	*13'599*	*99.1*	…
17	D.P.R. Korea	-	-	-	-	-	-
18	D.R. Congo	…	…	…	…	…	…
19	Equatorial Guinea	850	0.17	37.4	…	…	…
20	Eritrea	2'400	0.06	15.5	2'400	100.0	-
21	Ethiopia	7'709	0.01	77.0	*4'073*	*100.0*	…
22	Gambia	*4'000*	*0.30*	…	*1'200*	*30.0*	…
23	Georgia	3'650	0.07	…	2'730	74.8	920
24	Ghana	*20'120*	*0.10*	…	…	…	…
25	Guinea	*5'340*	*0.07*	…	…	…	…
26	Guinea-Bissau	221	0.02	…	…	…	-
27	Haiti	30'000	0.36	107.0	…	…	-
28	India	*3'200'000*	*0.31*	…	…	…	*50'000*
29	Indonesia	*600'000*	*0.29*	…	…	…	*15'000*
30	Kenya	*100'000*	*0.32*	…	*45'000*	*45.0*	…
31	Kyrgyzstan	4'566	0.09	30.5	…	…	…
32	Lao P.D.R.	2'555	0.05	29.1	2'555	100.0	-
33	Lesotho	1'500	0.07	…	…	…	…
34	Liberia	…	…	…	…	…	…
35	Madagascar	*12'500*	*0.08*	…	…	…	…
36	Malawi	13'450	0.13	55.0	13'450	100.0	-
37	Mali	12'000	0.11	9.5	11'000	91.7	43
38	Mauritania	…	…	…	…	…	…
39	Moldova	*10'500*	*0.24*	…	*9'629*	*91.7*	…
40	Mongolia	*10'000*	*0.42*	…	*10'000*	*100.0*	-
41	Mozambique	…	…	…	…	…	…
42	Myanmar	3'987	0.01	…	…	…	-
43	Nepal	15'000	0.07	…	15'000	100.0	-
44	Nicaragua	21'000	0.39	19.2	…	…	2'319
45	Niger	1'966	0.02	…	1'966	100.0	-
46	Nigeria	53'240	0.04	54.3	…	…	…
47	Pakistan	200'000	0.14	…	…	…	-
48	Papua New Guinea	…	…	…	…	…	-
49	Rwanda	*1'475*	*0.02*	…	…	…	-
50	S. Tomé & Principe	*562*	*0.37*	…	…	…	-
51	Senegal	9'587	0.10	32.2	…	…	-
52	Sierra Leone	*750*	*0.02*	…	…	…	…
53	Solomon Islands	988	0.22	-7.3	…	…	224
54	Somalia	*5'000*	*0.05*	*188.7*	…	…	…
55	Sudan	30'000	0.09	82.6	30'000	100.0	-
56	Tajikistan	258	0.00	93.4	258	100.0	-
57	Tanzania	*20'000*	*0.06*	…	…	…	…
58	Togo	12'000	0.26	41.4	…	…	…
59	Uganda	6'500	0.03	7.7	…	…	…
60	Ukraine	…	…	…	…	…	…
61	Uzbekistan	*6'969*	*0.03*	…	…	…	…
62	Viet Nam	392'336	0.48	96.0	166'600	66.0	-
63	Yemen	15'000	0.08	53.4	*7'034*	*100.0*	…
64	Zambia	11'647	0.11	38.4	*8'217*	*99.6*	-
65	Zimbabwe	39'997	0.34	15.5	…	…	-
	Low Income	**5'038'973**	**0.20**	**57.2**	**356'645**	**79.3**	**68'506**

4. Internet subscribers

		Internet subscribers		CAGR	Dial-up		Broadband
		Total	*per 100 inhabitants*	*%*	*Total*	*as % of total subscribers*	*subscribers*
		2002	*2002*	*2000-02*	*2002*	*2'002*	*2002*
66	Albania	*5'000*	*0.13*	…	…	…	…
67	Algeria	60'000	0.19	…	…	…	…
68	Belarus	18'117	0.18	96.7	6'605	81.6	20
69	Belize	5'200	0.00	…	5'156	99.2	-
70	Bolivia	48'999	0.59	10.7	…	…	…
71	Bosnia	87'000	2.12	141.8	…	…	-
72	Bulgaria	8'500	0.11	…	…	…	…
73	Cape Verde	3'935	0.90	26.6	…	…	-
74	China	49'700'000	3.87	134.7	…	…	2'260'000
75	Colombia	520'000	1.20	47.2	…	…	20'400
76	Cuba	…	…	…	…	…	…
77	Djibouti	1'600	0.24	37.2	…	…	-
78	Dominican Rep.	*64'086*	*0.74*	…	…	…	…
79	Ecuador	100'663	0.78	31.6	…	…	…
80	Egypt	…	…	…	…	…	…
81	El Salvador	94'866	1.47	…	…	…	…
82	Fiji	7'600	0.91	47.4	7'520	98.9	-
83	Guatemala	…	…	…	…	…	…
84	Guyana	*20'000*	*2.30*	…	…	…	…
85	Honduras	75'000	1.12	62.5	…	…	…
86	Iran (I.R.)	*402'000*	*0.62*	…	…	…	*661*
87	Iraq	…	…	…	…	…	…
88	Jamaica	…	…	…	…	…	…
89	Jordan	62'240	1.17	39.6	67'000	98.0	1'900
90	Kazakhstan	…	…	…	…	…	…
91	Kiribati	*548*	*0.64*	…	*548*	*100.0*	-
92	Maldives	1'059	0.38	…	…	…	190
93	Marshall Islands	*472*	*0.86*	…	*472*	*100.0*	-
94	Micronesia	*1'704*	*1.47*	…	*1'700*	*99.8*	-
95	Morocco	60'000	0.20	27.3	…	…	-
96	Namibia	*15'000*	*0.82*	…	…	…	…
97	Palestine	25'000	0.72	88.9	…	…	…
98	Paraguay	25'000	0.43	…	…	…	500
99	Peru	*175'000*	*0.67*	…	…	…	*34'282*
100	Philippines	1'000'000	1.25	41.4	…	…	21'000
101	Romania	…	…	…	300'000	…	6'000
102	Russia	1'890'500	1.29	96.0	…	…	-
103	Samoa	…	…	…	…	…	-
104	Serbia and Montenegro	…	…	…	…	…	…
105	South Africa	*937'526*	*2.10*	…	*937'526*	*100.0*	-
106	Sri Lanka	70'080	0.37	31.5	…	…	-
107	St. Vincent	5'982	5.11	50.0	3'178	97.2	1'086
108	Suriname	*4'840*	*1.10*	…	…	…	…
109	Swaziland	10'000	0.97	41.4	…	…	-
110	Syria	73'000	0.43	170.2	73'000	100.0	…
111	TFYR Macedonia	…	…	…	…	…	…
112	Thailand	*1'500'000*	*2.45*	…	…	…	*1'613*
113	Tonga	1'893	1.91	25.3	1'870	98.8	11
114	Tunisia	…	…	…	…	…	…
115	Turkey	4'300'000	6.39	69.3	…	…	21'205
116	Turkmenistan	*2'174*	*0.04*	…	…	…	…
117	Vanuatu	1'500	0.73	3.5	…	…	-
	Lower Middle Income	**61'386'084**	**2.81**	**119.5**	**1'404'575**	**99.8**	**2'368'868**

4. Internet subscribers

		Internet subscribers		CAGR	Dial-up		Broadband
		Total	*per 100 inhabitants*	*%*	*Total*	*as % of total subscribers*	*subscribers*
		2002	*2002*	*2000-02*	*2002*	*2'002*	*2002*
118	Antigua & Barbuda	…	…	…	…	…	…
119	Argentina	1'430'000	3.91	8.5	755'000	55.9	115'000
120	Barbados	…	…	…	…	…	…
121	Botswana	…	…	…	…	…	…
122	Brazil	7'900'000	4.54	87.4	…	…	731'000
123	Chile	1'280'000	8.50	48.8	889'000	69.5	104'469
124	Costa Rica	99'358	2.40	32.0	…	…	363
125	Croatia	538'000	11.11	69.6	…	…	12'000
126	Czech Republic	1'280'861	12.63	75.0	…	…	6'200
127	Dominica	4'474	5.74	27.4	…	…	320
128	Estonia	121'000	8.93	21.1	69'083	72.1	45'700
129	Gabon	8'000	0.62	26.5	…	…	1'000
130	Grenada	3'865	3.65	18.1	…	…	563
131	Guadeloupe	…	…	…	…	…	…
132	Hungary	445'863	4.39	42.2	*293'382*	*91.2*	63'244
133	Latvia	*43'550*	1.85	…	*40'090*	92.1	3'235
134	Lebanon	130'000	3.81	…	…	…	35'000
135	Libya	…	…	…	…	…	…
136	Lithuania	99'500	2.88	36.6	*56'126*	*95.3*	20'000
137	Malaysia	*2'119'000*	*8.90*	…	*2'115'000*	*99.8*	*4'000*
138	Malta	*60'000*	*15.31*	…	…	…	*17'679*
139	Mauritius	50'000	4.13	19.5	*43'302*	*99.6*	…
140	Mayotte	…	…	…	…	…	…
141	Mexico	1'723'000	1.72	…	…	…	50'000
142	Oman	48'232	1.78	42.1	…	…	…
143	Panama	…	…	…	…	…	…
144	Poland	…	…	…	…	…	12'000
145	Puerto Rico	…	…	…	…	…	…
146	Saudi Arabia	550'000	2.39	65.8	…	…	2'287
147	Seychelles	*2'050*	*2.50*	…	…	…	…
148	Slovak Republic	134'048	2.49	20.7	*97'560*	*97.5*	-
149	St. Kitts and Nevis	4'600	9.79	…	…	…	1'700
150	St. Lucia	…	…	…	…	…	…
151	Trinidad & Tobago	37'000	2.84	18.3	*31'599*	*99.8*	176
152	Uruguay	…	…	…	…	…	1'371
153	Venezuela	337'012	1.33	10.9	269'610	80.0	114'272
	Upper Middle Income	**18'449'413**	**3.63**	**59.2**	**4'659'752**	**80.7**	**1'341'579**

4. Internet subscribers

		Internet subscribers		CAGR	Dial-up		Broadband
		Total	per 100 inhabitants	%	Total	as % of total subscribers	subscribers
		2002	2002	2000-02	2002	2'002	2002
154	Andorra	…	…	…	…	…	…
155	Aruba	*8'000*	*7.55*	…	…	…	…
156	Australia	4'600'000	23.39	8.3	4'000'000	95.7	283'600
157	Austria	1'200'000	14.71	6.9	*858'300*	*78.0*	539'500
158	Bahamas	17'657	5.66	45.3	…	…	-
159	Bahrain	52'865	7.93	55.5	*26'900*	*61.0*	4'980
160	Belgium	1'694'384	16.38	21.4	…	…	870'000
161	Bermuda	…	…	…	…	…	…
162	Brunei Darussalam	*23'000*	*6.73*	…	…	…	-
163	Canada	5'624'000	18.74	…	…	…	3'515'000
164	Cyprus	70'000	10.00	16.0	62'200	95.7	5'879
165	Denmark	2'441'044	45.42	20.4	1'724'472	85.2	462'000
166	Faroe Islands	…	…	…	…	…	…
167	Finland	950'000	18.29	…	…	…	273'500
168	France	8'925'000	14.97	30.2	…	…	1'456'000
169	French Guiana	…	…	…	…	…	…
170	French Polynesia	11'000	4.58	25.4	…	…	-
171	Germany	15'000'000	18.20	…	…	…	3'240'000
172	Greece	353'750	3.34	…	…	…	-
173	Greenland	…	…	…	…	…	…
174	Guam	…	…	…	…	…	1'750
175	Guernsey	…	…	…	…	…	…
176	Hong Kong, China	2'374'332	35.06	4.2	1'371'705	57.8	1'009'426
177	Iceland	50'000	17.42	…	…	…	24'270
178	Ireland	…	…	…	…	…	4'954
179	Israel	956'000	14.69	…	…	…	135'000
180	Italy	…	…	…	…	…	850'000
181	Japan	29'562'509	23.18	27.7	20'470'470	69.2	9'092'039
182	Jersey	…	…	…	…	…	…
183	Korea (Rep.)	10'784'678	22.66	45.1	375'125	3.5	10'128'000
184	Kuwait	…	…	…	…	…	…
185	Luxembourg	*42'215*	*9.40*	*31.3*	*40'000*	*94.8*	*1'215*
186	Macao, China	47'016	10.74	30.8	24'875	71.7	16'954
187	Martinique	…	…	…	…	…	…
188	Neth. Antilles	…	…	…	…	…	…
189	Netherlands	4'500'000	27.79	-12.7	…	…	1'170'000
190	New Caledonia	14'200	6.34	-5.8	…	…	700
191	New Zealand	*660'000*	*17.27*	…	…	…	43'500
192	Northern Marianas	…	…	…	…	…	…
193	Norway	*1'235'596*	*27.29*	…	*1'036'031*	*83.8*	*88'541*
194	Portugal	5'165'057	49.62	56.4	4'902'294	94.9	259'491
195	Qatar	17'833	2.92	30.1	13'449	99.2	300
196	Réunion	…	…	…	…	…	…
197	Singapore	*927'000*	*22.44*	…	…	…	230'357
198	Slovenia	*280'000*	*14.04*	…	*130'000*	*46.4*	56'735
199	Spain	*3'673'959*	*9.09*	…	…	…	*430'055*
200	Sweden	2'849'000	31.98	…	…	…	700'000
201	Switzerland	2'550'000	35.02	23.7	2'075'408	94.4	460'000
202	Taiwan, China	7'441'994	33.14	26.7	5'250'000	84.4	2'100'000
203	United Arab Emirates	290'513	9.08	17.7	274'336	94.4	16'177
204	United Kingdom	13'100'000	22.17	15.0	12'600'000	96.9	1'370'000
205	United States	*70'000'000*	*24.58*	…	…	…	19'881'549
206	Virgin Islands (US)	…	…	…	…	…	…
	High Income	**197'492'602**	**20.62**	**22.6**	**55'235'565**	**70.3**	**58'721'472**
	WORLD	**282'367'072**	**4.59**	**44.0**	**61'656'537**	**71.5**	**62'500'425**
	Africa	**1'556'675**	**0.19**	**33.9**	**1'122'083**	**98.4**	**1'043**
	Americas	**89'659'332**	**10.63**	**57.8**	**1'953'543**	**65.1**	**24'574'370**
	Asia	**112'728'446**	**3.08**	**59.6**	**30'260'066**	**58.3**	**25'125'804**
	Europe	**73'122'444**	**9.14**	**23.4**	**24'301'180**	**93.3**	**12'469'423**
	Oceania	**5'299'905**	**16.84**	**8.3**	**4'012'110**	**95.7**	**329'785**

Note: For data comparability and coverage, see the technical notes.
Data in italics refer to 2001.

Source: ITU.

5. International connectivity

		International Circuits					
		Private Lines (to US)				All Lines (to US)	
		Total		CAGR	as %	Total	Capacity
		1998	2001	(%)	of active	2001	Usage(%)
1	Afghanistan	-	-	...	...	-	-
2	Angola	23	54	32.9	64.29	86	97.7
3	Armenia	2	165	335.3	55.18	301	99.3
4	Azerbaijan	22	62	41.3	48.06	129	100.0
5	Bangladesh	1	11	122.4	6.83	222	72.5
6	Benin	3	25	102.7	44.64	58	96.6
7	Bhutan	-	-	...	...	-	-
8	Burkina Faso	-	-	...	-	28	100.0
9	Burundi	-	8	...	100.00	8	100.0
10	Cambodia	-	15	...	22.39	67	100.0
11	Cameroon	5	135	200.0	70.31	193	99.5
12	Central African Rep.	-	12	...	60.00	20	100.0
13	Chad	2	20	115.4	76.92	26	100.0
14	Comoros	-	20	...	100.00	20	100.0
15	Congo	5	79	150.9	63.71	124	100.0
16	Côte d'Ivoire	12	57	68.1	49.14	118	98.3
17	D.P.R. Korea	-	-	...	...	-	-
18	D.R. Congo	7	5	(10.6)	7.81	64	100.0
19	Equatorial Guinea	-	-	...	...	-	-
20	Eritrea	…	…	...	...	...	...
21	Ethiopia	8	177	180.7	56.91	311	100.0
22	Gambia	-	8	...	11.76	68	100.0
23	Georgia	5	60	128.9	50.00	120	100.0
24	Ghana	11	376	224.5	68.24	568	97.0
25	Guinea	4	21	73.8	20.00	107	98.1
26	Guinea-Bissau	-	2	...	100.00	2	100.0
27	Haiti	16	640	242.0	66.12	1'071	90.4
28	India	795	10'888	139.3	84.53	14'436	89.2
29	Indonesia	294	3'510	128.6	80.08	5'764	76.0
30	Kenya	12	62	72.9	45.59	148	91.9
31	Kyrgyzstan	-	-	...	...	-	-
32	Lao P.D.R.	-	-	...	...	-	-
33	Lesotho	-	-	...	-	8	100.0
34	Liberia	3	82	201.2	50.31	166	98.2
35	Madagascar	-	55	...	100.00	55	100.0
36	Malawi	8	14	20.5	18.92	101	73.3
37	Mali	-	84	...	64.62	130	100.0
38	Mauritania	-	8	...	21.05	38	100.0
39	Moldova	-	162	...	100.00	162	100.0
40	Mongolia	-	4	...	30.77	13	100.0
41	Mozambique	-	40	...	83.33	48	100.0
42	Myanmar	-	-	...	...	-	-
43	Nepal	-	47	...	82.46	77	74.0
44	Nicaragua	54	266	70.1	61.01	472	92.4
45	Niger	-	12	...	100.00	12	100.0
46	Nigeria	34	734	178.4	70.78	1'037	100.0
47	Pakistan	69	311	65.2	27.67	1'155	97.3
48	Papua New Guinea	-	-	...	-	38	100.0
49	Rwanda	2	-	(100.0)	-	26	100.0
50	S. Tomé & Principe	-	-	...	...	-	-
51	Senegal	1	210	494.4	72.16	292	99.7
52	Sierra Leone	4	28	91.3	42.42	66	100.0
53	Solomon Islands	-	-	...	...	-	-
54	Somalia	-	5	...	2.98	168	100.0
55	Sudan	-	-	...	-	45	100.0
56	Tajikistan	-	-	...	...	-	-
57	Tanzania	1	32	217.5	50.79	63	100.0
58	Togo	4	54	138.1	77.14	70	100.0
59	Uganda	3	68	183.0	54.40	125	100.0
60	Ukraine	32	802	192.6	68.96	1'163	100.0
61	Uzbekistan	-	14	...	21.21	66	100.0
62	Viet Nam	60	173	42.3	23.25	830	89.6
63	Yemen	-	45	...	35.43	128	99.2
64	Zambia	2	12	81.7	16.90	71	100.0
65	Zimbabwe	19	46	34.3	38.33	135	88.9
	Low Income	**1'523**	**19'720**	**134.8**	**71.82**	**30'819**	**89.1**

5. International connectivity

		International Circuits					
		Private Lines (to US)				All Lines (to US)	
		Total		CAGR	as %	Total	Capacity
		1998	2001	(%)	of active	2001	Usage(%)
66	Albania	2	15	95.7	33.33	45	100.0
67	Algeria	43	179	60.9	72.18	248	100.0
68	Belarus	32	6	(42.8)	4.80	125	100.0
69	Belize	17	199	127.1	74.25	271	98.9
70	Bolivia	118	358	44.8	63.48	647	87.2
71	Bosnia	93	125	10.4	23.90	523	100.0
72	Bulgaria	74	152	27.1	50.84	299	100.0
73	Cape Verde	2	2	-	7.69	26	100.0
74	China	835	59'399	314.3	96.79	70'109	87.5
75	Colombia	924	5'079	76.5	47.98	12'178	86.9
76	Cuba	65	376	79.5	65.51	811	70.8
77	Djibouti	-	-	...	-	30	50.0
78	Dominican Rep.	447	1'274	41.8	31.86	8'440	47.4
79	Ecuador	134	2'294	157.7	78.35	3'217	91.0
80	Egypt	267	209	(7.8)	38.63	637	84.9
81	El Salvador	180	989	76.5	56.81	2'085	83.5
82	Fiji	1	1	-	0.71	2'052	6.9
83	Guatemala	182	502	40.2	44.23	1'208	94.0
84	Guyana	66	122	22.7	44.85	290	93.8
85	Honduras	66	539	101.4	47.45	1'595	71.2
86	Iran (I.R.)	5	84	156.1	22.16	379	100.0
87	Iraq	2	3	14.5	4.00	75	100.0
88	Jamaica	133	1'812	138.8	63.51	2'958	96.5
89	Jordan	22	579	197.5	80.53	720	99.9
90	Kazakhstan	12	24	26.0	21.43	125	89.6
91	Kiribati	-	-	...	...	-	-
92	Maldives	-	-	...	...	-	-
93	Marshall Islands	35	101	42.4	60.12	169	99.4
94	Micronesia	14	51	53.9	54.84	100	93.0
95	Morocco	9	24	38.7	17.39	139	99.3
96	Namibia	2	12	81.7	60.00	20	100.0
97	Palestine	…	…	...	...	...	...
98	Paraguay	8	268	222.4	60.77	472	93.4
99	Peru	394	1'044	38.4	41.63	12'722	19.7
100	Philippines	1'437	5'675	58.1	46.27	15'876	77.3
101	Romania	49	329	88.7	65.80	504	99.2
102	Russia	832	356	(24.6)	23.48	2'038	74.4
103	Samoa	1	1	-	6.25	16	100.0
104	South Africa	659	7'144	121.3	92.50	8'775	88.0
105	Sri Lanka	38	406	120.2	78.53	556	93.0
106	St. Vincent	-	141	...	29.94	471	100.0
107	Suriname	45	270	81.7	53.05	509	100.0
108	Swaziland	-	8	...	50.00	16	100.0
109	Syria	5	48	112.5	26.09	185	99.5
110	TFYR Macedonia	…	…	...	...	...	...
111	Thailand	564	6'121	121.4	92.60	7'227	91.5
112	Tonga	2	2	-	6.67	31	96.8
113	Tunisia	44	60	10.9	40.27	152	98.0
114	Turkey	123	6'462	274.5	94.38	6'983	98.1
115	Turkmenistan	-	4	...	14.29	28	100.0
116	Vanuatu	-	-	...	...	-	-
117	Yugoslavia	84	171	26.7	42.43	480	84.0
	Lower Middle Income	**8'067**	**103'020**	**133.7**	**78.15**	**166'562**	**79.1**

5. International connectivity

		International Circuits					
		Private Lines (to US)				All Lines (to US)	
		Total		CAGR	as %	Total	Capacity
		1998	2001	(%)	of active	2001	Usage(%)
118	Antigua & Barbuda	320	205	(13.8)	50.62	430	94.2
119	Argentina	1'665	4'249	36.7	60.32	18'251	38.6
120	Barbados	96	276	42.2	47.75	772	74.9
121	Botswana	10	8	(7.2)	28.57	30	93.3
122	Brazil	3'521	22'276	85.0	68.24	75'884	43.0
123	Chile	1'128	2'503	30.4	39.34	27'227	23.4
124	Costa Rica	348	1'901	76.1	77.88	2'820	86.6
125	Croatia	155	-	(100.0)	-	282	56.0
126	Czech Republic	50	51	0.7	19.62	286	90.9
127	Dominica	-	84	...	31.11	270	100.0
128	Estonia	-	5	...	7.69	65	100.0
129	Gabon	4	18	65.1	30.51	62	95.2
130	Grenada	12	33	40.1	8.82	411	91.0
131	Guadeloupe	2	-	(100.0)	-	33	100.0
132	Hungary	111	2'100	166.5	88.72	2'485	95.3
133	Latvia	-	5	...	7.69	65	100.0
134	Lebanon	44	390	107.0	73.45	534	99.4
135	Libya	-	-	...	-	4	100.0
136	Lithuania	12	8	(12.6)	11.76	95	71.6
137	Malaysia	1'978	7'456	55.6	83.81	11'264	79.0
138	Malta	8	-	(100.0)	-	28	100.0
139	Mauritius	28	2	(58.5)	11.76	17	100.0
140	Mayotte	…	…	...	...	...	...
141	Mexico	29'186	157'033	75.2	68.42	432'861	53.0
142	Oman	33	2'431	319.2	96.78	2'516	99.8
143	Panama	213	282	9.8	48.45	14'376	4.0
144	Poland	97	85	(4.3)	7.44	1'591	71.8
145	Puerto Rico	-	-	...	...	-	-
146	Saudi Arabia	141	2'996	177.0	86.24	3'553	97.8
147	Seychelles	-	8	...	100.00	8	100.0
148	Slovak Republic	8	-	(100.0)	-	120	100.0
149	St. Kitts and Nevis	1	31	214.1	15.66	200	99.0
150	St. Lucia	9	238	197.9	54.97	450	96.2
151	Trinidad & Tobago	85	532	84.3	37.18	1'536	93.2
152	Uruguay	134	764	78.6	81.97	1'033	90.2
153	Venezuela	1'412	5'157	54.0	46.76	31'564	34.9
	Upper Middle Income	**40'811**	**211'127**	**73.0**	**67.22**	**631'123**	**49.8**

5. International connectivity

		International Circuits					
		Private Lines (to US)				All Lines (to US)	
		Total 1998	2001	CAGR (%)	as % of active	Total 2001	Capacity Usage(%)
154	Andorra	-	-	...	...	-	-
155	Aruba	11	41	55.0	14.09	435	66.9
156	Australia	5'394	45'285	103.2	46.31	145'762	67.1
157	Austria	126	2'124	156.4	83.23	2'832	90.1
158	Bahamas	143	462	47.8	31.43	1'567	93.8
159	Bahrain	411	1'245	44.7	90.68	1'395	98.4
160	Belgium	929	4'030	63.1	64.54	7'647	81.7
161	Bermuda	200	1'150	79.2	69.74	2'154	76.6
162	Brunei Darussalam	1	65	302.1	8.16	797	100.0
163	Canada	53'330	307'235	79.3	65.92	919'312	50.7
164	Cyprus	26	18	(11.5)	18.00	233	42.9
165	Denmark	203	218	2.4	34.22	56'379	1.1
166	Faroe Islands	…	…	...	...	...	...
167	Finland	202	71	(29.4)	22.76	668	46.7
168	France	2'626	12'722	69.2	40.51	35'870	87.6
169	French Guiana	-	-	...	-	24	100.0
170	French Polynesia	-	4	...	9.30	51	84.3
171	Germany	7'364	69'456	111.3	82.96	100'037	83.7
172	Greece	52	3'179	293.9	86.95	3'806	96.1
173	Greenland	559	1'113	25.8	100.00	1'113	100.0
174	Guam	964	1'742	21.8	84.24	2'600	79.5
175	Guernsey	…	…	...	...	...	...
176	Hong Kong, China	4'689	15'166	47.9	71.73	29'255	72.3
177	Iceland	110	167	14.9	37.53	521	85.4
178	Ireland	893	3'246	53.8	63.24	6'293	81.6
179	Israel	1'243	4'235	50.5	74.42	6'402	88.9
180	Italy	859	27'296	216.7	84.56	36'063	89.5
181	Japan	12'417	148'766	128.8	85.81	411'426	42.1
182	Jersey	…	…	...	...	...	...
183	Korea (Rep.)	4'095	59'417	143.9	92.14	72'672	88.7
184	Kuwait	1'148	1'480	8.8	91.02	1'628	99.9
185	Luxembourg	42	756	162.1	83.54	1'006	90.0
186	Macao, China	18	8'064	665.2	99.14	8'140	99.9
187	Martinique	…	…	...	...	...	...
188	Neth. Antilles	74	433	80.2	51.92	984	84.8
189	Netherlands	6'129	50'459	101.9	76.34	153'327	43.1
190	New Caledonia	-	-	...	-	8	100.0
191	New Zealand	378	3'418	108.3	30.21	13'956	81.1
192	Northern Marianas	65	170	37.8	28.01	735	82.6
193	Norway	103	951	109.8	49.48	3'631	52.9
194	Portugal	1'550	2'303	14.1	67.84	4'692	72.4
195	Qatar	36	549	148.0	86.05	640	99.7
196	Réunion	-	-	...	...	-	-
197	Singapore	1'959	37'326	167.1	93.86	42'152	94.3
198	Slovenia	-	4	...	6.25	95	67.4
199	Spain	1'152	31'911	202.6	88.90	38'536	93.1
200	Sweden	9'460	19'414	27.1	75.33	26'882	95.9
201	Switzerland	1'573	20'842	136.6	81.96	27'139	93.7
202	Taiwan, China	1'914	29'087	147.7	94.27	45'031	68.5
203	United Arab Emirates	210	811	56.9	67.70	1'245	96.2
204	United Kingdom	75'828	586'542	97.8	87.64	2'461'730	27.2
205	United States	…	…	...	...	...	...
206	Virgin Islands (US)	343	824	33.9	83.06	1'707	58.1
	High Income	**199'081**	**1'504'058**	**96.2**	**77.97**	**4'679'551**	**41.2**
	WORLD	**249'230**	**1'837'664**	**94.6**	**76.51**	**5'507'082**	**43.6**
	Africa	**1'241**	**10'219**	**101.9**	**75.62**	**14'769**	**91.5**
	Americas	**95'334**	**522'143**	**76.3**	**65.48**	**1'584'691**	**50.3**
	Asia	**34'505**	**407'132**	**127.7**	**87.19**	**757'238**	**61.7**
	Europe	**111'548**	**847'656**	**96.6**	**83.75**	**2'985'839**	**33.9**
	Oceania	**6'854**	**50'775**	**94.9**	**45.21**	**165'518**	**67.9**

Source: US Federal Communications Commission (FCC)

6. Main telephone lines

		Main telephone lines (k) 1995	Main telephone lines (k) 2002	Main telephone lines CAGR (%) 1995-02	Main telephone lines per 100 inhabitants 1995	Main telephone lines per 100 inhabitants 2002	Main telephone lines per 100 inhabitants CAGR (%) 1995-02
1	Afghanistan	29.0	33.0	1.9	0.15	0.14	-0.6
2	Angola	52.7	85.0	7.1	0.49	0.61	3.2
3	Azerbaijan	639.5	989.2	6.4	8.49	12.15	5.3
4	Bangladesh	286.6	682.0	13.2	0.24	0.51	11.5
5	Benin	28.2	*59.3*	*13.2*	0.52	*0.92*	*10.1*
6	Bhutan	5.2	19.6	20.7	0.90	2.84	17.8
7	Burkina Faso	30.0	61.9	10.9	0.30	0.52	8.2
8	Burundi	17.3	22.1	3.6	0.28	0.32	1.5
9	Cambodia	8.5	*33.5*	*25.6*	0.08	*0.25*	*20.1*
10	Cameroon	65.6	*101.4*	*7.5*	0.49	*0.66*	*5.0*
11	Central African Rep.	8.4	*8.9*	*1.0*	0.25	*0.24*	*-1.1*
12	Chad	5.3	11.8	12.1	0.08	0.15	9.1
13	Comoros	4.4	10.3	12.9	0.72	1.35	9.4
14	Congo	21.4	22.0	0.4	0.81	0.67	-2.6
15	Côte d'Ivoire	115.8	336.1	16.4	0.86	2.04	13.2
16	D.P.R. Korea	500.0	500.0	-	2.26	2.11	-1.0
17	D.R. Congo	36.0	*20.0*	*-9.3*	0.08	*0.04*	*-11.5*
18	Equatorial Guinea	2.5	8.8	19.6	0.63	1.80	16.3
19	Eritrea	17.5	35.9	10.8	0.49	0.90	9.1
20	Ethiopia	142.5	368.2	14.5	0.25	0.55	11.9
21	Gambia	19.2	38.4	10.4	1.75	2.80	6.9
22	Georgia	554.3	648.5	2.3	10.23	13.14	3.6
23	Ghana	63.1	*242.1*	*25.1*	0.37	*1.16*	*21.0*
24	Guinea	10.9	26.0	13.3	0.16	0.34	11.7
25	Guinea-Bissau	7.4	11.2	6.2	0.69	0.89	3.8
26	Haiti	60.0	130.0	11.7	0.84	1.57	9.4
27	India	11'978.0	41'420.0	19.4	1.29	3.98	17.4
28	Indonesia	3'290.9	7'750.0	13.0	1.69	3.65	11.6
29	Kenya	256.4	328.1	3.6	1.00	1.03	0.3
30	Kyrgyzstan	357.0	394.8	1.4	7.92	7.75	-0.3
31	Lao P.D.R.	16.6	61.9	20.7	0.36	1.12	17.6
32	Lesotho	17.8	34.0	9.7	0.88	1.57	8.7
33	Liberia	4.5	*6.8*	*7.1*	0.16	*0.22*	*5.0*
34	Madagascar	37.1	59.4	7.0	0.29	0.37	3.8
35	Malawi	34.3	73.1	11.4	0.37	0.70	9.7
36	Mali	17.2	49.7	16.4	0.19	0.47	14.0
37	Mauritania	9.2	32.0	19.4	0.41	1.19	16.3
38	Moldova	566.5	*639.2*	*2.0*	13.02	*14.56*	*1.9*
39	Mongolia	77.7	128.0	7.4	3.50	5.27	6.0
40	Mozambique	59.8	*89.5*	*6.9*	0.40	*0.51*	*4.2*
41	Myanmar	157.8	*295.2*	*11.0*	0.36	*0.61*	*9.3*
42	Nepal	83.7	327.7	21.5	0.41	1.41	19.3
43	Nicaragua	96.6	171.6	8.6	2.22	3.20	5.4
44	Niger	13.7	*21.7*	*7.9*	0.15	*0.19*	*4.0*
45	Nigeria	405.1	702.0	8.2	0.39	0.58	5.9
46	Pakistan	2'127.3	3'690.0	8.2	1.67	2.53	6.1
47	Papua New Guinea	43.6	*62.0*	*6.0*	0.99	*1.17*	*2.8*
48	Rwanda	6.9	*21.5*	*20.9*	0.13	*0.27*	*12.5*
49	S. Tomé & Principe	2.5	*5.4*	*13.8*	1.97	*3.63*	*10.7*
50	Senegal	82.0	224.6	15.5	0.98	2.29	12.9
51	Sierra Leone	16.6	*22.7*	*5.4*	0.37	*0.46*	*3.6*
52	Solomon Islands	6.5	6.6	0.2	1.78	1.49	-2.5
53	Somalia	15.0	100.0	31.1	0.17	0.98	29.0
54	Sudan	75.0	671.8	36.8	0.28	2.06	32.7
55	Tajikistan	262.7	232.7	-1.7	4.50	3.65	-2.9
56	Tanzania	90.3	*148.5*	*8.6*	0.32	*0.44*	*5.6*
57	Togo	21.7	51.2	13.0	0.52	1.09	11.0
58	Uganda	39.0	55.0	5.0	0.20	0.22	1.4
59	Uzbekistan	1'544.2	1'670.0	1.1	6.81	6.60	-0.4
60	Viet Nam	775.0	3'929.1	26.1	1.05	4.84	24.4
61	Yemen	186.7	510.0	15.4	1.21	2.63	11.7
62	Zambia	76.8	88.5	2.0	0.86	0.83	-0.5
63	Zimbabwe	152.5	287.9	9.5	1.42	2.47	8.3
	Low Income	**25'735.6**	**68'867.5**	**15.1**	**1.19**	**2.79**	**13.0**

6. Main telephone lines

		Main telephone lines (k)			Main telephone lines per 100 inhabitants		
		1995	2002	CAGR (%) 1995-02	1995	2002	CAGR (%) 1995-02
64	Albania	42.1	220.0	26.6	1.17	5.46	24.6
65	Algeria	1'176.3	1'908.0	7.2	4.19	6.10	5.5
66	Armenia	582.8	531.3	-1.3	15.45	13.98	-1.4
67	Belarus	1'968.4	2'967.2	6.0	19.34	29.94	6.4
68	Belize	28.9	31.6	1.3	13.75	12.51	-1.3
69	Bolivia	246.9	563.9	12.5	3.33	6.76	10.6
70	Bosnia	237.8	490.2	10.9	5.99	11.96	10.4
71	Bulgaria	2'562.9	2'922.0	1.9	30.47	37.46	3.0
72	Cape Verde	21.5	70.2	18.4	5.57	15.99	16.3
73	China	40'705.7	214'420.0	26.8	3.30	16.69	26.0
74	Colombia	3'872.8	7'766.0	10.5	10.05	17.94	8.6
75	Cuba	353.2	*574.4*	*8.4*	3.21	*5.11*	*8.1*
76	Djibouti	7.6	10.1	4.3	1.31	1.54	2.4
77	Dominican Rep.	582.6	*955.1*	*8.6*	7.48	*11.02*	*6.7*
78	Ecuador	697.9	1'426.2	10.7	6.09	11.02	8.8
79	Egypt	2'716.2	7'430.0	15.5	4.67	11.32	13.5
80	El Salvador	284.8	667.7	12.9	5.03	10.34	10.8
81	Fiji	64.8	97.5	6.0	8.43	11.69	4.8
82	Guatemala	286.4	846.0	16.7	2.87	7.05	13.7
83	Guyana	44.6	80.4	8.8	5.37	9.15	7.9
84	Honduras	160.8	322.5	10.5	2.70	4.80	8.6
85	Iran (I.R.)	5'090.4	13'075.0	14.4	8.60	19.95	12.8
86	Iraq	638.6	675.0	0.8	3.18	2.78	-1.9
87	Jamaica	290.3	450.0	6.5	11.76	17.19	5.6
88	Jordan	317.0	687.6	11.7	7.39	12.90	8.3
89	Kazakhstan	1'962.9	2'082.3	0.8	11.87	13.04	1.4
90	Kiribati	2.0	*3.6*	*10.2*	2.61	*4.21*	*8.3*
91	Maldives	13.9	28.7	10.9	5.67	10.20	8.8
92	Marshall Islands	3.2	4.4	4.7	6.64	7.74	2.2
93	Micronesia	7.9	*10.1*	*4.2*	7.37	*8.67*	*2.7*
94	Morocco	1'128.0	1'127.4	-	4.24	3.80	-1.5
95	Namibia	78.5	*117.4*	*6.9*	5.02	*6.43*	*4.2*
96	Palestine	80.0	298.5	20.7	3.45	8.64	14.0
97	Paraguay	166.9	273.2	7.3	3.46	4.73	4.6
98	Peru	1'109.2	*2'022.3*	*10.5*	4.71	*7.75*	*8.6*
99	Philippines	1'409.6	3'338.9	13.1	2.05	4.17	10.7
100	Romania	2'968.0	*4'116.0*	*5.6*	13.09	*18.38*	*5.8*
101	Russia	25'018.9	35'500.0	5.1	16.91	24.22	5.3
102	Samoa	7.8	10.3	4.0	4.64	5.70	3.0
103	Serbia and Montenegro	2'017.1	2'493.0	3.1	19.15	23.26	2.8
104	South Africa	4'002.2	4'895.0	2.9	10.14	10.77	0.9
105	Sri Lanka	205.9	883.1	23.1	1.18	4.66	21.7
106	St. Vincent	18.2	27.3	5.9	16.46	23.35	5.1
107	Suriname	54.1	*77.4*	*6.1*	13.21	*17.58*	*4.9*
108	Swaziland	21.1	35.1	7.5	2.32	3.40	5.6
109	Syria	958.5	2'099.3	11.9	6.77	12.32	8.9
110	TFYR Macedonia	351.0	*538.5*	*7.4*	17.85	*26.35*	*6.7*
111	Thailand	3'482.0	6'499.8	9.3	6.06	10.50	8.2
112	Tonga	6.6	11.2	7.8	6.80	11.31	7.5
113	Tunisia	521.7	1'148.0	11.9	5.82	11.70	10.5
114	Turkey	13'215.7	18'914.9	5.3	21.44	28.12	3.9
115	Turkmenistan	320.3	*387.6*	*3.2*	7.14	*8.02*	*1.9*
116	Ukraine	8'311.0	*10'669.6*	*4.3*	16.09	*21.21*	*4.7*
117	Vanuatu	4.2	6.6	6.6	2.49	3.22	3.8
	Lower Middle Income	**130'428.0**	**356'807.5**	**15.5**	**6.15**	**15.90**	**14.5**

6. Main telephone lines

		Main telephone lines (k)			Main telephone lines per 100 inhabitants		
		1995	*2002*	*CAGR (%) 1995-02*	*1995*	*2002*	*CAGR (%) 1995-02*
118	Antigua & Barbuda	25.9	*37.3*	*6.3*	38.84	*48.13*	*3.6*
119	Argentina	5'622.5	8'009.4	5.2	16.53	21.88	4.1
120	Barbados	90.1	*129.0*	*6.2*	34.09	*48.06*	*5.9*
121	Botswana	59.7	*142.6*	*15.6*	4.09	*8.48*	*12.9*
122	Brazil	13'263.0	38'810.0	16.6	8.51	22.32	14.8
123	Chile	1'818.0	3'467.2	9.7	12.74	23.04	8.8
124	Costa Rica	478.9	1'038.0	11.7	14.38	25.05	8.3
125	Croatia	1'287.1	1'879.0	5.6	28.28	38.79	4.6
126	Czech Republic	2'444.2	*3'860.8*	*7.9*	23.65	*37.76*	*8.1*
127	Dominica	17.8	25.4	5.2	24.13	32.58	4.4
128	Estonia	411.7	475.0	2.1	27.74	35.06	3.4
129	Gabon	32.0	32.1	-	2.98	2.47	-2.6
130	Grenada	23.2	33.5	5.4	26.02	31.65	2.8
131	Guadeloupe	165.3	*210.0*	*4.1*	38.98	*45.65*	*2.7*
132	Hungary	2'157.2	3'666.4	7.9	21.05	36.12	8.0
133	Latvia	704.5	701.2	-0.1	27.85	30.11	1.1
134	Lebanon	448.8	678.8	6.1	14.91	19.88	4.2
135	Libya	318.0	*660.0*	*12.9*	5.88	*11.83*	*12.4*
136	Lithuania	941.0	935.9	-0.1	25.35	27.05	0.9
137	Malaysia	3'332.4	4'670.0	4.9	16.57	19.04	2.0
138	Malta	170.7	207.3	2.8	45.88	52.34	1.9
139	Mauritius	148.2	327.2	12.0	13.21	27.03	10.8
140	Mayotte	5.3	*10.0*	*11.3*	4.66	*6.98*	*7.0*
141	Mexico	8'801.0	14'941.6	7.9	9.39	14.67	6.6
142	Oman	169.9	245.0	5.4	7.87	9.04	2.0
143	Panama	303.9	*376.5*	*3.6*	11.56	*12.99*	*2.0*
144	Poland	5'728.5	*11'400.0*	*12.2*	14.84	*29.51*	*12.1*
145	Puerto Rico	1'195.9	*1'329.5*	*1.8*	32.65	*34.64*	*1.0*
146	Saudi Arabia	1'719.4	3'317.5	9.8	9.42	14.39	6.2
147	Seychelles	13.1	*21.4*	*8.5*	17.41	*26.11*	*7.0*
148	Slovak Republic	1'118.5	1'402.7	3.3	20.84	26.08	3.3
149	St. Kitts and Nevis	14.4	23.5	7.2	33.83	50.00	5.7
150	St. Lucia	30.6	*50.0*	*8.5*	21.44	*31.69*	*6.7*
151	Trinidad & Tobago	209.3	325.1	6.5	16.78	24.98	5.9
152	Uruguay	622.0	946.5	6.2	19.50	27.96	5.3
153	Venezuela	2'463.2	2'841.8	2.1	11.38	11.23	-0.2
	Upper Middle Income	**56'355.2**	**107'227.4**	**9.6**	**12.13**	**21.03**	**8.2**

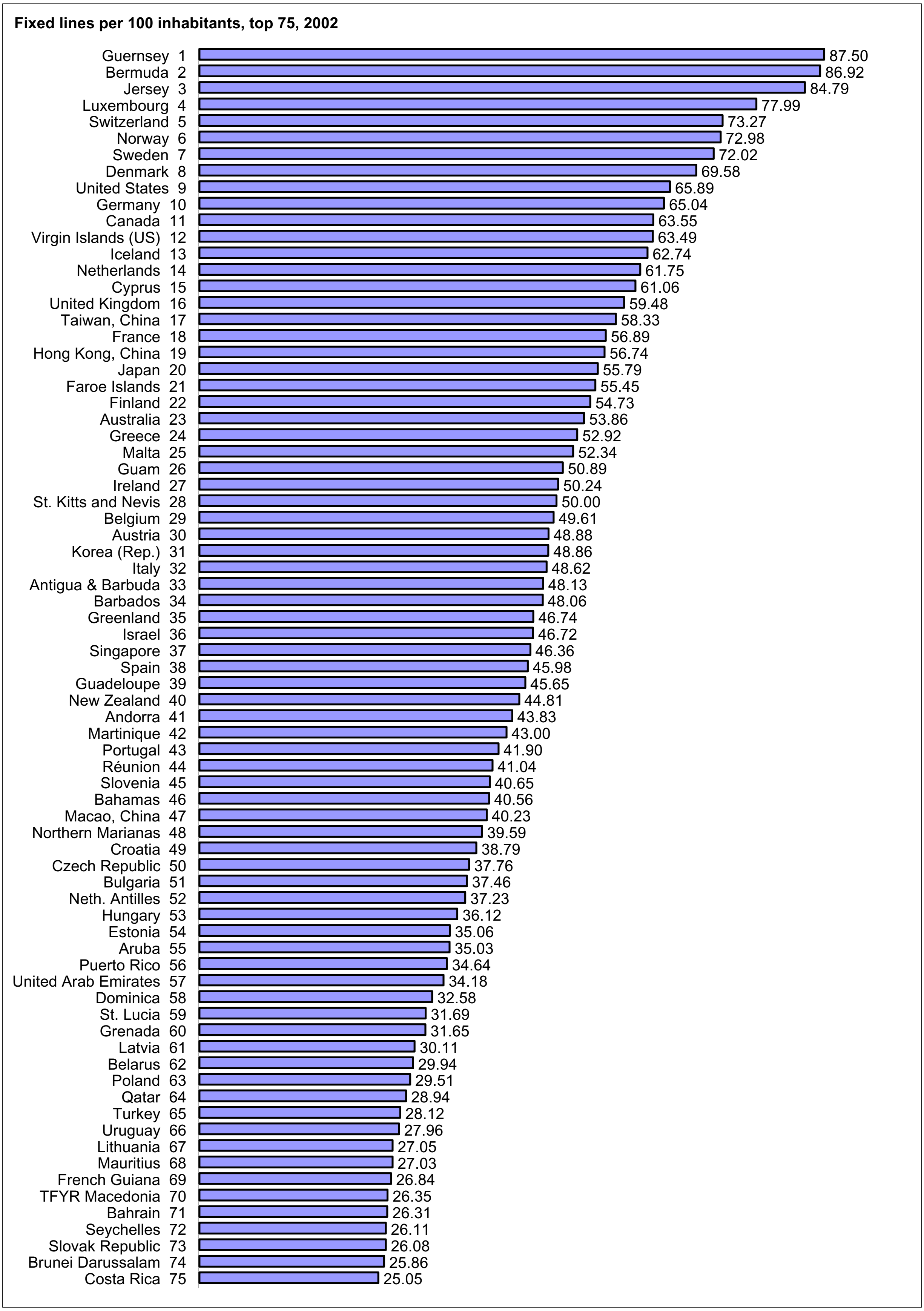
6. Main telephone lines

		Main telephone lines (k)			Main telephone lines per 100 inhabitants		
		1995	2002	CAGR (%) 1995-02	1995	2002	CAGR (%) 1995-02
154	Andorra	29.8	*35.0*	*2.7*	43.82	*43.83*	-
155	Aruba	27.3	*37.1*	*5.3*	33.50	*35.03*	*0.7*
156	Australia	8'900.0	10'590.0	2.5	49.27	53.86	1.3
157	Austria	3'796.9	3'988.0	0.7	47.18	48.88	0.5
158	Bahamas	83.7	126.6	6.1	30.00	40.56	4.4
159	Bahrain	140.8	175.4	3.2	25.11	26.31	0.7
160	Belgium	4'682.1	5'132.4	1.3	46.26	49.61	1.0
161	Bermuda	46.4	*56.2*	*3.2*	73.65	*86.92*	*2.8*
162	Brunei Darussalam	68.1	*88.4*	*4.4*	23.99	*25.86*	*1.3*
163	Canada	17'567.0	19'962.1	1.8	61.57	63.55	0.5
164	Cyprus	347.3	427.4	3.0	55.22	61.06	1.4
165	Denmark	3'193.4	3'739.2	2.3	61.08	69.58	1.9
166	Faroe Islands	22.2	*25.0*	*2.3*	50.52	*55.45*	*1.9*
167	Finland	2'810.0	2'850.0	0.2	54.28	54.73	0.1
168	France	32'400.0	33'928.7	0.7	56.01	56.89	0.2
169	French Guiana	41.7	*51.0*	*3.4*	27.88	*26.84*	*-0.6*
170	French Polynesia	48.7	52.5	1.1	22.32	21.88	-0.3
171	Germany	42'000.0	53'720.0	3.6	51.33	65.04	3.4
172	Greece	5'162.8	*5'607.7*	*1.4*	49.40	*52.92*	*1.2*
173	Greenland	19.6	*26.2*	*5.0*	35.08	*46.74*	*4.9*
174	Guam	69.2	*80.0*	*2.4*	48.19	*50.89*	*0.9*
175	Guernsey	42.0	*55.0*	*4.6*	68.86	*87.50*	*4.1*
176	Hong Kong, China	3'277.9	3'842.9	2.3	53.25	56.74	0.9
177	Iceland	148.7	180.7	2.8	55.52	62.74	1.8
178	Ireland	1'310.0	1'975.0	6.0	36.33	50.24	4.7
179	Israel	2'342.6	3'100.0	4.1	41.69	46.72	1.6
180	Italy	24'845.0	27'452.0	1.4	43.33	48.62	1.7
181	Japan	62'292.0	71'149.0	1.9	49.61	55.79	1.7
182	Jersey	59.3	*73.9*	*3.7*	68.88	*84.79*	*3.5*
183	Korea (Rep.)	18'600.2	23'257.0	3.2	41.75	48.86	2.3
184	Kuwait	382.3	481.9	3.4	21.22	20.38	-0.6
185	Luxembourg	233.9	*346.8*	*6.8*	57.10	*77.99*	*5.3*
186	Macao, China	153.3	176.1	2.0	37.45	40.23	1.0
187	Martinique	160.9	*172.0*	*1.1*	41.68	*43.00*	*0.5*
188	Neth. Antilles	75.9	*81.0*	*1.1*	36.59	*37.23*	*0.3*
189	Netherlands	8'124.0	10'000.0	3.0	52.43	61.75	2.4
190	New Caledonia	43.7	*50.7*	*2.5*	22.80	*23.12*	*0.2*
191	New Zealand	1'719.0	1'765.0	0.4	47.34	44.81	-0.8
192	Northern Marianas	15.5	*21.0*	*6.3*	32.21	*39.59*	*4.2*
193	Norway	2'476.5	3'325.0	4.3	56.67	72.98	3.7
194	Portugal	3'642.9	4'361.0	2.6	36.72	41.90	1.9
195	Qatar	122.7	176.5	5.3	22.27	28.94	3.8
196	Réunion	218.7	*300.0*	*5.4*	33.13	*41.04*	*3.6*
197	Singapore	1'428.6	1'930.2	4.4	40.52	46.36	1.9
198	Slovenia	614.8	811.4	4.0	30.93	40.65	4.0
199	Spain	15'095.4	18'705.6	3.1	38.50	45.98	2.6
200	Sweden	6'013.0	6'441.0	1.0	68.04	72.02	0.8
201	Switzerland	4'480.0	5'335.0	2.5	63.66	73.27	2.0
202	Taiwan, China	9'174.8	13'099.4	5.2	42.96	58.33	4.5
203	United Arab Emirates	672.3	1'093.7	7.2	28.77	34.18	2.5
204	United Kingdom	29'411.4	35'145.0	2.6	50.18	59.48	2.5
205	United States	159'735.2	190'000.0	2.5	60.38	65.89	1.3
206	Virgin Islands (US)	58.3	*69.4*	*2.9*	54.86	*63.49*	*2.5*
	High Income	**478'427.8**	**565'672.2**	**2.4**	**52.19**	**58.79**	**1.7**
	WORLD	**690'946.6**	**1'098'574.6**	**6.8**	**12.18**	**17.77**	**5.5**
	Africa	**12'549.6**	**22'777.4**	**8.9**	**1.80**	**2.79**	**6.4**
	Americas	**221'295.8**	**299'535.4**	**4.4**	**28.71**	**35.23**	**3.0**
	Asia	**182'974.8**	**435'804.4**	**13.2**	**5.40**	**11.82**	**11.8**
	Europe	**263'183.7**	**327'686.0**	**3.2**	**33.28**	**40.98**	**3.0**
	Oceania	**10'942.7**	**12'771.5**	**2.2**	**38.41**	**40.43**	**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.

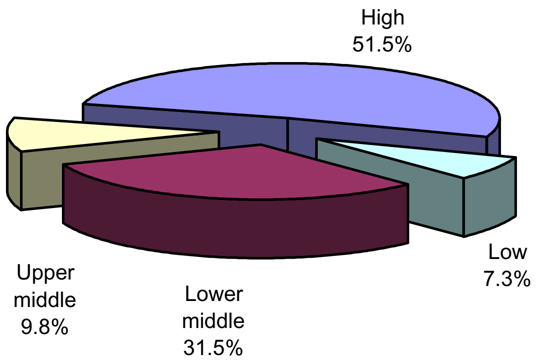
Source: ITU.

6. Main telephone lines

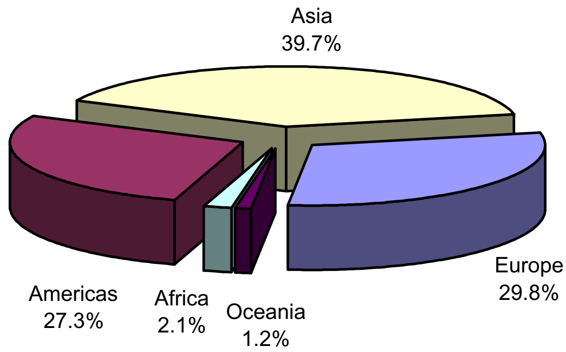


6. Main telephone lines

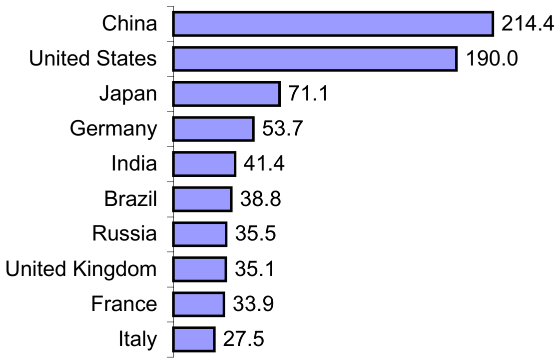
Fixed lines, by income, 2002



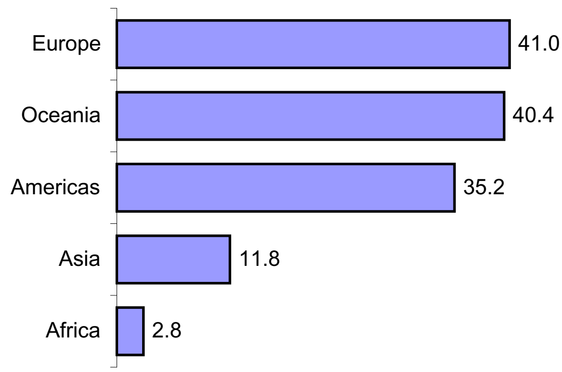
Fixed lines, by region, 2002



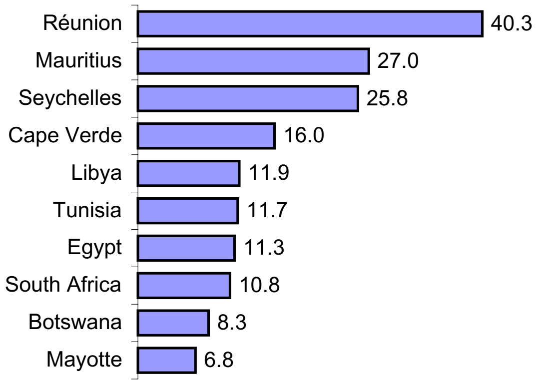
Total fixed lines, top 10, 2002, millions



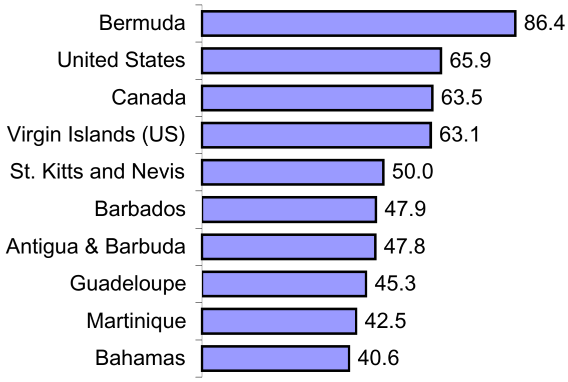
World: Fixed line penetration*, by region, 2002



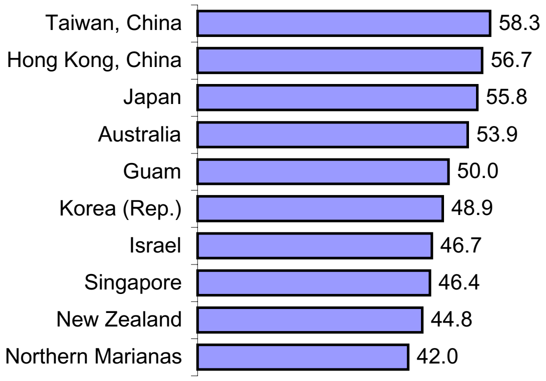
Africa: Fixed line penetration, top 10, 2002



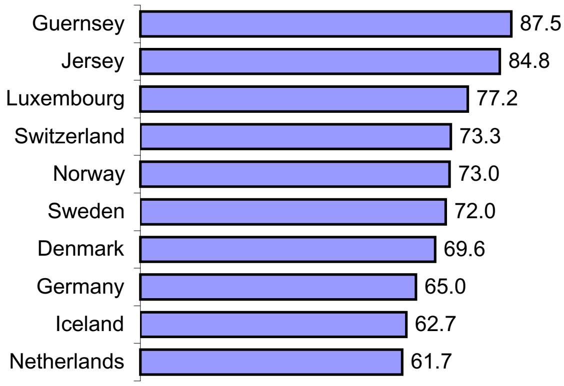
Americas: Fixed line penetration, top 10, 2002



Asia/Pacific: Fixed line penetration, top 10, 2002



Europe: Fixed line penetration, top 10, 2002



* Penetration = subscribers per 100 inhabitants

7. Mobile subscribers

		Cellular mobile subscribers					*As % of total*
		(k)		*CAGR (%)*	*Per 100 inhabitants*	*% Digital*	*telephone subscribers*
		1995	*2002*	*1995-02*	*2002*	*2002*	*2002*
1	Afghanistan	-	12.0	-	0.05	...	26.6
2	Angola	2.0	130.0	81.6	0.93	...	60.5
3	Azerbaijan	6.0	870.0	103.6	10.69	...	46.8
4	Bangladesh	2.5	1'075.0	137.8	0.81	...	61.2
5	Benin	1.1	*125.0*	*121.8*	*1.94*	*100.0*	*67.8*
6	Bhutan	-	-	-	-	-	-
7	Burkina Faso	-	89.9	-	0.75	...	59.2
8	Burundi	0.6	52.0	90.8	0.74	...	70.2
9	Cambodia	14.1	380.0	60.1	2.76	...	91.9
10	Cameroon	2.8	563.0	113.3	3.57	100.0	84.7
11	Central African Rep.	-	*11.0*	*151.0*	*0.29*	...	*55.2*
12	Chad	-	34.2	-	0.43	...	74.3
13	Comoros	-	-	-	-	-	-
14	Congo	-	221.8	-	6.74	...	91.0
15	Côte d'Ivoire	-	1'027.1	-	6.23	100.0	75.3
16	D.P.R. Korea	-	-	-	-	-	-
17	D.R. Congo	8.5	*150.0*	*61.4*	*0.29*	...	*88.2*
18	Equatorial Guinea	-	27.0	-	5.53	...	75.4
19	Eritrea	-	-	-	-	-	-
20	Ethiopia	-	50.4	-	0.07	100.0	12.0
21	Gambia	1.4	100.0	83.2	7.29	...	72.3
22	Georgia	0.1	503.6	218.9	10.21	97.4	43.7
23	Ghana	6.2	405.0	81.7	1.87	12.0	62.6
24	Guinea	0.9	90.8	91.8	1.18	...	77.7
25	Guinea-Bissau	-	-	-	-	-	-
26	Haiti	-	140.0	-	1.69	...	51.9
27	India	76.7	12'687.6	107.5	1.22	100.0	23.4
28	Indonesia	210.6	11'700.0	77.5	5.52	...	60.2
29	Kenya	2.3	1'325.2	148.3	4.15	...	80.2
30	Kyrgyzstan	-	53.1	-	1.04	...	11.9
31	Lao P.D.R.	1.5	55.2	66.7	1.00	100.0	47.1
32	Lesotho	-	92.0	-	4.25	100.0	73.0
33	Liberia	-	*2.0*	-	*0.06*	...	*22.7*
34	Madagascar	1.3	163.0	99.4	1.02	...	73.3
35	Malawi	0.4	86.0	116.8	0.82	100.0	54.1
36	Mali	-	52.6	-	0.50	...	51.4
37	Mauritania	-	245.7	-	9.16	...	88.5
38	Moldova	-	*225.0*	*402.4*	*5.13*	...	*26.0*
39	Mongolia	-	216.0	-	8.89	...	62.8
40	Mozambique	-	297.0	-	1.63	...	76.8
41	Myanmar	2.8	*13.8*	*30.7*	*0.03*	*98.1*	*4.5*
42	Nepal	-	21.9	-	0.09	100.0	6.3
43	Nicaragua	4.4	239.9	77.0	4.47	...	58.3
44	Niger	-	*2.1*	-	*0.02*	-	*8.9*
45	Nigeria	13.0	1'633.1	99.5	1.36	...	69.9
46	Pakistan	41.0	1'219.0	62.4	0.84	56.7	24.8
47	Papua New Guinea	-	*10.7*	-	*0.20*	-	*14.7*
48	Rwanda	-	90.0	-	1.10	100.0	80.7
49	S. Tomé & Principe	-	-	-	-	-	-
50	Senegal	0.1	553.4	233.0	5.65	100.0	71.1
51	Sierra Leone	-	66.3	-	1.34	...	74.4
52	Solomon Islands	0.2	1.0	23.3	0.22	...	13.1
53	Somalia	-	35.0	-	0.34	...	25.9
54	Sudan	-	190.8	-	0.59	100.0	22.1
55	Tajikistan	-	13.2	-	0.21	...	5.4
56	Tanzania	3.5	*427.0*	*122.7*	*1.27*	*100.0*	*74.2*
57	Togo	-	160.0	-	3.42	...	75.8
58	Uganda	1.7	393.3	116.8	1.59	100.0	87.7
59	Uzbekistan	3.7	186.9	74.9	0.74	...	10.1
60	Viet Nam	23.5	1'638.0	83.4	2.02	...	29.4
61	Yemen	8.3	500.0	79.7	2.58	...	49.5
62	Zambia	1.5	139.1	90.2	1.30	...	61.1
63	Zimbabwe	-	353.0	-	3.03	100.0	55.1
	Low Income	**442.9**	**41'145.6**	**91.1**	**1.67**	**43.6**	**37.4**

7. Mobile subscribers

		Cellular mobile subscribers (k) 1995	2002	CAGR (%) 1995-02	Per 100 inhabitants 2002	% Digital 2002	As % of total telephone subscribers 2002
64	Albania	-	800.0	-	19.85	100.0	78.4
65	Algeria	4.7	400.0	88.7	1.28	100.0	17.3
66	Armenia	-	44.3	-	1.17	100.0	7.7
67	Belarus	5.9	465.2	86.6	4.69	96.3	13.6
68	Belize	1.5	52.5	65.5	20.75	...	62.4
69	Bolivia	7.2	872.7	98.3	10.46	100.0	60.7
70	Bosnia	-	748.8	-	18.26	...	60.4
71	Bulgaria	20.9	1'550.0	104.9	19.12	...	34.7
72	Cape Verde	-	42.9	-	9.78	100.0	38.0
73	China	3'629.0	206'620.0	78.1	16.09	100.0	49.1
74	Colombia	274.6	4'597.0	49.6	10.62	100.0	37.2
75	Cuba	1.9	17.9	37.3	0.16	...	3.0
76	Djibouti	-	15.0	-	2.29	...	59.7
77	Dominican Rep.	56.0	1'270.1	68.3	14.65	65.5	57.1
78	Ecuador	54.4	1'560.9	61.5	12.06	...	52.3
79	Egypt	7.4	4'494.7	150.0	6.85	98.2	37.7
80	El Salvador	13.5	888.8	81.9	13.76	...	57.1
81	Fiji	2.2	89.9	69.9	10.78	100.0	48.0
82	Guatemala	30.0	1'577.1	76.1	13.15	...	65.1
83	Guyana	1.2	87.3	83.6	9.93	...	52.0
84	Honduras	-	326.5	-	4.86	...	50.3
85	Iran (I.R.)	15.9	2'319.6	103.8	3.54	...	15.1
86	Iraq	-	20.0	-	0.08	...	2.9
87	Jamaica	45.1	1'400.0	63.3	53.48	...	75.7
88	Jordan	12.4	1'219.6	92.6	22.89	...	63.9
89	Kazakhstan	4.6	1'027.0	116.5	6.43	...	33.0
90	Kiribati	-	0.5	-	0.58	-	12.1
91	Maldives	-	41.9	-	14.91	100.0	59.4
92	Marshall Islands	0.3	0.6	11.1	0.98	...	11.2
93	Micronesia	-	1.8	-	1.48	...	14.8
94	Morocco	29.5	6'198.7	114.7	20.91	100.0	84.6
95	Namibia	3.5	150.0	71.1	8.00	100.0	56.1
96	Palestine	20.0	320.0	48.6	9.26	...	51.7
97	Paraguay	15.8	1'667.0	94.5	28.83	100.0	85.9
98	Peru	73.5	2'300.0	63.5	8.60	...	53.2
99	Philippines	493.9	14'216.2	61.6	17.77	...	81.0
100	Romania	9.1	3'845.1	174.1	17.17	43.4	48.3
101	Russia	88.5	17'668.1	113.1	12.05	...	33.2
102	Samoa	-	2.7	-	1.50	...	20.8
103	Serbia and Montenegro	-	2'750.4	-	25.66	...	52.5
104	South Africa	535.0	12'081.0	56.1	26.58	100.0	71.2
105	Sri Lanka	51.3	931.6	51.3	4.92	...	51.3
106	St. Vincent	0.2	10.0	73.0	8.53	...	26.8
107	Suriname	1.7	87.0	92.9	19.77	100.0	52.9
108	Swaziland	-	63.0	-	6.10	100.0	64.2
109	Syria	-	400.0	-	2.35	...	16.0
110	TFYR Macedonia	-	223.3	-	10.92	100.0	29.3
111	Thailand	1'297.8	16'117.0	43.3	26.04	...	71.3
112	Tonga	0.3	3.4	41.2	3.39	100.0	23.0
113	Tunisia	3.2	503.9	106.1	5.13	...	30.5
114	Turkey	437.1	23'374.4	76.6	34.75	100.0	55.3
115	Turkmenistan	-	8.2	-	0.17	...	2.1
116	Ukraine	14.0	2'224.6	132.7	4.42	...	17.3
117	Vanuatu	0.1	4.9	69.7	2.39	...	42.6
	Lower Middle Income	**7'263.4**	**337'702.8**	**73.1**	**15.04**	**78.4**	**48.6**

7. Mobile subscribers

		Cellular mobile subscribers					As % of total
		(k)		CAGR (%)	Per 100 inhabitants	% Digital	telephone subscribers
		1995	2002	1995-02	2002	2002	2002
118	Antigua & Barbuda	...	*25.0*	...	*32.29*	...	*40.2*
119	Argentina	340.7	6'500.0	52.4	17.76	...	44.8
120	Barbados	4.6	*53.1*	*50.3*	*19.80*	...	*29.2*
121	Botswana	-	415.0	-	24.13	100.0	74.4
122	Brazil	1'285.5	34'881.0	60.2	20.06	...	47.3
123	Chile	197.3	6'445.7	64.6	42.83	...	65.0
124	Costa Rica	18.8	528.0	61.1	12.75	100.0	33.7
125	Croatia	33.7	2'278.0	82.6	47.03	...	54.8
126	Czech Republic	48.9	8'610.2	109.3	84.88	...	69.0
127	Dominica	-	9.4	-	11.99	...	26.9
128	Estonia	30.5	881.0	61.7	65.02	100.0	65.0
129	Gabon	4.0	280.7	83.5	21.61	...	89.7
130	Grenada	0.4	7.6	52.2	7.13	...	18.4
131	Guadeloupe	-	323.5	-	69.72	...	60.6
132	Hungary	265.0	6'562.0	58.2	64.64	...	64.2
133	Latvia	15.0	917.2	80.0	39.38	...	56.7
134	Lebanon	120.0	775.1	30.5	22.70	108.4	53.3
135	Libya	-	70.0	-	1.26	...	9.6
136	Lithuania	14.8	1'631.6	95.8	47.16	...	63.5
137	Malaysia	1'005.1	9'245.0	37.3	37.69	97.9	66.4
138	Malta	10.8	276.9	59.0	69.91	100.0	57.2
139	Mauritius	11.7	350.0	62.4	28.91	...	51.7
140	Mayotte	-	21.7	-	14.66	...	68.5
141	Mexico	688.5	25'928.3	67.9	25.45	...	63.4
142	Oman	8.1	463.0	78.4	17.08	100.0	65.4
143	Panama	-	*475.4*	-	*16.40*	*100.0*	*55.8*
144	Poland	75.0	14'000.0	111.1	36.26	...	55.1
145	Puerto Rico	287.0	*1'211.1*	*27.1*	*31.56*	...	*47.7*
146	Saudi Arabia	16.0	5'008.0	127.2	21.72	...	60.2
147	Seychelles	0.1	*44.1*	*209.7*	*53.87*	*100.0*	*67.4*
148	Slovak Republic	12.3	2'923.4	118.4	54.36	...	67.6
149	St. Kitts and Nevis	...	5.0	...	10.64	...	17.5
150	St. Lucia	1.0	*2.7*	*18.0*	*1.71*	...	*5.1*
151	Trinidad & Tobago	6.4	361.9	78.2	27.81	...	52.7
152	Uruguay	39.9	652.0	49.0	19.26	...	40.8
153	Venezuela	403.8	6'463.6	48.6	25.55	...	69.5
	Upper Middle Income	**4'944.8**	**138'625.9**	**61.0**	**27.19**	**9.4**	**56.4**

7. Mobile subscribers

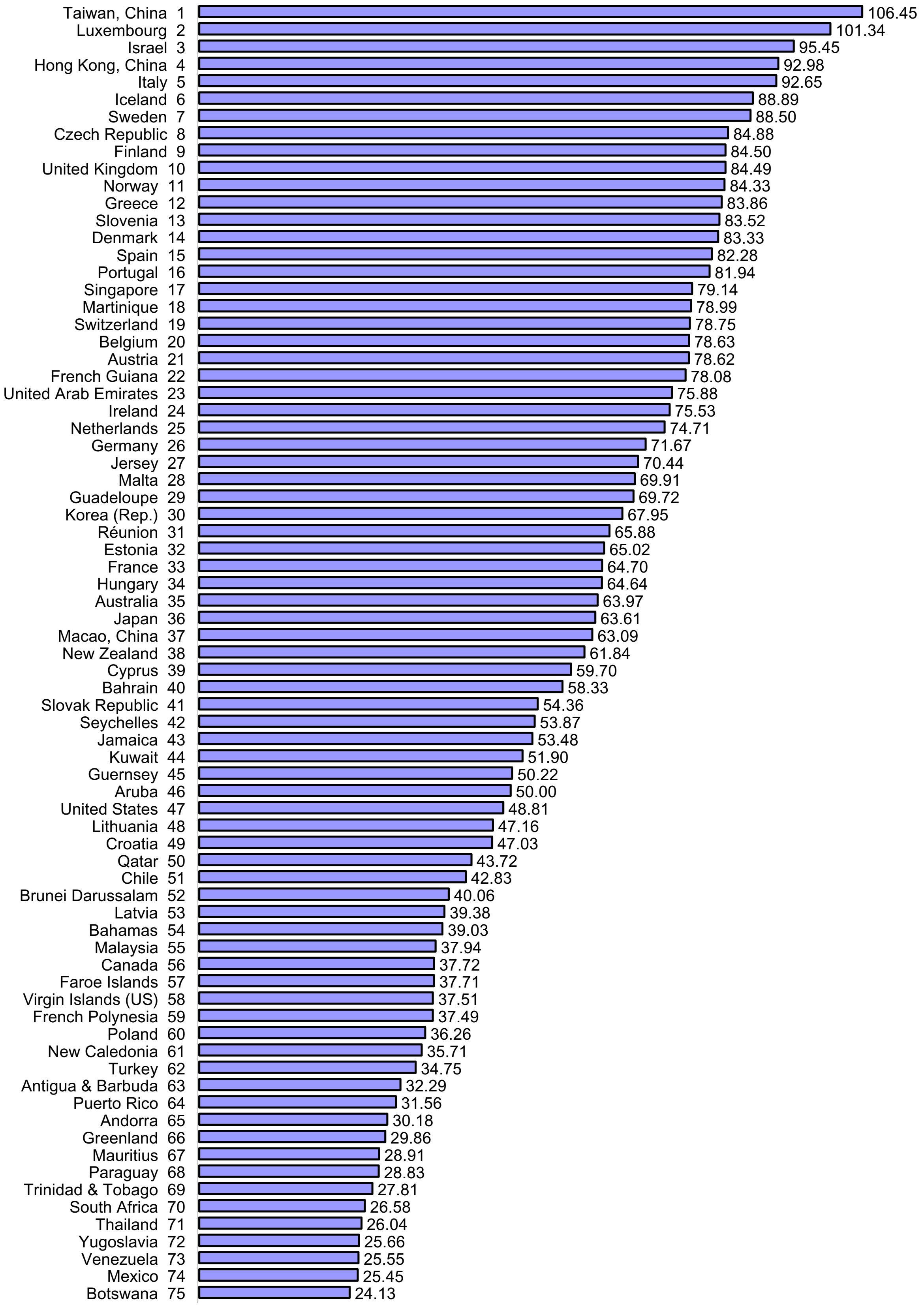
		Cellular mobile subscribers					*As % of total telephone subscribers*
		(k)		*CAGR (%)*	*Per 100 inhabitants*	*% Digital*	
		1995	*2002*	*1995-02*	*2002*	*2002*	*2002*
154	Andorra	2.8	*23.5*	*52.8*	*30.18*	*100.0*	*40.8*
155	Aruba	1.7	*53.0*	*77.1*	*50.00*	...	*58.8*
156	Australia	2'242.0	12'579.0	27.9	63.97	95.4	54.3
157	Austria	383.5	6'415.0	49.5	78.62	...	61.7
158	Bahamas	4.1	121.8	62.3	39.03	...	49.0
159	Bahrain	27.6	389.0	45.9	58.33	100.0	68.9
160	Belgium	235.3	8'135.5	65.9	78.63	...	61.3
161	Bermuda	6.3	*13.3*	*13.2*	*20.64*	...	*19.2*
162	Brunei Darussalam	35.9	*137.0*	*25.0*	*40.06*	*100.0*	*60.8*
163	Canada	2'589.8	11'849.0	24.3	37.72	...	37.2
164	Cyprus	44.5	417.9	37.7	59.70	...	49.4
165	Denmark	822.3	4'478.1	27.4	83.33	100.0	54.5
166	Faroe Islands	2.6	*17.0*	*46.0*	*37.71*	*74.9*	*40.5*
167	Finland	1'039.1	4'400.0	22.9	84.50	...	60.7
168	France	1'302.5	38'585.3	62.3	64.70	100.0	53.2
169	French Guiana	-	138.2	-	78.08	100.0	73.0
170	French Polynesia	1.1	90.0	86.4	37.49	100.0	63.1
171	Germany	3'725.0	59'200.0	48.5	71.67	100.0	52.4
172	Greece	273.0	9'314.3	65.6	84.54	100.0	62.4
173	Greenland	2.1	*16.7*	*41.9*	*29.86*	...	*39.0*
174	Guam	5.0	*32.6*	*36.8*	*20.74*	...	*29.0*
175	Guernsey	2.4	*31.5*	*54.1*	*50.22*	*100.0*	*36.5*
176	Hong Kong, China	798.4	6'297.5	34.3	92.98	100.0	62.1
177	Iceland	30.9	256.0	35.3	88.89	...	58.6
178	Ireland	158.0	2'969.0	52.1	75.53	100.0	60.1
179	Israel	445.5	6'334.0	46.1	95.45	...	67.1
180	Italy	3'923.0	52'316.0	44.8	92.65	...	65.6
181	Japan	11'712.1	81'118.0	31.8	63.61	100.0	53.3
182	Jersey	4.4	*61.4*	*55.4*	*70.44*	*100.0*	*45.4*
183	Korea (Rep.)	1'641.3	32'342.0	53.1	67.95	100.0	58.2
184	Kuwait	117.6	1'227.0	39.8	51.90	...	71.8
185	Luxembourg	26.8	455.0	49.8	101.34	100.0	56.7
186	Macao, China	35.9	276.1	33.8	63.09	...	61.1
187	Martinique	-	319.9	-	78.99	100.0	65.0
188	Neth. Antilles	11.7	...	...	...	...	...
189	Netherlands	539.0	12'100.0	56.0	74.71	100.0	54.8
190	New Caledonia	0.8	80.0	92.2	35.71	100.0	61.2
191	New Zealand	365.0	2'436.0	31.2	61.84	...	58.0
192	Northern Marianas	1.2	*3.0*	*20.1*	*5.66*	...	*12.5*
193	Norway	981.3	3'842.0	21.5	84.33	100.0	53.6
194	Portugal	340.8	8'528.9	58.4	81.94	100.0	66.2
195	Qatar	18.5	266.7	46.4	43.72	...	60.2
196	Réunion	5.5	489.8	89.9	65.88	100.0	62.0
197	Singapore	306.0	3'295.1	40.4	79.14	100.0	63.1
198	Slovenia	27.3	1'667.0	79.9	83.52	...	67.3
199	Spain	945.0	33'475.0	66.5	82.28	...	64.2
200	Sweden	2'008.0	7'915.0	21.6	88.50	...	55.1
201	Switzerland	447.2	5'734.0	44.0	78.75	100.0	51.8
202	Taiwan, China	772.2	23'905.4	63.3	106.45	...	64.6
203	United Arab Emirates	129.0	2'428.1	52.1	75.88	100.0	68.9
204	United Kingdom	5'735.8	49'921.0	36.2	84.49	100.0	58.7
205	United States	33'785.7	140'766.8	22.6	48.81	89.0	42.6
206	Virgin Islands (US)	...	*41.0*	...	*37.51*	...	*37.1*
	High Income	**78'062.1**	**637'304.7**	**35.0**	**66.22**	**72.1**	**53.0**
	WORLD	**90'713.1**	**1'154'779.0**	**43.8**	**18.67**	**65.4**	**51.2**
	Africa	**652.0**	**35'004.3**	**76.7**	**4.28**	**80.8**	**60.6**
	Americas	**40'254.4**	**254'270.8**	**30.1**	**29.89**	**53.0**	**45.9**
	Asia	**23'104.7**	**447'937.6**	**52.7**	**12.15**	**79.7**	**50.7**
	Europe	**24'083.9**	**402'230.3**	**49.5**	**50.27**	**55.4**	**55.1**
	Oceania	**2'618.3**	**15'336.0**	**28.7**	**48.54**	**80.0**	**54.6**

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.

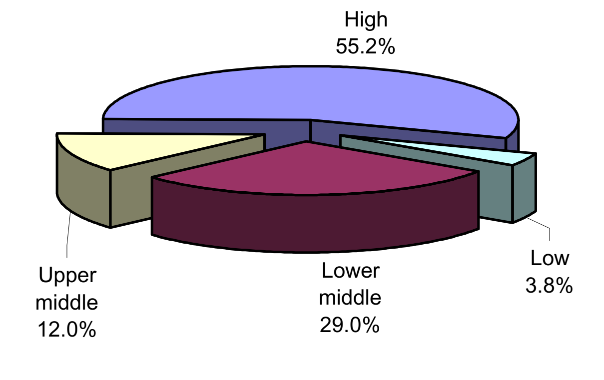
7. Mobile subscribers

Mobile subscribers per 100 inhabitants, top 75, 2002

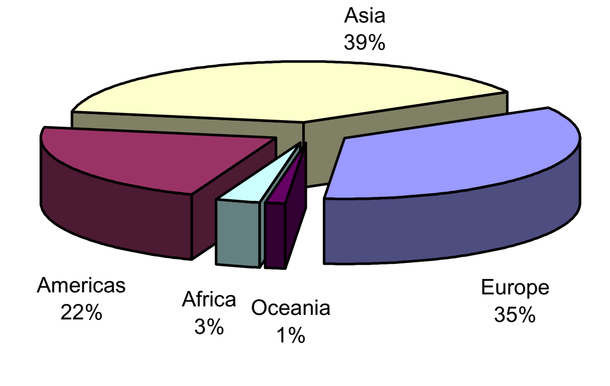


7. Mobile subscribers

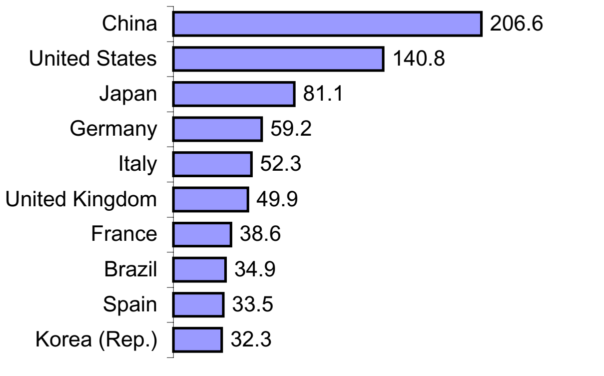
Mobile subscribers, by income, 2002



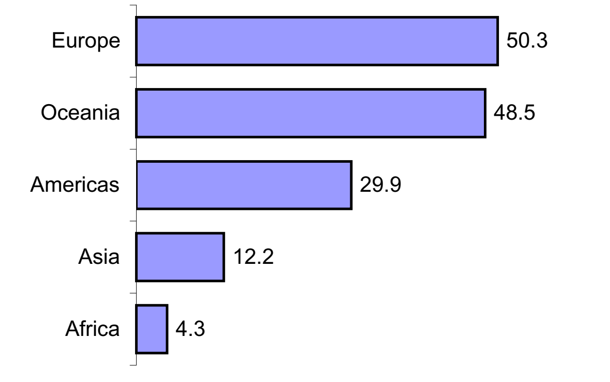
Mobile subscribers, by region, 2002



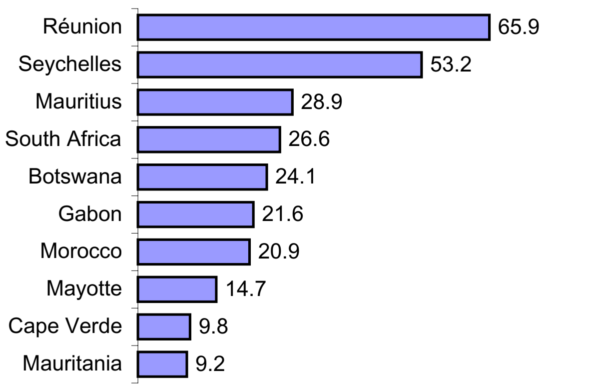
Total mobile subscribers, top 10, 2002, millions



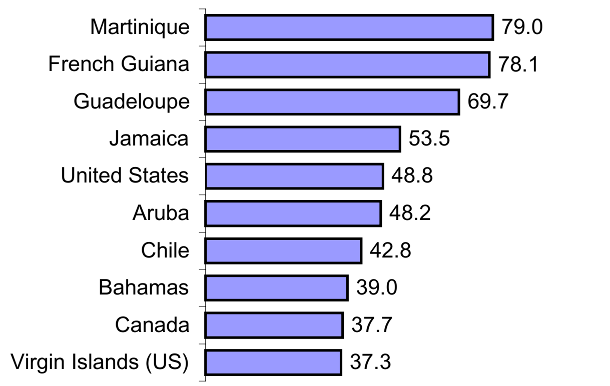
Mobile penetration*, by region, 2002



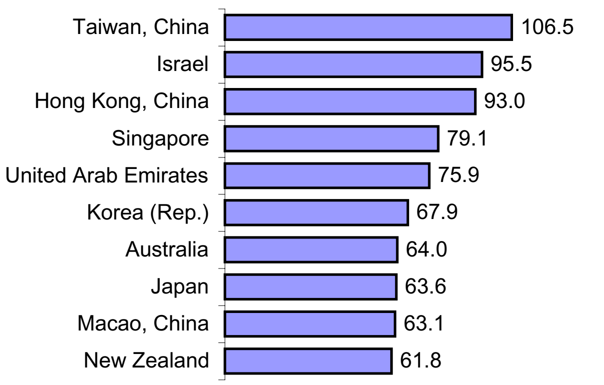
Africa: Mobile penetration, top 10, 2002



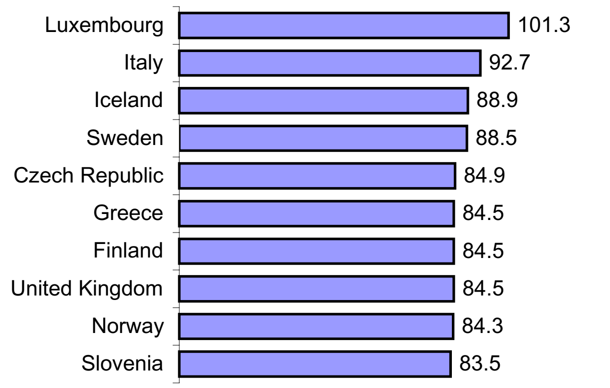
Americas: Mobile penetration, top 10, 2002



Asia/Pacific: Mobile penetration, top 10, 2002



Europe: Mobile penetration, top 10, 2002



* Penetration = subscribers per 100 inhabitants

8. Network penetration

		Effective Teledensity	*Rank*	*Internet users per 100 inhabitants*	*Rank*	*Broadband subscribers per 100 inhabitants*	*Rank*	*Broadband as % of total Internet subscribers*	*Internet subscribers as % of telephone*
		2002	*2002*	*2002*	*2002*	*2002*	*2002*	*2002*	*2002*
1	Afghanistan	0.14	202	...		...		...	...
2	Angola	0.93	183	*0.29*	166	-		-	...
3	Armenia	13.98	111	1.84	130	...		...	*3.8*
4	Azerbaijan	12.15	117	3.69	106	...		...	*1.3*
5	Bangladesh	0.81	189	0.15	186	-		-	10.0
6	Benin	*1.94*	168	*0.39*	161	...		...	*6.7*
7	Bhutan	2.84	160	1.45	140	-		-	8.2
8	Burkina Faso	0.75	190	0.21	178	...		...	12.9
9	Burundi	0.74	191	0.12	189	...		...	6.3
10	Cambodia	*1.66*	170	0.22	177	-		-	...
11	Cameroon	*2.01*	167	*0.29*	167	...		...	*4.3*
12	Central African Rep.	*0.29*	198	*0.08*	192	...		...	*11.0*
13	Chad	0.43	197	0.19	182	...		...	15.2
14	Comoros	1.35	175	0.42	159	...		...	8.7
15	Congo	6.74	136	0.15	187	...		...	2.7
16	Côte d'Ivoire	6.23	139	0.55	156	...		...	*4.7*
17	D.P.R. Korea	*2.13*	165	*0.00*	198	-		...	-
18	D.R. Congo	*0.29*	199	*0.01*	197	...		...	...
19	Equatorial Guinea	5.53	144	0.35	163	0.001	68	0.59	9.7
20	Eritrea	0.90	184	0.23	175	-		-	6.7
21	Ethiopia	0.55	194	0.07	193	...		...	2.1
22	Gambia	7.29	134	1.35	142	...		...	*11.4*
23	Georgia	13.14	114	1.49	139	...		...	0.6
24	Ghana	*1.16*	179	*0.19*	181	...		...	*8.3*
25	Guinea	*0.73*	192	*0.20*	180	...		...	*20.9*
26	Guinea-Bissau	0.89	185	0.40	160	-		-	2.0
27	Haiti	1.69	169	0.96	151	...		...	23.1
28	India	3.98	154	1.59	138	*0.005*	66	*1.56*	*8.3*
29	Indonesia	5.52	145	3.77	105	*0.01*	65	*2.50*	*8.3*
30	Kenya	4.15	153	*1.60*	136	...		...	*30.6*
31	Kyrgyzstan	7.75	132	2.98	113	...		...	1.2
32	Lao P.D.R.	1.12	180	0.27	168	-		-	4.1
33	Lesotho	4.25	151	0.97	150	...		...	4.4
34	Liberia	*0.22*	200	*0.03*	195	...		...	...
35	Madagascar	*0.95*	182	*0.23*	176	...		...	*21.4*
36	Malawi	0.82	187	0.26	170	-		-	18.4
37	Mali	0.50	196	0.30	164	...		...	24.1
38	Mauritania	9.16	127	0.37	162	...		...	...
39	Moldova	*14.56*	110	*1.37*	141	...		...	*1.6*
40	Mongolia	8.89	128	2.06	126	-		-	*8.0*
41	Mozambique	*0.86*	186	*0.17*	183	...		...	...
42	Myanmar	*0.61*	193	*0.02*	196	-		-	*1.4*
43	Nepal	1.41	173	*0.26*	169	-		-	*5.0*
44	Nicaragua	4.47	150	1.68	134	0.04	54	11.04	12.2
45	Niger	*0.19*	201	*0.11*	190	...		...	*9.1*
46	Nigeria	1.36	174	0.17	184	...		...	7.6
47	Pakistan	2.48	163	1.01	149	-		-	*5.9*
48	Papua New Guinea	*1.17*	178	*0.94*	152	-		...	...
49	Rwanda	*0.82*	188	*0.25*	174	...		...	*6.9*
50	S. Tomé & Principe	*3.63*	156	*6.00*	83	...		...	*10.3*
51	Senegal	5.65	143	1.07	146	...		...	4.3
52	Sierra Leone	*0.55*	195	*0.14*	188	...		...	*3.3*
53	Solomon Islands	1.49	172	0.50	157	-		-	15.0
54	Somalia	0.98	181	0.88	154	...		...	5.0
55	Sudan	2.06	166	0.26	171	-		-	4.5
56	Tajikistan	3.65	155	0.05	194	-		-	*0.1*
57	Tanzania	*1.27*	177	*0.30*	165	...		...	13.5
58	Togo	3.42	157	4.27	100	...		...	23.5
59	Uganda	1.59	171	*0.25*	173	...		...	11.8
60	Ukraine	*21.21*	93	*1.19*	144	...		...	...
61	Uzbekistan	6.60	137	1.09	145	...		...	*0.4*
62	Viet Nam	4.51	149	1.85	129	-		-	10.7
63	Yemen	2.63	162	0.21	179	...		...	2.9
64	Zambia	1.30	176	0.49	158	-		-	13.2
65	Zimbabwe	3.03	159	4.30	99	...		...	13.9
	Low Income	**3.60**		**1.29**		**0.003**		**1.36**	**5.23**

8. Network penetration

		Effective Teledensity 2002	*Rank* 2002	*Internet users per 100 inhabitants* 2002	*Rank* 2002	*Broadband subscribers per 100 inhabitants* 2002	*Rank* 2002	*Broadband as % of total Internet subscribers* 2002	*Internet subscribers as % of telephone* 2002
66	Albania	19.85	97	*0.25*	172	...		...	*2.5*
67	Algeria	6.10	141	1.60	136	...		...	*3.2*
68	Belarus	29.94	72	8.16	73	0.00	70	0.11	0.6
69	Belize	20.75	95	8.70	70	-		-	15.6
70	Bolivia	10.46	124	3.24	111	...		...	8.7
71	Bosnia	18.26	101	2.44	120	-		-	17.7
72	Bulgaria	*35.94*	65	8.97	69	...		...	0.3
73	Cape Verde	15.99	107	3.64	107	-		-	5.6
74	China	16.69	105	4.60	93	0.18	45	4.55	23.2
75	Colombia	17.94	102	4.58	94	0.05	53	3.92	6.7
76	Cuba	*5.11*	146	*1.07*	147	...		...	...
77	Djibouti	2.29	164	0.69	155	...		...	15.8
78	Dominican Rep.	*14.65*	109	*2.15*	125	...		...	*6.7*
79	Ecuador	12.06	118	3.89	103	...		...	7.1
80	Egypt	11.32	121	2.29	122	...		...	...
81	El Salvador	13.76	112	4.65	92	...		...	14.2
82	Fiji	*11.23*	123	2.64	118	-		-	7.8
83	Guatemala	13.15	113	3.33	109	...		...	...
84	Guyana	9.93	125	*10.92*	60	...		...	*25.0*
85	Honduras	4.86	148	2.98	114	...		...	23.3
86	Iran (I.R.)	19.95	96	4.83	91	0.001	69	0.16	*3.7*
87	Iraq	2.78	161	0.10	191	...		...	...
88	Jamaica	53.48	47	*3.85*	104	...		...	...
89	Jordan	22.89	87	5.76	86	0.04	56	3.05	9.1
90	Kazakhstan	13.04	115	*0.93*	153	...		...	...
91	Kiribati	*4.21*	152	*2.32*	121	-		-	*15.1*
92	Maldives	14.91	108	5.34	88	0.07	49	17.94	3.7
93	Marshall Islands	*7.67*	133	*1.65*	135	...		...	*11.3*
94	Micronesia	*8.67*	129	*4.30*	98	-		-	*16.9*
95	Morocco	20.91	94	1.69	132	...		...	5.3
96	Namibia	*6.43*	138	*2.46*	119	...		...	*12.8*
97	Palestine	9.26	126	3.04	112	...		...	8.4
98	Paraguay	28.83	75	1.73	131	0.01	64	2.00	9.2
99	Peru	*7.75*	131	*7.66*	76	0.13	46	4.14	*8.7*
100	Philippines	17.77	103	4.38	96	0.03	48	2.10	29.9
101	Romania	*18.38*	100	8.06	74	0.03	59	...	...
102	Russia	24.22	85	4.09	102	-		-	5.3
103	Samoa	5.70	142	2.22	124	-		...	...
104	Serbia and Montenegro	25.66	81	5.97	85	...		...	...
105	South Africa	26.58	78	6.82	79	-		-	*19.0*
106	Sri Lanka	4.92	147	1.06	148	-		-	7.9
107	St. Vincent	23.35	86	5.98	84	0.93	30	18.15	21.9
108	Suriname	*19.77*	98	*3.30*	110	...		...	*6.3*
109	Swaziland	6.10	140	1.94	127	-		-	28.5
110	Syria	12.32	116	1.29	143	...		...	3.5
111	TFYR Macedonia	*26.35*	79	*3.42*	108	...		...	...
112	Thailand	26.04	80	7.76	*75*	*0.00*	67	*0.11*	*24.8*
113	Tonga	11.31	122	2.93	116	-		-	16.9
114	Tunisia	11.70	120	5.15	89	...		...	...
115	Turkey	34.75	66	7.28	77	*0.03*	57	*0.49*	22.7
116	Turkmenistan	*8.02*	130	*0.17*	185	...		...	*0.6*
117	Vanuatu	*3.36*	158	*2.74*	117	-		-	22.7
	Lower Middle Income	**17.75**		**4.45**		**0.11**		**3.79**	**17.79**

8. Network penetration

		Effective Teledensity	Rank	Internet users per 100 inhabitants	Rank	Broadband subscribers per 100 inhabitants	Rank	Broadband as % of total Internet subscribers	Internet subscribers as % of telephone
		2002	2002	2002	2002	2002	2002	2002	2002
118	Antigua & Barbuda	*48.13*	52	*9.04*	68	...		...	...
119	Argentina	21.88	90	11.20	58	0.31	44	8.04	17.9
120	Barbados	*48.06*	53	*5.59*	87	...		...	...
121	Botswana	*18.80*	99	*2.97*	115	...		...	...
122	Brazil	22.32	89	8.22	72	0.42	42	9.25	20.4
123	Chile	42.83	58	23.75	39	1.21	28	14.22	36.9
124	Costa Rica	25.05	84	*9.34*	67	0.01	63	0.37	9.6
125	Croatia	47.03	55	16.29	44	...		...	28.6
126	Czech Republic	*67.95*	29	24.65	38	*0.06*	50	*0.49*	...
127	Dominica	32.58	68	16.03	46	0.41	43	7.15	17.6
128	Estonia	65.02	32	41.33	17	3.37	19	37.77	25.5
129	Gabon	21.61	92	1.92	128	0.10	48	12.50	24.9
130	Grenada	31.65	70	6.13	82	0.53	36	14.57	11.5
131	Guadeloupe	*63.59*	37	*4.35*	97	...		...	...
132	Hungary	64.64	34	15.76	47	0.62	33	14.18	12.2
133	Latvia	39.38	62	13.31	53	0.43	41	...	...
134	Lebanon	22.70	88	11.71	55	...		...	19.2
135	Libya	*11.83*	119	2.25	123	...		...	...
136	Lithuania	47.16	54	14.45	52	0.58	34	20.10	10.6
137	Malaysia	37.94	63	30.78	29	0.02	60	0.19	*45.0*
138	Malta	69.91	28	*25.26*	36	4.46	16	15.26	*28.9*
139	Mauritius	28.91	74	14.87	50	...		...	15.3
140	Mayotte	*6.98*	135	...		...		...	...
141	Mexico	25.45	83	4.58	95	*0.05*	52	*2.90*	*12.5*
142	Oman	17.08	104	6.64	81	...		...	19.7
143	Panama	*16.40*	106	*4.14*	101	...		...	...
144	Poland	*29.51*	73	*9.84*	66	*0.03*	58	...	...
145	Puerto Rico	*34.64*	67	*15.63*	48	...		...	...
146	Saudi Arabia	21.72	91	6.94	78	0.01	62	0.42	16.6
147	Seychelles	*53.87*	46	*10.99*	59	...		...	*9.6*
148	Slovak Republic	54.36	45	16.04	45	-		-	9.6
149	St. Kitts and Nevis	50.00	50	10.64	61	...		...	19.6
150	St. Lucia	*31.69*	69	*8.24*	71	...		...	...
151	Trinidad & Tobago	27.81	77	10.60	62	0.01	61	0.48	11.4
152	Uruguay	27.96	76	*11.90*	54	*0.04*	55	...	...
153	Venezuela	25.55	82	5.04	90	0.45	40	33.91	11.9
	Upper Middle Income	**28.60**		**9.95**		**0.26**		**7.27**	**17.21**

8. Network penetration

		Effective Teledensity 2002	*Rank* 2002	*Internet users per 100 inhabitants* 2002	*Rank* 2002	*Broadband subscribers per 100 inhabitants* 2002	*Rank* 2002	*Broadband as % of total Internet subscribers* 2002	*Internet subscribers as % of telephone* 2002
154	Andorra	…	…	…		...		...	...
155	Aruba	*50.00*	50	*22.64*	40	...		...	*21.5*
156	Australia	63.97	35	42.72	15	1.44	27	6.17	43.4
157	Austria	78.62	21	40.94	18	6.61	10	44.96	30.1
158	Bahamas	40.56	59	6.80	80	...		...	14.0
159	Bahrain	58.33	43	24.75	37	0.75	32	9.42	30.1
160	Belgium	78.63	20	32.86	26	8.41	7	51.35	33.0
161	Bermuda	*86.92*	9	*46.44*	12	...		...	...
162	Brunei Darussalam	*40.06*	60	*10.23*	64	-		-	*26.0*
163	Canada	63.55	38	48.39	10	11.19	3	50.43	*27.7*
164	Cyprus	61.06	42	30.00	33	0.84	31	8.40	16.4
165	Denmark	83.33	15	46.52	11	8.60	6	18.93	65.3
166	Faroe Islands	…	…	…		...		...	...
167	Finland	84.50	11	50.89	7	5.25	15	5.47	*33.4*
168	France	64.70	33	31.38	28	2.44	22	16.31	26.3
169	French Guiana	*39.64*	61	*1.68*	133	...		...	...
170	French Polynesia	37.49	64	14.58	51	...		...	20.9
171	Germany	71.67	26	42.37	16	3.79	18	14.00	*28.7*
172	Greece	*75.14*	24	18.15	43	-		-	*6.3*
173	Greenland	*46.74*	56	*35.66*	24	...		...	...
174	Guam	*50.89*	49	*30.53*	30	*1.11*	29	...	...
175	Guernsey	*87.50*	8	…		...		...	...
176	Hong Kong, China	92.98	3	43.09	14	14.90	2	42.51	61.8
177	Iceland	88.89	6	60.76	1	8.68	5	20.85	*26.2*
178	Ireland	75.53	23	27.09	34	0.13	47	...	...
179	Israel	95.45	2	30.14	31	2.03	24	4.18	*31.5*
180	Italy	92.65	4	30.11	32	1.51	26	...	...
181	Japan	63.61	36	44.85	13	6.76	9	29.15	41.6
182	Jersey	*84.79*	10	…		...		...	...
183	Korea (Rep.)	67.95	30	55.19	3	20.72	1	91.47	46.4
184	Kuwait	51.90	48	10.58	63	...		...	...
185	Luxembourg	*92.00*	5	36.75	22	*0.27*	45	*3.50*	*10.0*
186	Macao, China	63.09	40	26.27	35	3.87	17	36.06	26.7
187	Martinique	*71.53*	27	*10.00*	65	...		...	...
188	Neth. Antilles	…	…	…		...		...	...
189	Netherlands	74.71	25	53.04	6	6.54	11	23.55	45.0
190	New Caledonia	*30.97*	71	*11.35*	57	*0.06*	51	*0.88*	...
191	New Zealand	61.84	41	48.44	9	*0.45*	39	*2.62*	*36.2*
192	Northern Marianas	…	…	…		…		…	...
193	Norway	84.33	13	50.48	8	*1.96*	25	*7.17*	*37.3*
194	Portugal	81.94	17	35.55	25	2.49	21	5.02	118.4
195	Qatar	43.72	57	11.48	56	-		-	10.1
196	Réunion	*57.61*	44	*20.52*	41	...		...	...
197	Singapore	79.14	18	53.97	4	5.53	14	16.29	*47.6*
198	Slovenia	83.52	14	40.08	20	2.84	20	1.96	*34.9*
199	Spain	82.28	16	19.31	42	*0.55*	35	*6.10*	*21.0*
200	Sweden	88.50	7	57.31	2	7.83	8	12.51	*43.3*
201	Switzerland	78.75	19	32.62	27	6.32	12	18.04	47.8
202	Taiwan, China	106.45	1	38.25	21	9.35	4	28.22	56.8
203	United Arab Emirates	75.88	22	36.74	23	0.51	38	5.57	26.6
204	United Kingdom	84.49	12	40.62	19	2.32	23	10.46	37.3
205	United States	65.89	31	53.75	5	6.89	13	18.28	*36.8*
206	Virgin Islands (US)	*63.49*	39	*15.55*	49	...		...	...
	High Income	**72.20**		**43.92**		**6.10**		**29.73**	**34.92**
	WORLD	**21.42**		**9.82**		**1.00**		**22.12**	**25.64**
	Africa	**5.12**		**1.13**		**0.00**		**0.07**	**6.83**
	Americas	**37.85**		**24.29**		**2.89**		**27.41**	**29.93**
	Asia	**13.83**		**5.76**		**0.68**		**22.25**	**25.88**
	Europe	**54.20**		**20.93**		**1.56**		**17.05**	**22.32**
	Oceania	**48.95**		**33.34**		**1.04**		**6.22**	**41.57**

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)	Bit-Circuit Index		Bit-Minute-Index		Bits per capita		Bits per subscriber	
		2001	2001	Rank	2001	Rank	2001	Rank	2001	Rank
1	Afghanistan	…	…		…		…		…	
2	Angola	2	0.07	122	0.03	135	0.1	163	…	
3	Armenia	*10*	0.00		0.1	110	*2.6*	119	*809.7*	76
4	Azerbaijan	4	0.06	127	0.04	128	0.5	142	330.7	112
5	Bangladesh	40	0.23	86	0.1	87	0.3	151	645.2	82
6	Benin	2	0.10	112	0.04	127	0.3	149	506.5	92
7	Bhutan	2	0.27	81	…		3.0	114	1'538.5	53
8	Burkina Faso	2	0.07	120	0.1	120	0.2	161	366.6	109
9	Burundi	0.6	…		0.1	118	0.1	169	581.8	85
10	Cambodia	6	0.12	105	0.1	92	0.4	144	1'177.4	61
11	Cameroon	0.26	0.004	158	…		0.02	184	58.2	142
12	Central African Rep.	0.8	0.10	113	0.1	107	0.2	156	782.1	77
13	Chad	0.26	0.04	135	0.03	130	0.03	181	168.8	131
14	Comoros	0.06	…		0.005	149	0.1	170	98.0	139
15	Congo	0.13	0.003	163	0.1	122	0.04	178	426.7	104
16	Côte d'Ivoire	7	0.06	130	0.05	123	0.4	147	490.5	95
17	D.P.R. Korea	…	…		…		…		…	
18	D.R. Congo	2	0.03	136	0.1	108	0.04	179	…	
19	Equatorial Guinea	0.06	…		…		0.1	164	98.5	138
20	Eritrea	1	0.05	133	0.02	141	0.1	165	249.3	118
21	Ethiopia	2	0.06	126	0.04	129	0.03	182	491.0	94
22	Gambia	0.13	0.00	165	…		0.1	168	32.0	144
23	Georgia	4	0.06	124	0.02	137	0.8	138	…	
24	Ghana	4	0.02	148	0.02	138	0.2	157	203.6	127
25	Guinea	0.13	0.00	159	0.01	144	0.02	183	24.3	145
26	Guinea-Bissau	0.06	…		0.01	148	0.1	174	106.5	137
27	Haiti	…	…		…		…		…	
28	India	1'475	1.01	46	0.5	55	1.4	128	460.9	99
29	Indonesia	343	0.56	57	0.5	53	1.6	125	571.7	86
30	Kenya	56	0.90	48	0.7	49	1.8	123	560.0	87
31	Kyrgyzstan	…	…		…		…		…	
32	Lao P.D.R.	2	0.08	119	0.1	119	0.3	150	1'020.9	67
33	Lesotho	1.0	0.13	103	1.5	33	0.5	143	…	
34	Liberia	0.13	0.002	166	…		0.04	177	…	
35	Madagascar	3	0.13	102	0.1	99	0.2	158	240.0	120
36	Malawi	0.9	0.03	139	0.02	139	0.1	171	92.4	140
37	Mali	5	0.12	104	0.1	113	0.5	141	488.7	96
38	Mauritania	0.8	0.03	146	…		0.3	152	…	
39	Moldova	10	0.37	72	0.1	115	2.4	121	987.4	71
40	Mongolia	10	1.11	44	0.4	60	4.2	111	1'000.0	69
41	Mozambique	4	0.56	56	0.1	102	0.3	153	…	
42	Myanmar	2	0.00	161	0.03	133	0.04	176	501.6	93
43	Nepal	10	0.14	97	0.1	86	0.4	145	666.7	81
44	Nicaragua	17	0.10	111	0.2	74	3.3	112	1'163.7	62
45	Niger	0.5	0.05	131	…		0.05	175	260.4	117
46	Nigeria	9	0.03	140	0.03	132	0.1	172	320.6	114
47	Pakistan	225	0.38	71	0.2	81	1.6	126	1'125.0	65
48	Papua New Guinea	6	0.16	93	0.1	90	1.1	132	…	
49	Rwanda	0.13	0.005	157	…		0.02	185	86.8	141
50	S. Tomé & Principe	2	0.52	60	0.5	52	13.3	82	3'558.7	27
51	Senegal	48	0.23	85	0.2	75	5.0	101	6'468.1	20
52	Sierra Leone	0.5	0.01	153	…		0.1	167	682.7	79
53	Solomon Islands	*0.26*	…		*0.03*	136	*0.6*	140	*222.6*	124
54	Somalia	0.06	0.0004	168	…		0.01	188	…	
55	Sudan	0.5	0.003	162	0.002	151	0.02	186	33.2	143
56	Tajikistan	…	…		…		…		…	
57	Tanzania	4	0.13	101	0.1	96	0.1	166	205.0	125
58	Togo	6	0.11	108	0.1	94	1.3	130	600.0	84
59	Uganda	5	0.09	115	0.3	71	0.2	155	870.1	73
60	Ukraine	217	0.60	53	0.3	66	4.3	107	…	
61	Uzbekistan	0.9	0.001	167	0.01	146	0.04	180	128.6	135
62	Viet Nam	34	0.09	114	0.1	117	0.4	146	134.7	134
63	Yemen	3	0.03	144	0.01	142	0.2	162	409.4	105
64	Zambia	2	0.06	125	0.04	126	0.2	159	248.3	119
65	Zimbabwe	*7*	…		…		*0.6*	139	*233.3*	122
	Low Income	**22'551**	**0.35**		**0.3**		**1.1**		**547.9**	

9. International Internet bandwidth

		Total (Mbit/s)	Bit-Circuit Index		Bit-Minute-Index		Bits per capita		Bits per subscriber	
		2001	2001	Rank	2001	Rank	2001	Rank	2001	Rank
66	Albania	1	0.004	160	0.003	150	0.2	154	192.0	129
67	Algeria	86	0.27	79	…		2.8	115	1'438.3	55
68	Belarus	44	0.14	99	0.1	98	4.4	106	5'435.5	21
69	Belize	13	0.55	58	0.4	61	51.6	63	2'449.2	41
70	Bolivia	23	0.11	107	0.2	77	2.8	116	515.6	90
71	Bosnia	25	0.11	110	0.1	112	6.1	96	1'581.2	52
72	Bulgaria	*44*	…		*0.1*	89	*5.4*	98	…	
73	Cape Verde	2	0.06	128	0.04	125	4.6	105	672.5	80
74	China	7'598	1.54	38	1.4	35	5.8	97	437.5	101
75	Colombia	5'600	2.18	30	15.4	6	130.8	38	14'395.9	12
76	Cuba	52	0.27	80	0.2	80	4.6	104	…	
77	Djibouti	0.5	0.03	137	0.03	131	0.8	137	465.5	98
78	Dominican Rep.	82	0.03	141	0.1	121	9.4	87	1'272.3	59
79	Ecuador	*25*	…		0.05	124	*2.0*	122	*430.1*	102
80	Egypt	275	0.41	66	0.3	70	4.3	109	…	
81	El Salvador	63	0.09	117	0.1	114	9.9	86	…	
82	Fiji	*4*	…		…		*5.0*	102	*1'142.9*	64
83	Guatemala	226	0.36	75	0.3	67	19.3	77	…	
84	Guyana	8	0.15	96	0.1	104	9.0	90	390.4	108
85	Honduras	34	0.06	129	0.1	97	5.3	99	766.6	78
86	Iran (I.R.)	160	0.28	78	0.4	64	2.5	120	398.0	106
87	Iraq	0.19	0.003	164	…		0.0	187	…	
88	Jamaica	116	0.11	106	0.2	72	44.6	64	…	
89	Jordan	37	0.14	98	0.1	103	7.2	95	541.8	88
90	Kazakhstan	68	0.77	50	0.2	76	4.2	110	…	
91	Kiribati	0.13	…		…		1.5	127	233.6	121
92	Maldives	5	0.36	74	0.3	69	16.3	80	4'090.9	23
93	Marshall Islands	…	…		…		…		…	
94	Micronesia	3	0.50	62	0.4	62	28.1	73	1'915.5	45
95	Morocco	136	1.19	42	…		4.7	103	2'566.0	40
96	Namibia	3	0.38	69	0.0	134	1.7	124	204.8	126
97	Palestine	…	…		…		…		…	
98	Paraguay	15	0.09	116	0.1	88	2.7	118	451.8	100
99	Peru	412	0.69	52	0.7	45	15.8	81	2'354.3	44
100	Philippines	237	0.24	84	0.1	100	3.0	113	395.0	107
101	Romania	1'418	2.92	23	1.6	32	63.3	60	…	
102	Russia	3'909	3.37	20	…		26.6	75	3'804.4	26
103	Samoa	2	…		0.1	106	12.6	83	…	
104	Serbia and Montenegro	11	0.02	147	0.0	143	1.0	134	…	
105	South Africa	475	0.82	49	0.4	63	10.7	84	506.7	91
106	Sri Lanka	18	0.08	118	0.1	116	1.0	136	292.5	116
107	St. Vincent	9	0.03	145	0.2	78	78.5	53	2'761.3	37
108	Suriname	4	0.11	109	0.1	109	9.1	89	826.4	75
109	Swaziland	1.0	0.02	151	0.02	140	1.0	135	157.5	132
110	Syria	3	0.02	149	0.01	147	0.2	160	153.6	133
111	TFYR Macedonia	…	…		…		…		…	
112	Thailand	642	1.29	39	1.0	42	10.5	85	428.0	103
113	Tonga	0.5	0.05	132	…		5.2	100	363.9	110
114	Tunisia	42	0.14	100	0.1	111	4.3	108	…	
115	Turkey	620	0.50	63	0.3	68	9.3	88	177.0	130
116	Turkmenistan	0.26	0.01	154	0.01	145	0.1	173	117.8	136
117	Vanuatu	…	…		…		…		…	
	Lower Middle Income	**22'551**	**0.92**		**0.7**		**10.2**		**850.9**	

9. International Internet bandwidth

		Total (Mbit/s)	Bit-Circuit Index		Bit-Minute-Index		Bits per capita		Bits per subscriber	
		2001	*2001*	*Rank*	*2001*	*Rank*	*2001*	*Rank*	*2001*	*Rank*
118	Antigua & Barbuda	13	0.07	123	…		169.5	37	…	
119	Argentina	4'172	2.92	22	4.4	17	115.2	43	3'090.4	31
120	Barbados	18	…		0.1	91	65.8	59	…	
121	Botswana	14	0.70	51	0.2	83	8.3	93	…	
122	Brazil	6'069	1.83	34	2.9	23	35.3	69	1'734.0	49
123	Chile	1'770	1.99	32	3.3	21	114.9	44	2'593.8	39
124	Costa Rica	275	0.54	59	1.1	40	66.9	58	2'864.6	35
125	Croatia	…	…		…		…		…	
126	Czech Republic	11'466	15.47	11	13.9	8	1'121.5	16	9'124.2	16
127	Dominica	5	0.03	143	…		69.1	57	1'404.8	56
128	Estonia	517	0.19	91	3.0	22	361.5	26	5'397.4	22
129	Gabon	1.2	…		…		…		…	
130	Grenada	*4*	…		…		*42.4*	66	*1'443.0*	54
131	Guadeloupe	0.5	0.02	152	0.1	101	1.1	133	…	
132	Hungary	2'979	11.16	12	5.1	16	298.7	29	9'260.9	15
133	Latvia	262	1.57	37	1.7	30	111.4	47	…	
134	Lebanon	25	0.18	92	…		7.5	94	293.6	115
135	Libya	2	0.51	61	…		0.4	148	…	
136	Lithuania	102	1.70	36	0.7	47	27.7	74	1'731.7	50
137	Malaysia	733	0.28	77	0.5	54	30.8	72	345.9	111
138	Malta	*34*	*0.38*	70	*0.3*	65	*87.2*	52	*988.1*	70
139	Mauritius	10	0.15	94	0.1	95	8.3	92	230.0	123
140	Mayotte	…	…		…		…		…	
141	Mexico	3'183	0.04	134	0.5	57	31.7	70	1'847.4	46
142	Oman	156	1.92	33	0.6	51	59.3	62	3'824.6	25
143	Panama	*330*	*1.20*	41	*2.0*	27	*116.2*	41	*7'677.6*	18
144	Poland	2'337	2.21	29	1.1	38	60.5	61	…	
145	Puerto Rico	…	…		…		…		…	
146	Saudi Arabia	192	0.40	67	0.1	105	8.6	91	479.4	97
147	Seychelles	6	…		…		73.3	56	2'926.8	33
148	Slovak Republic	6'821	56.84	2	21.5	4	1'268.1	14	68'142.5	1
149	St. Kitts and Nevis	2	…		0.1	93	43.3	65	…	
150	St. Lucia	15	…		0.5	56	96.5	50	…	
151	Trinidad & Tobago	96	0.58	55	0.4	58	73.8	54	3'030.7	32
152	Uruguay	375	2.23	28	1.9	28	111.6	46	…	
153	Venezuela	433	0.21	87	0.7	48	17.6	78	1'274.0	58
	Upper Middle Income	**42'417**	**0.47**		**2.0**		**85.7**		**3'438.2**	

9. International Internet bandwidth

		Total (Mbit/s)	Bit-Circuit Index		Bit-Minute-Index		Bits per capita		Bits per subscriber	
		2001	2001	Rank	2001	Rank	2001	Rank	2001	Rank
154	Andorra	…	…		…		…		…	
155	Aruba	3	0.01	156	…		24.8	76	328.0	113
156	Australia	7'025	1.20	40	1.7	31	362.4	25	1'680.2	51
157	Austria	17'729	41.42	4	8.3	12	2'178.0	11	16'117.3	11
158	Bahamas	30	0.03	142	0.2	82	96.3	51	2'428.6	42
159	Bahrain	80	0.36	73	0.2	73	122.5	40	1'806.4	47
160	Belgium	81'426	36.94	5	23.5	3	7'898.0	3	57'160.7	2
161	Bermuda	74	0.15	95	1.1	41	1'139.3	15	…	
162	Brunei Darussalam	60	0.59	54	1.2	36	175.4	36	2'608.7	38
163	Canada	55'623	0.40	68	3.7	20	1'853.7	12	9'890.3	14
164	Cyprus	69	0.20	89	0.2	79	100.1	49	1'061.5	66
165	Denmark	43'456	103.71	1	…		8'114.9	2	21'476.1	6
166	Faroe Islands	…	…		…		…		…	
167	Finland	7'820	32.45	6	7.9	13	1'505.3	13	8'231.6	17
168	France	191'992	22.34	7	18.5	5	3'235.3	8	27'480.4	5
169	French Guiana	0.26	0.01	154	0.2	85	1.3	129	…	
170	French Polynesia	8	0.19	90	…		31.7	71	833.3	74
171	Germany	207'669	16.65	10	13.3	9	2'519.2	10	13'844.6	13
172	Greece	1'205	2.53	24	0.7	46	113.7	45	3'406.4	29
173	Greenland	*6*	…		…		*107.1*	48	…	
174	Guam	…	…		…		…		…	
175	Guernsey	…	…		…		…		…	
176	Hong Kong, China	6'308	2.27	25	1.1	39	938.0	19	2'417.4	43
177	Iceland	68	0.24	83	0.8	44	236.9	32	1'360.0	57
178	Ireland	4'203	2.24	26	1.4	34	1'094.8	17	…	
179	Israel	1'190	0.91	47	0.6	50	182.9	34	1'244.8	60
180	Italy	35'771	7.20	16	3.8	19	616.6	22	…	
181	Japan	22'705	2.11	31	5.2	15	178.4	35	943.6	72
182	Jersey	…	…		…		…		…	
183	Korea (Rep.)	5'432	1.13	43	2.8	24	116.1	42	606.5	83
184	Kuwait	95	0.43	65	…		41.6	67	…	
185	Luxembourg	1'313	8.81	14	1.7	29	2'953.0	9	37'815.7	4
186	Macao, China	120	0.43	64	0.4	59	267.9	30	3'457.0	28
187	Martinique	1	…		…		1.3	131	…	
188	Neth. Antilles	28	0.07	121	…		127.4	39	…	
189	Netherlands	173'154	49.52	3	34.6	2	10'751.4	1	38'478.7	3
190	New Caledonia	8	0.26	82	…		36.5	68	533.3	89
191	New Zealand	1'900	1.06	45	1.2	37	497.3	23	2'878.8	34
192	Northern Marianas	11	0.03	138	…		217.6	33	…	
193	Norway	21'637	22.28	8	34.6	1	4'778.5	6	17'511.4	10
194	Portugal	3'522	3.23	21	2.4	26	341.8	27	1'018.1	68
195	Qatar	45	0.21	88	0.2	84	73.8	55	3'320.3	30
196	Réunion	2	…		9.6	10	2.7	117	…	
197	Singapore	2'639	2.23	27	0.9	43	638.8	20	2'846.8	36
198	Slovenia	500	1.76	35	…		250.6	31	1'785.7	48
199	Spain	25'394	6.38	17	4.0	18	628.1	21	6'911.9	19
200	Sweden	60'349	19.00	9	…		6'773.2	4	21'182.5	7
201	Switzerland	40'056	8.73	15	8.4	11	5'528.7	5	18'209.8	9
202	Taiwan, China	7'228	4.92	19	2.7	25	322.6	28	1'162.0	63
203	United Arab Emirates	52	0.02	150	…		16.7	79	202.6	128
204	United Kingdom	238'074	5.64	18	15.3	7	3'962.9	7	18'313.4	8
205	United States	273'770	9.22	13	5.9	14	961.3	18	3'911.0	24
206	Virgin Islands (US)	53	0.31	76	…		482.5	24	…	
	High Income	**1'539'900**	**5.15**		**8.5**		**1'610.4**		**8'378.3**	
	WORLD	**1'607'470**	**3.82**		**6.6**		**264.6**		**7'069.4**	
	Africa	**1'236**	**0.28**		**0.2**		**1.5**		**845.9**	
	Americas	**353'040**	**1.34**		**4.4**		**426.9**		**4'189.2**	
	Asia	**57'996**	**1.40**		**1.4**		**16.0**		**815.1**	
	Europe	**1'186'230**	**11.58**		**11.6**		**1'495.3**		**18'077.3**	
	Oceania	**8'968**	**1.06**		**1.5**		**292.0**		**1'840.2**	

Source: Telegeography, ITU World Telecommunication Indicators database.

10. Broadband prices

		Broadband prices per month (July 2003)			Speed (kbit/s)		Type	ISP
		US$	per 100 kbit/s	as % of monthly income (GNI)	Down	Up		
1	Afghanistan	...	...	...	...	...	…	…
2	Angola	...	...	...	...	...	…	…
3	Armenia	...	...	...	...	...	…	…
4	Azerbaijan	...	...	...	...	...	…	…
5	Bangladesh	...	...	...	...	...	…	…
6	Benin	...	...	...	...	...	…	…
7	Bhutan	...	...	...	...	...	…	…
8	Burkina Faso	...	...	...	...	...	…	…
9	Burundi	...	...	...	...	...	…	…
10	Cambodia	...	...	...	...	...	…	…
11	Cameroon	4'254.10	1'661.76	9115.93	256	...	ADSL	Camnet
12	Central African Rep.	...	...	...	...	...	…	…
13	Chad	...	...	...	...	...	…	…
14	Comoros	...	...	...	...	...	…	…
15	Congo	...	...	...	...	...	…	…
16	Côte d'Ivoire	...	...	...	...	...	…	…
17	D.P.R. Korea	...	...	...	...	...	…	…
18	D.R. Congo	...	...	...	...	...	…	…
19	Equatorial Guinea	...	...	...	...	...	…	…
20	Eritrea	...	...	...	...	...	…	…
21	Ethiopia	...	...	...	...	...	…	…
22	Gambia	...	...	...	...	...	…	…
23	Georgia	1'099.00	429.30	2028.92	256	256	ADSL	Geonet
24	Ghana	...	...	...	...	...	…	…
25	Guinea	...	...	...	...	...	…	…
26	Guinea-Bissau	...	...	...	...	...	…	…
27	Haiti	...	...	...	...	...	…	…
28	India	...	...	...	...	...	…	…
29	Indonesia	...	...	...	...	...	…	…
30	Kenya	...	...	...	...	...	…	…
31	Kyrgyzstan	120.00	23.44	496.55	512	...	ADSL	Elkat
32	Lao P.D.R.	...	...	...	...	...	…	…
33	Lesotho	...	...	...	...	...	…	…
34	Liberia	...	...	...	...	...	…	…
35	Madagascar	...	...	...	...	...	…	…
36	Malawi	...	...	...	...	...	…	…
37	Mali	...	...	...	...	...	…	…
38	Mauritania	...	...	...	...	...	…	…
39	Moldova	...	...	...	...	...	…	…
40	Mongolia	...	...	...	...	...	…	…
41	Mozambique	...	...	...	...	...	…	…
42	Myanmar	...	...	...	...	...	…	…
43	Nepal	...	...	...	...	...	…	…
44	Nicaragua	...	...	...	...	...	…	…
45	Niger	...	...	...	...	...	…	…
46	Nigeria	...	...	...	...	...	…	…
47	Pakistan	...	...	...	...	...	…	…
48	Papua New Guinea	...	...	...	...	...	…	…
49	Rwanda	...	...	...	...	...	…	…
50	S. Tomé & Principe	...	...	...	...	...	…	…
51	Senegal	48.49	18.94	123.82	256	128	ADSL	Sonatel
52	Sierra Leone	...	...	...	...	...	…	…
53	Solomon Islands	...	...	...	...	...	…	…
54	Somalia	...	...	...	...	...	…	…
55	Sudan	...	...	...	...	...	…	…
56	Tajikistan	...	...	...	...	...	…	…
57	Tanzania	...	...	...	...	...	…	…
58	Togo	...	...	...	...	...	…	…
59	Uganda	...	...	...	...	...	…	…
60	Ukraine	...	...	...	...	...	…	…
61	Uzbekistan	...	...	...	...	...	…	…
62	Viet Nam	...	...	...	...	...	…	…
63	Yemen	...	...	...	...	...	…	…
64	Zambia	...	...	...	...	...	…	…
65	Zimbabwe	...	...	...	...	...	…	…
	Low Income	**1'380.40**	**533.36**		**320**	**192**		

10. Broadband prices

		Broadband prices per month (July 2003)			*Speed (kbit/s)*		*Type*	*ISP*
		US$	*per 100 kbit/s*	*as % of monthly income (GNI)*	*Down*	*Up*		
66	Albania	...	...	...	...	...	…	…
67	Algeria	...	...	...	...	...	…	…
68	Belarus	1'368.00	534.38	1207.06	256	...	ADSL	MGTS
69	Belize	...	...	...	...	...	…	…
70	Bolivia	...	...	...	...	...	…	…
71	Bosnia	57.40	11.21	54.24	512	128	ADSL	Bihnet
72	Bulgaria	...	...	...	...	...	…	…
73	Cape Verde	...	...	...	...	...	…	…
74	China	15.71	3.07	20.05	512	...	ADSL	China Telecom
75	Colombia	...	...	...	...	...	…	…
76	Cuba	...	...	...	...	...	…	…
77	Djibouti	...	...	...	...	...	…	…
78	Dominican Rep.	...	...	...	...	...	…	…
79	Ecuador	...	...	...	...	...	…	…
80	Egypt	...	...	...	...	...	…	…
81	El Salvador	...	...	...	...	...	…	…
82	Fiji	...	...	...	...	...	…	…
83	Guatemala	...	...	...	...	...	…	…
84	Guyana	...	...	...	...	...	…	…
85	Honduras	...	...	...	...	...	…	…
86	Iran (I.R.)	...	...	...	...	...	…	…
87	Iraq	...	...	...	...	...	…	…
88	Jamaica	129.00	16.80	54.89	768	256	ADSL	CW Jamaica
89	Jordan	14.06	2.75	9.59	512	128	ADSL	Jordan Telecom
90	Kazakhstan	...	...	...	...	...	…	…
91	Kiribati	...	...	...	...	...	…	…
92	Maldives	169.92	66.38	97.56	256	128	ADSL	Dhiraagu
93	Marshall Islands	...	...	...	...	...	…	…
94	Micronesia	...	...	...	...	...	…	…
95	Morocco	93.33	36.46	94.11	256	...	ADSL	Maroc Telecom
96	Namibia	...	...	...	...	...	…	…
97	Palestine	...	...	...	...	...	…	…
98	Paraguay	...	...	...	...	...	…	…
99	Peru	99.00	19.34	57.95	512	128	DSL	Telefonica
100	Philippines	...	...	...	...	...	…	…
101	Romania	301.00	117.58	195.24	256	...	Cable	Astral
102	Russia	...	...	...	...	...	…	…
103	Samoa	...	...	...	...	...	…	…
104	South Africa	88.17	17.22	40.69	512	256	ADSL	Telekom SA
105	Sri Lanka	68.97	3.37	98.53	2'048	512	ADSL	Sri Lanka Telecom
106	St. Vincent	...	...	...	...	...	…	…
107	Suriname	...	...	...	...	...	…	…
108	Swaziland	...	...	...	...	...	…	…
109	Syria	...	...	...	...	...	…	…
110	TFYR Macedonia	...	...	...	...	...	…	…
111	Thailand	174.75	68.26	105.91	256	128	ADSL	Inet-ADSL
112	Tonga	1'117.74	436.62	951.26	256	...	ADSL	TCC
113	Tunisia	...	...	...	...	...	…	…
114	Turkey	372.39	72.73	178.75	512	128	ADSL	Ttnet
115	Turkmenistan	...	...	...	...	...	…	…
116	Vanuatu	...	...	...	...	...	…	…
117	Yugoslavia	...	...	...	...	...	…	…
	Lower Middle Income	**290.67**	**100.44**		**530**	**199**		

10. Broadband prices

		Broadband prices per month (July 2003)			Speed (kbit/s)		Type	ISP
		US$	per 100 kbit/s	as % of monthly income (GNI)	Down	Up		
118	Antigua & Barbuda	...	...	...	...	...	…	…
119	Argentina	68.90	13.46	20.36	512	512	ADSL	Canopus
120	Barbados	171.64	67.05	21.12	256	64	ADSL	Caribsurf
121	Botswana	...	...	...	...	...	…	…
122	Brazil	22.44	8.77	9.45	256	...	ADSL	Speedy
123	Chile	35.50	13.87	10.00	256	128	ADSL	Entel
124	Costa Rica	80.00	31.25	23.41	256	128	Cable	Tica Cable
125	Croatia	30.10	7.84	7.79	384	64	ADSL	Hrvatski Telekom
126	Czech Republic	...	...	...	...	...	…	…
127	Dominica	...	...	...	...	...	…	…
128	Estonia	24.26	9.48	7.05	256	128	ADSL	Atlas
129	Gabon	...	...	...	...	...	…	…
130	Grenada	93.26	36.43	31.97	256	64	ADSL	CW Grenada
131	Guadeloupe	...	...	...	...	...	…	…
132	Hungary	42.95	11.18	9.76	384	...	ADSL	Axelero
133	Latvia	75.31	29.42	25.97	256	64	ADSL	Lattelekom
134	Lebanon	...	...	...	...	...	…	…
135	Libya	...	...	...	...	...	…	…
136	Lithuania	12.80	5.00	4.20	256	128	ADSL	Lietuvos Telekomas
137	Malaysia	29.21	7.61	9.90	384	128	ADSL	Streamyx
138	Malta	53.34	10.42	6.96	512	128	ADSL	Waldonet
139	Mauritius	85.13	16.63	26.53	512	128	ADSL	Telecom Plus
140	Mayotte	...	...	...	...	...	…	…
141	Mexico	57.46	22.44	11.67	256	...	ADSL	Prodigy
142	Oman	...	...	...	...	...	…	…
143	Panama	...	...	...	...	...	…	…
144	Poland	76.15	14.87	20.00	512	128	DSL	Telekomunikacja
145	Puerto Rico	...	...	...	...	...	…	…
146	Saudi Arabia	238.65	93.22	33.85	256	128	ADSL	Sahara Network
147	Seychelles	...	...	...	...	...	…	…
148	Slovak Republic	...	...	...	...	...	…	…
149	St. Kitts and Nevis	...	...	...	...	...	…	…
150	St. Lucia	...	...	...	...	...	…	…
151	Trinidad & Tobago	291.25	113.77	53.85	256	64	ADSL	TSTT
152	Uruguay	...	...	...	...	...	…	…
153	Venezuela	49.72	4.86	14.59	1'024	1'024	WLL	TECEL
	Upper Middle Income	**80.95**	**27.24**		**371**	**188**		

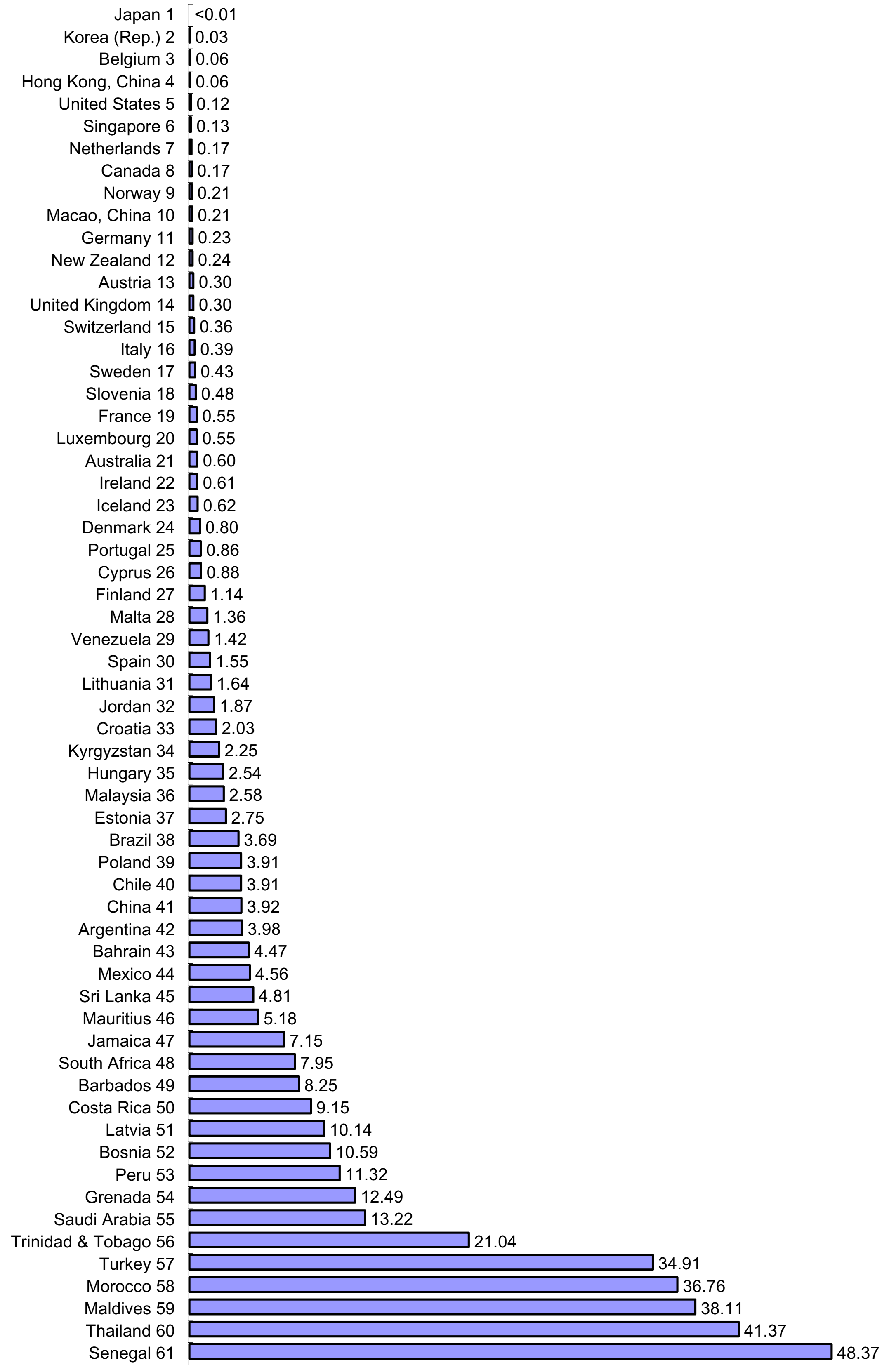
10. Broadband prices

		Broadband prices per month (July 2003)			Speed (kbit/s)		Type	ISP
		US$	per 100 kbit/s	as % of monthly income (GNI)	Down	Up		
154	Andorra	...	...	...	...	...	…	…
155	Aruba	...	...	...	...	...	…	…
156	Australia	50.56	9.87	3.07	512	128	ADSL	Telstra
157	Austria	45.20	5.89	2.32	768	128	ADSL	Telekom Austria
158	Bahamas	54.99	5.37	...	1'024	384	ADSL	Batelnet
159	Bahrain	106.10	41.44	11.44	256	...	ADSL	Inet
160	Belgium	34.41	1.15	1.78	3'000	128	ADSL	Belgacom
161	Bermuda	89.00	5.93	...	1'500	256	ADSL	Bermuda Tel. Co.
162	Brunei Darussalam	95.54	37.32	...	256	...	ADSL	E-Speed
163	Canada	32.48	3.25	1.75	1'000	160	ADSL	Bell sympatico
164	Cyprus	58.03	9.07	5.65	640	128	ADSL	Global Express
165	Denmark	118.89	5.81	4.71	2'048	512	ADSL	Tele2
166	Faroe Islands	...	...	...	...	...	…	…
167	Finland	165.89	8.10	8.47	2'048	512	ADSL	Sonera
168	France	51.46	10.05	2.81	512	...	ADSL	France Telecom
169	French Guiana	...	...	...	...	...	…	…
170	French Polynesia	...	...	...	...	...	…	…
171	Germany	33.93	4.42	1.80	768	...	ADSL	Deutsche Telekom
172	Greece	...	...	...	...	...	…	…
173	Greenland	...	...	...	...	...	…	…
174	Guam	...	...	...	...	...	…	…
175	Guernsey	46.40	9.06	...	512	128	ADSL	CW Guernsey
176	Hong Kong, China	38.21	1.27	1.85	3'000	640	ADSL	PCCW IMS Ltd
177	Iceland	73.66	14.39	3.16	512	256	ADSL	Íslandssími
178	Ireland	61.69	12.05	3.10	512	...	ADSL	Eircom
179	Israel	20.40	3.98	...	512	64	ADSL	Bezeqint
180	Italy	73.59	6.13	4.66	1'200	256	ADSL	Tin.IT
181	Japan	24.19	0.09	0.87	26'000	1'000	ADSL	YahooBB
182	Jersey	46.40	9.06	...	512	128	ADSL	Jersey Telecoms
183	Korea (Rep.)	49.23	0.25	5.95	20'000	20'000	VDSL	Hanaro
184	Kuwait	...	...	...	...	...	…	…
185	Luxembourg	91.77	17.92	2.84	512	128	ADSL	Bamboo
186	Macao, China	38.34	2.56	3.20	1'500	...	ADSL	CTM
187	Martinique	...	...	...	...	...	…	…
188	Neth. Antilles	...	...	...	...	...	…	…
189	Netherlands	51.55	3.36	2.58	1'536	256	ADSL	Ixs
190	New Caledonia	71.19	27.81	...	256	...	ADSL	OPT
191	New Zealand	40.61	2.71	3.55	1'500	800	ADSL	FastADSL
192	Northern Marianas	...	...	...	...	...	…	…
193	Norway	46.16	6.56	1.46	704	128	DSL	Tele2
194	Portugal	39.64	7.74	4.39	512	128	ADSL	Sabo
195	Qatar	82.15	32.09	...	256	...	ADSL	Qatar Internet
196	Réunion	...	...	...	...	...	…	…
197	Singapore	33.18	2.21	1.92	1'500	...	Cable	StarHub
198	Slovenia	79.54	3.88	9.73	2'048	700	ADSL	Amis.net
199	Spain	47.63	18.61	3.96	256	...	ADSL	Terra
200	Sweden	44.56	8.91	2.15	500	...	ADSL	Tele 2
201	Switzerland	57.84	11.30	1.83	512	128	DSL	Bluewin
202	Taiwan, China	45.64	1.52	...	3'000	512	ADSL	So-net
203	United Arab Emirates	68.06	17.72	...	384	128	ADSL	EIM
204	United Kingdom	32.59	6.37	1.55	512	256	ADSL	PIPEX
205	United States	52.99	3.53	1.81	1'500	256	Cable	Comcast
206	Virgin Islands (US)	...	...	...	...	...	…	…
	High Income	**58.81**	**9.71**		**2'156**	**1'008**		
	WORLD	**176.62**	**58.37**		**1'313**	**607**		
	Africa	**913.84**	**350.20**		**358**	**171**		
	Americas	**88.51**	**24.41**		**642**	**263**		
	Asia	**126.57**	**41.89**		**3'083**	**1'827**		
	Europe	**116.08**	**31.37**		**757**	**200**		
	Oceania	**320.02**	**119.25**		**631**	**464**		

Source: ITU.
Note: Exchange rates valid July 11, 2003, see technical notes for more details.

10. Broadband prices

Broadband prices per 100 kbit/s, as percentage of monthly income, July 2003



11. Top 20 broadband providers, world
Ranked by subscribers, December 2002

		Broadband subscribers		*% of domestic*
		Total (k)	*Change*	*broadband*
Rank	*Operator*	*2002*	*2001-02*	*subscribers*
1	Korea Telecom	4'923	27.6%	48.6
2	Comcast (USA)	3'600	140.0% *	20.0
3	Deutsche Telekom	3'100	72.2%	95.7
4	Hanaro (Korea, Rep.)	2'878	40.7%	28.4
5	Time Warner Cable (USA)	2'600	36.8%	13.9
6	NTT (Japan)	2'400	147.9%	27.8
7	SBC (USA)	2'200	65.0%	11.8
8	CHT (Taiwan, China)	1'910	123.1%	91.0
9	Verizon (USA)	1'800	50.0%	9.6
10	Yahoo! BB (Japan)	1'504	-	17.5
11	Cox (USA)	1'408	59.3%	7.5
12	France Telecom	1'366	217.7%	93.8
13	Thrunet (Korea, Rep.)	1'302	0.0%	13.2
14	Charter (USA)	1'200	97.4%	6.4
15	Bell Canada	1'110	46.6%	30.8
16	Bell South (USA)	1'021	64.4%	5.5
17	Telefonica (Spain)	957	154.5%	88.9
18	Telecom Italia	850	539.1%	100.0
19	Cablevision (USA)	770	-	4.1
20	PCCW (Hong Kong, China)	559	39.1%	55.4
	TOP 20	**37'458**	**58.5%**	

* Change computed using 2001 subscribers of AT&T.
Source: ITU PTO Database.

TECHNICAL NOTES

General methodology
The compound annual growth rate (CAGR) is computed by the formula:

$$[(P_v / P_0)^{(1/n)}]-1$$

where P_v = Present value
P_0 = Beginning value
n = Number of periods

The result is multiplied by 100 to obtain a percentage.

United States dollar figures are reached by applying the average annual exchange rate (from the International Monetary Fund, IMF) to the figure reported in national currency. For 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 was 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 g*ross 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. 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 digital subscriber line. *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. *As % of cable TV subscribers* is calculated by dividing the number of cable modem Internet subscribers by the total cable TV subscribers and multiplying by 100. Note that DSL and cable modem subscribers may not sum to equal total broadband subscribers due to the possible presence of other broadband technologies.

3. 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 code generally reflecting the nature of the organization using the Internet computer. The number of hosts are assigned to countries based on the country code although this does not necessarily indicate that the host is actually physically in the country. In addition, all other hosts for which there is no country code identification (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.

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.

5. International connectivity
International private line service measures leased dedicated channels of communications (leased circuits) between US territories and foreign points. Circuits are counted in 56/64 kbit/s or "voice channel" equivalents. *CAGR* measures the compound annual growth rate between 1998 and 2001 for private lines to the United States. *Private lines as a percentage of active lines* takes the percentage of private lines to all active circuits to the United States. It does not include idle circuits. *Total international circuits* is the sum of active *International message telephone service, International private line service, and Other circuits* to the United States. It includes both active and idle circuits. *Capacity usage %* measures the ratio of active circuits to all circuits (active and idle) to the United States. Data reflecting international circuits to the United States may only reflect a portion of the total international circuits in a country.

6. Main telephone lines
This table shows the number of *Main telephone lines* and *Main telephone lines per 100 inhabitants* 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.

7. 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.

8. Network penetration
Network penetration looks at density of main lines, mobile subscribers, Internet users and Internet subscribers. *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. *Effective teledensity* refers to either main line density or mobile density, whichever is higher. *Internet user per 100 inhabitants* is calculated by dividing total Internet users by population and multiplying by 100. *Broadband subscribers per 100 inhabitants* is calculated by dividing total broadband subscribers (note: not users) by population 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). *Bit-Circuit-Index* refers to international bandwidth divided by the number of International telephone circuits (converted at 56/64 kbit/s per circuit or voice channel equivalents). *Bit-Minute-Index* refers to international Internet bandwidth divided by the combined number of outgoing and incoming international telephone minutes. *Bits per capita* refers to international Internet bandwidth divided by the population. *Bits per subscriber* refers to international Internet bandwidth divided by the number of Internet subscribers. International Internet bandwidth data are provided from various sources including: TeleGeography Inc. (http://www.telegeography.com), ITU research, and other sources.

10. Broadband prices
Broadband prices per month are meant to be representative examples of general prices for broadband in an economy and represent the monthly subscription cost to broadband service. The prices shown do not include installation charges or telephone line rentals that are often required for DSL service. The prices do not necessarily represent the least expensive or fastest connections available and are can only be used as a rough estimate of current offers available to users within an economy. The prices were gathered looking for the most "common" or cost-efficient broadband offer. As an example, if an economy offered 256 and 512 kbit/s ADSL, the faster speed was only used if it offered better value per 100 kbit/s. In other words, the *Monthly price per 100 kbit/s* had to be equal or less than the lower speed in order to be used. Some ISPs place download limits on broadband connections (Australia, Bosnia, Iceland, Kyrgyzstan). Where applicable, the service offering closest to 1 Gigabyte of data per month was used. Other economies, such as Hong Kong, China; Macao, China;

and Lithuania put time restrictions on broadband usage. The service offering closest to 100 hours per month was selected. All prices were gathered between June and July 2003 with exchange rates valid as of 11 July 2003. All prices are listed in nominal US$. Broadband offers are usually residential offerings unless only business connections are available from the ISP. Most services are DSL-based but cable and WLL prices were used where they were less expensive per 100 kbit/s, or were the only services available. Broadband prices *per 100 kbit/s* represent *Broadband prices per month* divided by the *Speed down* and then multiplied by 100. Broadband prices *as a % of monthly income (GNI)* are calculated by dividing *Broadband prices per month* by average monthly income per capita in the economy as given by its GNI per capita (Atlas method, current US$). *Speed down* represents the maximum advertised download speeds, while *Speed up* represents the maximum upload speeds, when given. *Type* represents the type of broadband service selected for comparison. *ISP* the Internet service provider offering the broadband service in the economy. *Download speeds* do not represent actual speeds that individual users are able to obtain; many factors contribute to overall speed and the published speeds are the advertised maximum speeds from the ISP. *ISP* choices do not necessarily reflect the dominant ISP in the market. When upload speeds are not listed it is because they were not indicated in the promotional materials. With ADSL however, it is safe to assume that upload speeds are significantly lower than download speeds. Most economies combine ISP and ADSL charges, although some economies tend to keep them as separate items (e.g. Japan). The prices included are those advertised and may or may not include ISP charges. Where ISP charges were known to be separate, they were included. Taxes may or may not be included in the advertised prices. Broadband prices in some countries have a limit on the amount of data transferred in a month. Others, such as Hong Kong, China, have time limits on connections for the monthly fee. Income figures are calculated based on 2002 World Bank data on GNI according to purchasing power parity (PPP).

11. Top 20 broadband providers

The *Broadband providers* table shows the top 20 PTOs that provide broadband Internet access, ranked by 2002 broadband subscribers. *Broadband subscribers* refers only to domestic subscribers and does not include foreign subscribers if the company does business in more than one economy. The *% of domestic broadband subscribers* is calculated by dividing the company's domestic subscribers by the total number of broadband subscribers in the economy.

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.

Broadcasting

In addition to national sources, broadcasting statistics were obtained from:

United Nations Educational, Scientific and Cultural Organization. Various years. *Statistical Yearbook*. Paris.

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.

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