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ITU Internet Report 2006

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For more information on this reports, including the full text of this edition and statistical highlights, visit www.itu.int/digitalife. For previous titles in the series, visit www.itu.int/internetreports.

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

Foreword

This report, entitled "*digital.life*" is the eighth in the series of "ITU Internet Reports", originally launched in 1997 under the title "Challenges to the Network". This edition has been specially prepared for ITU TELECOM WORLD, to be held in Hong Kong, China, from 4-8 December 2006.

Today's digital world has transformed individual lifestyles the world over. The computing industry has long been all-digital, the telecommunications industry is almost fully digital and the broadcasting sector is well on the way to becoming digital. Always-on internet access has become the norm, with people spending more and more time consuming digital media than any other medium. Daily lives from China to Croatia are brimming with SMS, e-mail, chats, online dating, multiplayer gaming, virtual worlds and digital multimedia. Although these technologies mean added convenience and enjoyment for many, regulators and users alike are often a step behind fast-paced innovations in this field. Concerns over privacy and data protection are important examples, as is the role of regulation in relation to content convergence and distribution. Moreover, as the number of channels for service delivery diversifies, the sector's traditional and less traditional businesses face a number of new dilemmas.

The first chapter of the report, *Going digital*, explores the meaning and importance of being digital. Chapter two, *lifestyles.digital*, examines the key technologies and services enabling new digital lifestyles, including higher-speed networks and content distribution. Chapter three, *business.digital*, considers the challenges and opportunities facing businesses in adapting to fast-paced innovation, before addressing whether a fresh approach to policy-making might be required in light of rapid media convergence. Chapter four, *identity.digital*, explores the changing nature of the digital individual and the need for greater emphasis on the creation and management of digital identity. Chapter five, *Living the digital world*, concludes by examining the social impacts of digital technologies and imagining how lifestyles might further evolve in the digital age. The Information Society Statistics in the annex present the latest data and charts for some 206 economies worldwide in their use of digital technologies.

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 telephony and information and communication technologies (ICTs) and embracing the opportunities for telecommunication development that arise from the growth of IP-based services. The ITU Internet Reports are one contribution towards this commitment.

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Data notes

Introduction

A number of economic and regional groupings are used in the report. Economic groupings are based on gross national income (GNI) per capita classifications used by the World Bank. Economies are classified according to their 2004 GNI per capita in the following groups:

Gross National Income (GNI) per capita of:

- Low Income USD 875 or less
- Lower middle USD 876–3'465
- Upper middle USD 3'466–10'725
- High USD 10'726 or more

See the Information Society Statistics in the Annex for the income classification of specific economies.

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

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

Data notes

- Billion is one thousand million.
- Dollars are current United States dollars (USD) unless otherwise noted. National currency values have been converted using average annual exchange rates (unless stated otherwise in the Technical notes; two tables of current prices use most recent exchange rates). Growth rates are based on current prices, unless otherwise noted.
- Thousands are separated by an apostrophe (1'000).
- Totals may not always add up due to rounding.

Additional definitions are provided in the technical notes of the *Indicators Handbook* at www.itu.int/ITU-D/ict/handbook.html. Note that data in some charts and tables referring to the same item may not be consistent and may also differ from the tables shown in the Information Society Statistics in the Annex. This can happen due to revisions to data that occurred after sections of the report were written, as well as different estimation techniques and/or exchange rates. Such variations tend to be insignificant in their impact on the analysis and conclusions drawn in the report. Finally, it should be noted that data generally refer to fiscal years as reported by countries.

Glossary

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

3G: Third-generation mobile network or service. Generic name for third-generation networks or services under the IMT-2000 banner, for example W-CDMA and CDMA2000 1x.

3GPP: Third Generation Partnership Project. A cooperation between regional standards bodies to ensure global interworking for 3G systems.

Actuator: An actuator is the mechanism by which an agent acts upon an environment. The agent can be either an artificial intelligent agent or any other autonomous being.

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.

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

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

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

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.

Broadband: Broadband is defined, for the purposes of this report, as internet access with a minimum capacity of greater or equal to 256 kbit/s in one or both directions (see Technical notes). Fixed broadband is implemented through technologies such as digital subscriber line (DSL), cable modem, fibre to the home (FTTH), metro ethernet, wireless local area networks (WLAN) etc. Mobile broadband is implemented through technologies such as wideband CDMA, HSDPA, CDMA 1x EV-DO, etc.

Broadcast: Point-to-multipoint video transmitted only once over the entire service area.

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

Byte: (1) A set of bits that represent a single character. A byte is composed of 8 bits.

(2) A bit string that is operated upon as a unit and the size of which is independent of redundancy or framing techniques.

CAGR: Compound annual growth rate. See the Technical notes.

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

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

CDMA2000: Code division multiple access 2000. A third-generation digital cellular standard under the IMT-2000 banner, first deployed in Korea, includes

CDMA2000 1x and 1xEV-DO (Evolution, Data Optimized).

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

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

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

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

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

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

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

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

Encryption: The process of converting plain text into code to secure information from being read by unauthorized persons or those without special computing knowledge.

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.

FTTx: generally refers to broadband telecommunications systems based on fibre-optic cables directly to the homes or business.

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

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

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

GPRS: General Packet Radio Service. It refers to a standard for wireless communications that supports a wide range of bandwidths. It runs at speeds up to 115 kilobits per second and is particularly suited for sending and receiving small bursts of data, such as e-mail and Web browsing, as well as large volumes of data.

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

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

standard. The most widespread 2G digital mobile cellular standard, available in over 170 countries worldwide. For more information see the GSM Association website at www.gsmworld.com/index.html.

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

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

HSDPA: High-Speed Downlink Packet Access. An enhancement protocol to W-CDMA networks that allows a higher data capacity in the down link up to 14.4Mbit/s.

HSUPA: High-Speed Uplink Packet Access. An enhancement protocol to W-CDMA networks that allows a higher data capacity in the up link up to 5.76 Mbit/s.

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

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

IM: Instant Messaging. It 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.

IMS: IP Multimedia Subsystem. Framework originally developed by the 3rd Generation Partnership Projects (3GPP and 3GPP2) for their third generation mobile networks.

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

Infotainment: The combination of information on current event and entertainment content or of their formats.

internet: Interconnected global networks that use the internet protocol (see IP).

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

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

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

IPTV: The generic term describes a system where a digital television service is delivered using the Internet Protocol over a network infrastructure.

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

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).

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.

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.

MMS: Multimedia Message Service. MMS will provide more sophisticated mobile messaging than SMS or EMS. A global standard for messaging, MMS will enable users to send and receive messages with

formatted text, graphics, audio and video clips. Unlike SMS and most EMS, it will not be limited to 160-characters per message.

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

NGN: Next generation networks. These are packet-based networks in which service-related functions are independent from underlying transport-related technologies. They are able to provide telecommunication services and make use of multiple broadband transport technologies.

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

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

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

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).

PETS: Privacy enhancing technologies. Either stand alone solutions helping individuals and companies protect their privacy or add-on features designed to enhance the privacy of an existing system.

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.

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.

Robotics: A branch of engineering that involves the conception, design, manufacture, and operation of robots which is a mechanical device that performs a variety of often complex human tasks on command or through advanced programming.

Sensor: A device, such as a photoelectric cell, that receives and responds to a signal or stimulus.

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

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

Skimming: Refers to the unauthorized capture by an intruder of electronic information contained in a chip or tag, such as a passport chip.

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

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

TD-SCDMA: Time Division Synchronous Code Division Multiple Access. A third-generation mobile standard under the IMT-2000 project. It uses spread spectrum CDMA technology in the TDD technique.

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

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

Trust: The property of a system that it will behave in the expected manner for the intended purpose.

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.

UWB: Ultra-Wide Band. Wireless communications technology that can currently transmit data at speeds between 40 to 60 megabits per second and eventually up to 1 gigabit per second. It uses ultra-low power radio signals.

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

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.

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.

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

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

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

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

WMAN: Wireless Metropolitan Access Network. Refers to a wireless communications network that covers a geographic area, such as a city or suburb.

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

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

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

List of abbreviations & 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.

2G	2nd Generation
3G	3rd Generation
CCTV	Closed caption television
COFDM	Coded orthogonal frequency division multiplexing
DAB	Digital audio broadcasting
DMB	Digital multimedia broadcasting
DSL	Digital subscriber line
DVB	Digital video broadcasting
DVD	Digital videodisc
EC	European Commission
EFF	Electronic Frontier Foundation
E-mail	Electronic mail
EPIC	Electronic Information Privacy Organization
ETRI	Electronics and Telecommunications Research Institute
ETSI	European Telecommunications Standards Institute
EU	European Union
EV-DO	Evolution data optimized
FDD	Frequency division duplex
GHz	Gigahertz
GSM	Global System for Mobile Communications
HDTV	High definition television
ICT	Information and communication technologies
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMS	IP multimedia subsystem
IMT-2000	International mobile telecommunications-2000
IP	Internet protocol
IPR	Intellectual property rights
ISO	International Organization for Standardization
ISP	internet Service Provider
ITU	International Telecommunication Union
kHz	kiloHertz
LAN	Local area network

LDC	Least developed countries
MHz	Megahertz
MMS	Multimedia message service
MP3	MPEG-1 Audio Layer-3
MP4	MPEG-4 Part 14
MPEG	Moving Picture Experts Group
NFC	Near Field Communication
OECD	Organisation for Economic Co-operation and Development
P2P	Peer-to-peer
P3P	Platform for privacy preferences
PDA	Personal digital assistant
PKI	Public key infrastructure
PSTN	Public switched telephone network
PTO	Public telephone operator, also public telecommunications operator
SIN	Single identification number
SPU	ITU Strategy and Policy Unit
TDD	Time division duplex
UN	United Nations
URL	Uniform resource locator
USD	United States dollars
W3C	World Wide Web Consortium
Wi-Fi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless local area network
WLL	Wireless local loop
XML	Extensible markup language

chapter one
going digital

1.1 The importance of being digital

We are in the middle of a digital revolution. Around one in every three people on the planet now carries a digital mobile phone around with them wherever they go. Globally, more hours are spent consuming digital media, such as the internet, than any analogue media, including television and radio. Digital technologies are transforming businesses and governments, and changing the ways we live and interact. The 2006 ITU TELECOM WORLD event, in Hong Kong, China (4-8 December 2006) for which this report has been prepared has the tagline "Living the Digital World". But what does it mean to be "digital"?[1]

In a sense, humans have always been digital, but this magical word "digital" needs some demystification. The word "digital" arises from the Latin "*digitus*", meaning "finger". This, then, is its first meaning. Fingers have always been used to signal, among other things, numerical data such as number and quantity. Later, the notion of a number, as expressed by the finger, was transferred to the written or oral symbol, i.e. number or digit. This is the second meaning. The decimal system, or the system based on ten digits, is the one most of us use and are familiar with.

From days immemorial, the digits of the hand have been used to create, to innovate, and to communicate. And just as they were used to represent discrete numbers, in recent times, a system of discrete binary digits (limited to the two digits: zero and one) has been developed to which all transmissible data can be reduced. This binary digit system is the modern and third meaning of this widely used word. Otherwise stated, in ordinary technological parlance today, when speaking of "digital", we mean machines capable of recording, transmitting, or receiving data in binary digit form.

The various advantages of the use of this method for data storage and transmission are discussed further in this publication. In this context, it is striking that smoke signals and even the Morse and Murray codes relied upon the binary idea (off and on, dot or dash). And one may say that, in this sense, technology has come around full circle.

Digital technologies have been crucial in the distribution of knowledge and information, which many argue are at the core of power in society. Through the use of communication technologies like the internet and the mobile phone, the reach of our relatively short digits has been extended to a much larger sphere—that of the global digital world.

1.1.1 The rule of the thumb

As a digit, the human thumb (also known as pollex) merits special attention. It is unique in that it has much more freedom of movement and is opposable to the tips of all of the other fingers. This has distinguished human beings from other members of the animal kingdom, including primates. Charles Darwin pointed to the pivotal role of the opposable thumb in the evolution of the human species[2].

In English, the alternative word for "thumb" is "*pollex*", from the Latin. In Latin, the derivation of the

latter from "*polleo*" meaning "powerful" is significant, revealing the singular importance assigned to this digit. In Roman times, the thumb was used in many aspects of culture–it played a prominent role for the preparation of medicines[3] and in voting for death in the gladiatorial arena.

The Greeks were no less attached to their thumbs, calling them "*αντιχειρας*" or "*anticheir*" meaning "another hand"[4]. If one is adept at making plants grow, one is said to have a "green thumb". As Isaac Newton once remarked–"in the absence of any other proof, the thumb alone would convince me of God's existence". Indeed, in many cultures, the thumb has become a vital tool for social relationships. In Europe and the Americas, it is used for hitchhiking or as a signal for victory, agreement, or going ahead ("thumbs up"). In India, the thumb has long been used by priests, and other authorized persons, to place the sacred mark on the forehead.

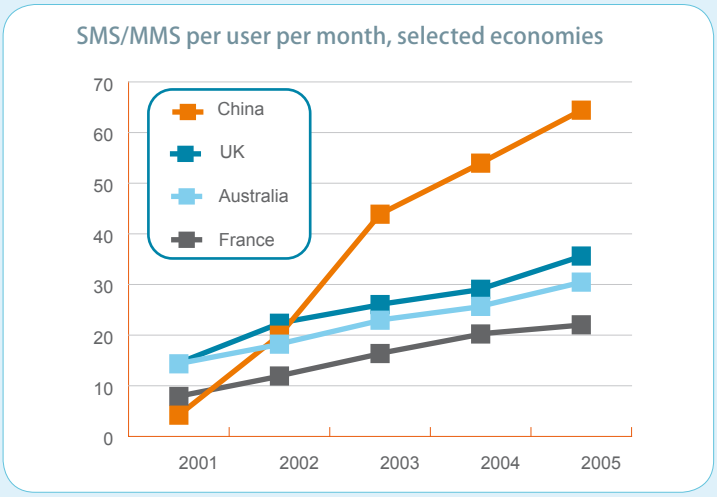
Today, the thumb can be seen as a cementing force in human society. From the narrow streets of Varanasi (India) to the wide avenues of Barcelona (Spain), people are regularly seen walking, eating, talking and even driving while their thumbs busily tap on the keypads of handheld digital devices. As an industry sector, messaging on mobile phones has in the space of just a few years become a global industry generating around USD 80 billion annually in revenue[5]. Interestingly, it has also taken off faster in some developing countries, like China or the Philippines, than in many developed countries (figure 1.1 and box 3.2). Expressions like "thumb culture" and "thumb tribes"[6] are widespread, as the mobile phone gets closer to the human body[7], providing a digital extension of the physical self.

Due to the thumb's important role in digital messaging (and also gaming), it has been observed that it is replacing other digits in different categories of tasks, from pointing to ringing doorbells, e.g. in countries like Japan[8]. So it is no wonder that people have been known to complain of the occasional repetitive strain injury due to overuse[9]. In his book "The Singularity is Near"[10], Ray Kurzweil talks about the role of this important digit in enabling humans to evolve far ahead of animals, allowing them to experiment and build things. The thumb has long been a catalyst for innovation and invention, and it seems it will continue to be so for some time to come.

1.1.2 From digits to digital

Digital technologies, as they are known today, have radically transformed businesses and individual

Figure 1.1: Thumb culture
Growth in SMS/MMS usage in selected economies, 2001-2005



Source: ITU, adapted from Eurostat, OECD, OFCOM, China Mobile, China Unicom

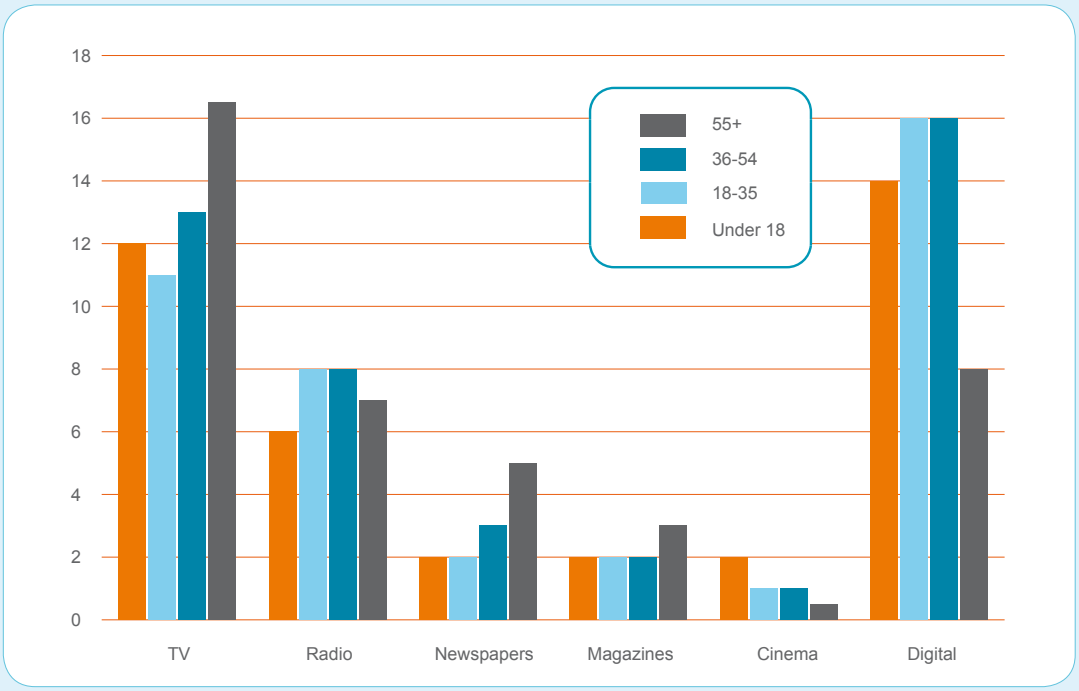
lifestyles alike. Storage and communications have been made much more efficient. The digitization of information also makes it more easily transferable between media, reduces information loss, and is more suitable for remote or distributed access. Underlying these developments was the microprocessor—a catalyst for technological development and at the heart of Moore's law, which stipulates that processing power will double every 18 months. The internet, especially since the creation of the World Wide Web (WWW), has allowed humans to create and share information and knowledge instantly on a global scale. The advent of digital mobile technologies was an equally revolutionary development, as technologies like GSM and CDMA heralded the dawn of an entirely new world of digital individuals who, even on the move, remain constantly networked and connected.

The use of digital techniques offers a number of advantages over the analogue equivalent:

- Digital techniques can enable large numbers of copies to be produced at low cost;
- Digital copies are more faithful to the original;
- Digital media makes it easier for virtually anyone to create, save, edit, and distribute any document or part thereof;
- Digital storage allows a greater volume of information to be stored and made available with the same resources;
- Digital signals are more robust and less vulnerable to static and noise or degradation over time;
- Digital technologies enable greater speeds of communication, a higher number of channels and frequencies, and a higher resolution of images and sounds.

Not surprisingly, the global consumption of media today is primarily in digital form, with those under the age of 55 spending more time consuming digital media than any other type of media, including traditional television and radio (figure 1.2). Broadband is leading to more diverse and

Figure 1.2: Going digital
Global consumption of media during leisure time by age group (hours per week)



Source: Adapted from *Financial Times*, "Advertisers in search of revenues look to web's latest heroes", 23 August 2006, based on figures from Nielsen/Net Ratings & Credit Suisse

on-demand content services. Moreover, digital platforms are being used for banking and other transactions: from e-commerce to new mobile payment systems. We are witnessing what has been termed a "digital revolution", which had its beginnings in the early 1980s and refers to the replacement of analogue devices and services with their digital successors. This technological shift has brought about considerable change in the human condition itself, especially in its socio-economic and cultural aspects.

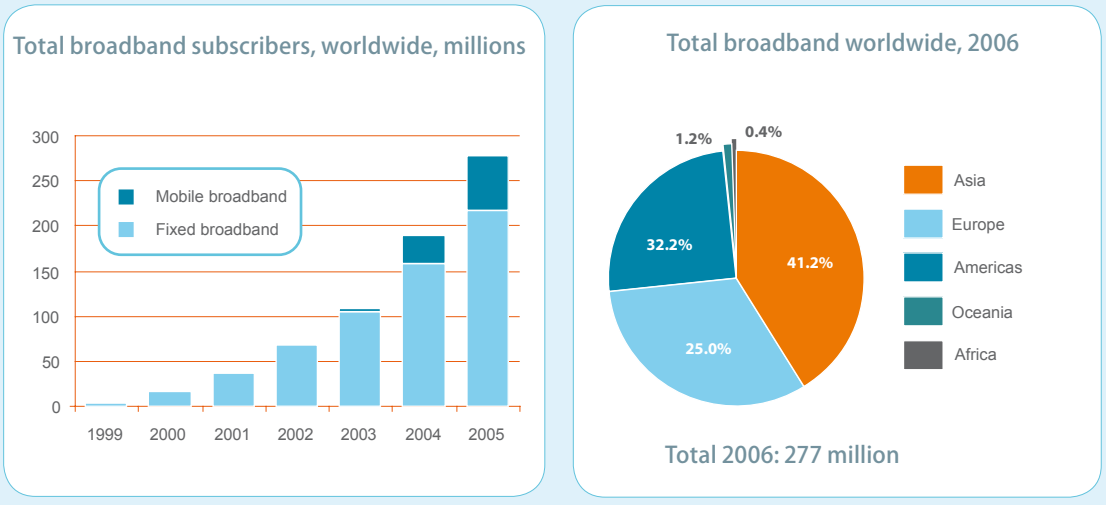
The transition from narrowband to broadband[11] digital networks (figure 1.3) is now well-advanced in the fixed-line world where there were some 216 million broadband subscribers across the world at the end of 2005 (see data table 6), amounting to just over half the total number of internet subscribers and around one-fifth of total fixed lines. In the mobile network, the transition to broadband has been slower, but as of the end of 2005 there were just over 60 million mobile broadband users in around 60 different economies, representing almost three per cent of total mobile users (see data table 4).

1.2 Digital, invisible and ubiquitous

The next step in the digital revolution is digital ubiquity. Technical innovation based on advances in, *inter alia*, radio-frequency identification (RFID) and sensor technologies, are giving rise to a new paradigm for the digital age, in which information and communications capabilities would be invisibly embedded in the environment around us. In this future "internet of things"[12], mundane daily tasks would be fully automated and no longer require manual input. Technology would seem to slowly fade and disappear from the consciousness of the user. This notion of "ubiquitous computing", which was first expounded by Mark Weiser, points to the "invisibility" of technology through the transformation of everyday items into tiny computers[13]. We should thus expect to see the computer, which has already transformed itself from the mainframe (one computer for many people) to the personal computer (one computer per person), to proceed to the phase of the ever-present (ubiquitous) computer (many computers per person) (figure 1.4).

Figure 1.3: Broadening the scope

Development of broadband networks, worldwide, 1999-2005 and by region, 2006

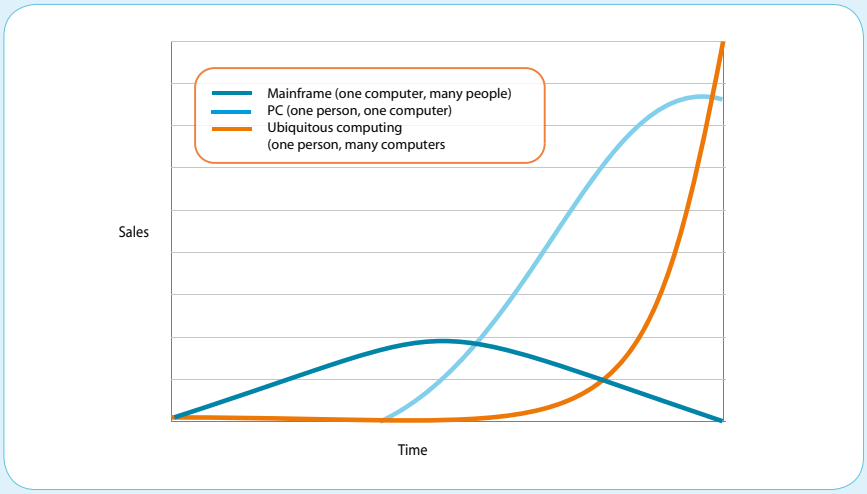


Note: "Broadband" in this context means networks offering capacity equal to or greater than 256 kbit/s in one or both directions. For mobile services, this includes W-CDMA, CDMA 1x EV-DO and CDMA 1x EV-DV. For fixed-line broadband it includes DSL, cable modems, metro ethernet, fixed wireless access, fibre to the home, etc. (see Technical notes).

Source: ITU Information Society Statistics Database (see data tables 4 and 6)

Figure 1.4: The ubiquity of digital

From one computer for many people to many computers for one person



Source: Adapted from Ignas G. Niemegeers, "The Invisible Network", TU Delft, 2005

People today have a large number of personal devices that they carry around with them daily, what with laptops and mobile phones, digital cameras and portable music players, to name the popular items. One out of every three human beings on the planet is a mobile user[14], and more and more mobile phones are coming equipped with digital cameras and music-playing capabilities. As such, the mobile phone has begun to resemble a pocket computer more than a telephone. Household appliances have also begun taking a similar route, with audio/video devices embracing digital and processing capabilities, together with other white goods such as fridges and ovens. Not only is the workplace being increasingly equipped with digital information and communication technologies, but so too are our cars and homes. Passengers in moving vehicles might enjoy internet access and digital television, before heading home to a fridge stocked with fruit juices pre-ordered via the internet, and an oven that has been pre-set to cook a casserole.

1.3 Digital dilemmas, digital dexterity

As the world becomes increasingly digital, new challenges and important dilemmas arise for businesses and policy-makers. Private individuals, too, are faced with a bewildering number of choices for their information and communications needs.

For businesses, one of the main areas of concern is deploying services that are of interest to the end-user, while providing an adequate return on investment. In this context, customer retention is more to the point than customer acquisition, at least in the long-run and particularly in markets nearing saturation.

A level-playing field is considered to be vital to stimulating investment, affordability and innovation. This holds no less true for the information and communication sector. As such, policy-makers have been increasingly relying on general principles of competition policy to ensure that incumbents do not possess undue advantages over their competitors and that new entrants are not squeezed out of the market. In an era of digital convergence, these tasks are rendered all the more complex, due to services having to be delivered through a complex array of channels and media. Moreover, deriving value from these services is no longer as straightforward as it has been in the past, when there was typically one network per service provided. In today's multi-service and multi-network environment, operators and service providers are faced with important choices: collaboration, competition, innovation or a combination?

Nowhere is this more evident than in the content market. The role of content provider, network operator and service provider are not yet distinctly clear and this is so not only among businesses themselves, but also among regulators and industry watchdogs. For instance, the allocation and degree of responsibility for content transmitted over a network remains a grey area. Both regulators and businesses need added flexibility and dexterity in dealing with these new and important issues. Change, which lies at the very foundation of the new digital world, will be a constant driving force and will require continuous adaptation and rapid response.

As always-on digital access becomes the norm, users must learn to manage a new digital lifestyle—both in terms of the benefits it yields but also the threats it poses. One of the most important areas in this regard is the protection of privacy and identity. In the digital world, there are times when people need to represent themselves accurately and securely, for instance, for the purposes of e-commerce. However, there are other circumstances in which people may want to have the freedom to project a persona in cyberspace which is quite different to that in the real world. Being able to distinguish between the two in a manner which is predictable, proportional, manageable, and socially acceptable is important for maintaining human dignity in an ever deepening sea of digits.

1.4 About this report

This report, entitled digital.life, is the eighth in the series of ITU Internet Reports. The reports series, which was launched in 1997, has been tracking the development of the internet worldwide. This edition focuses on consumers and looks at how human lives are being shaped and re-shaped by advances in digital technologies:

- Chapter two, lifestyles.digital, begins by examining the underlying technological enablers of new network infrastructures and content diversification;
- Chapter three, business.digital, considers how businesses are adapting to fast-paced digital innovation, how digital access can be extended to underserved areas, and how policy-making might need to adapt in light of rapid media convergence;
- Chapter four, identity.digital, explores the changing nature and role of the digital individual and of digital identity (both abstract and practical) as human lives become increasingly mediated by technology;
- Chapter five, living the digital world, concludes by putting forth a number of important challenges to be addressed, and imagining how our lifestyles might evolve in the digital age.

The Information Society Statistics in the annex to the report present the latest available data for more than 200 economies worldwide in terms of their use of digital information and communication services.

Endnotes for Chapter one

1 "Being digital" was the title of a seminal book by Nicholas Negroponte published in 1995.

2 Charles Darwin, The Descent of Man, 1871.

3 Anthony Corbeill, Nature Embodied: Gesture in Ancient Rome, Princeton University Press, 2004.

4 Michel de Montaigne, "Of Thumbs", Essays, 1533-1592.

5 There are many different and wildly varying estimates of the size of the global market for SMS and MMS traffic. For instance, Portia Research estimate the global market for mobile messaging to have been worth USD 55bn in 2005 (see www.portioresearch.com/Mob_Mess_Fut_brochure.pdf). IMImobile estimates that 92 billion SMS/MMS were generated each month in 2005 (see www.imimobile.com/whitepapers/MMSC%20Whitepaper.pdf#search=%22sms%20market%20size%22). The GSM Association estimates a total of one trillion SMS were sent during 2005 (see www.gsmworld.com/services/messaging.shtml). At a conservative estimate of USD 0.08 per message, this generates a total market size of USD 80 billion. The global average price for an SMS was around USD 0.12 in 2006 (see data table 3).

6 Howard Rheingold, Smart Mobs: The Next Social Revolution, Perseus Books, 2002.

7 Lara Srivastava, "Mobile manners, mobile mania", in P. Glotz, S. Bertschi, C. Locke (eds), Thumb Culture: The meaning of Mobile Phones for Society, Transcript, 2005.

8 Sadie Plant, On the Mobile, Motorola, 2002.

9 New York Times, "All thumbs, without the stigma", 12 August 2004.

10 Ray Kurzweil, "The Singularity is Near: When Humans Transcend Biology", Penguin Group, 2005.

11 In this content, "broadband" is defined as a network offering a combined speed of equal to, or greater than, 256 kbit/s in one or both directions.

12 ITU Internet Report 2005: The Internet of Things, November 2005 (available at www.itu.int/internetofthings).

13 Mark Weiser, The Computer for the 21st Century, Scientific American, September 1991.

14 ITU Information Society Statistics Database. There were 2.17 billion mobile phone subscribers in January 2006.

chapter two
lifestyles.digital

This chapter examines the key digital enablers that constitute the platforms for our new digital lifestyle. It discusses how digitization has changed the way we communicate and the astonishing growth in digital content worldwide, generated both by companies and end-users themselves. It ends with an exploration of promising recent developments in the area of digital transactions.

2.1 Digital enablers

Long anticipated, digital convergence is now becoming a reality in many areas. Formerly segregated user services are merging due to network convergence between fixed line and wireless networks. Advances in connected computing will further enable networks of composed of millions of tiny devices with the ability to compute and to communicate via the internet. Media convergence is generating new avenues for distributing digital entertainment. User devices, as the entry point for these networks, are transforming into multi-functional gadgets but, at the same time, allowing for more personalization of features. The process of digital transformation, driven by technology and innovation, is only just beginning.[1]

2.1.1 From narrowband to broadband

Faced with the relentless growth in demand for bandwidth across all types of network, operators are pushing for ever more powerful infrastructure. "Broadband" connections, on both fixed and mobile networks, are becoming the norm in the industrialized world and beyond. As of the end of 2005, some 166 economies had launched fixed-line broadband services (figure 2.1, left chart) and a further 60 or so economies had launched mobile broadband services (see data table 4). In both fixed line and cellular markets, the transition to higher capacity networks is accompanied also by a shift to IP-based networks.

2.1.2 Mobile broadband

The number of mobile phones users worldwide passed the 2 billion mark in late 2005. While it took around 21 years to reach the first billion users, the second billion signed up in just the three years (figure 2.2). By contrast, it took some 125 years to reach the first billion fixed lines users. In the cellular industry, the evolution from second to third generation networks is arguably just as important as the jump from analogue to digital (which took place more than a decade ago) and is proceeding much more rapidly. By the end of 2005, the number of subscribers to 3G mobile networks of broadband speed (equal to or greater than 256 kbit/s in one or both directions) was just over 60 million and a further 50 million or so were added during the first six months of 2006, passing the 100m subscribers mark.[2] This is a significant milestone and illustrates that this technology is approaching maturity.

Although 2G networks are adequate for voice, there is a growing interest in shifting from 2G to 3G, based on a number of important drivers. First, the higher speed of 3G technologies translates into added convenience, capacity and functionality for the user. Second, there is much excitement over adding IP capability, and hence internet access, to the mobile phone. 3G networks also use the spectrum more efficiently, and support a family of global standards to facilitate roaming. In developing 3G standards, ITU worked with regional bodies and industry associations to reduce a large number of initial proposals to a smaller number of global standards (the IMT-2000 family[3]) to ensure interoperability.

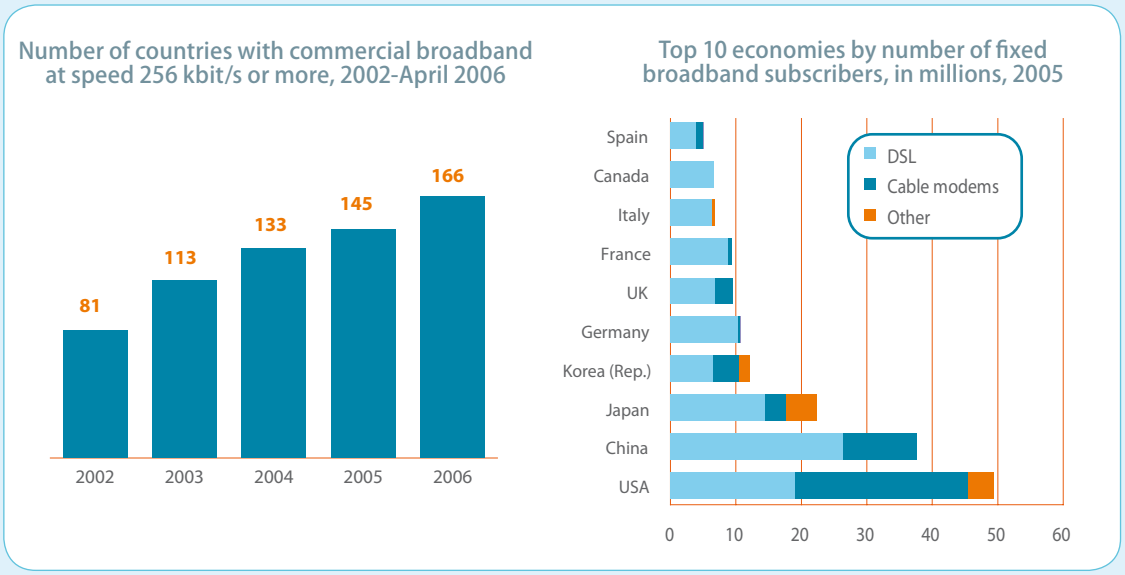
The goal of the IMT-2000 project was to harmonize different radio interfaces and produce a single family of 3G standards that would be able to cover future value-added services and applications. Three different access technologies (TDMA, CDMA and FDMA) for five radio interfaces were included in the IMT-2000 family. Most 3G deployments to date have used one of two interfaces, CDMA 2000 and W-CDMA (also known in Europe as UMTS). China has chosen a third interface, TD-SCDMA, for its national deployment of 3G mobile. GSM EDGE handsets are also now available in many countries, but because of the methodological difficulty in tracking sales of handsets, consideration of EDGE is not covered in the statistics presented here.

W-CDMA (wideband code division multiple access)

Although 3G mobile services are a new departure for mobile communications, in practice, W-CDMA is perceived as the logical upgrade for GSM, which is the dominant 2G mobile standard worldwide with over 80 per cent of the installed base and more than two billion users worldwide[4]. In fact, W-CDMA has been dubbed "3GSM" for marketing purposes. W-CDMA was launched in Japan in 2001, when NTT DoCoMo launched its FOMA service. W-CDMA initially experienced a slow start in the global market, due to the high costs of building an entirely new network and some early difficulties in standardizing handsets and manufacturing them in bulk at a price that is competitive with 2G handsets. A further constraint, especially in Europe, was the huge amount of money committed by operators to obtain their 3G licenses at auctions. The value of licences exceeded USD 100 billion in Europe alone,

Figure 2.1: Building the broadband platform

Number of economies offering a commercial fixed-line broadband service, 2002-2006, and top ten broadband economies, 2005



Note: The charts cover fixed broadband services, at capacity equal to or greater than 256 kbit/s in one or both directions (see Technical notes).

Source: ITU World Information Society Report 2006 (left chart) and ITU Information Society Statistics Database (right chart)

and this was committed during the early part of the current decade and coincided with the bursting of the *dot.com* bubble, which saw billions of dollars wiped off the value of ICT companies (see chapter three).

Despite these early difficulties, W-CDMA has subsequently grown more rapidly and now constitutes around 60 per cent of the mobile broadband market (figure 2.3). It is the preferred technology in Europe and shares the market in Asia. W-CDMA is theoretically able to achieve a data rate of 2 Mbit/s for low-mobility environment, and 384 kbit/s for mobile systems and therefore fits within the adopted definition of "broadband". These speeds are adequate for downloading music and video to a handset. However, speeds achieved in the laboratory are not always matched in actual use.

For this reason, W-CDMA operators in many economies are already pressing ahead with a further upgrade to HSDPA (high-speed downlink packet access), a W-CDMA enhancement that promises to boost the download rate to a theoretical maximum of 14 Mbit/s. HSDPA is a software upgrade that can be deployed rapidly and cost effectively without the need for substantial infrastructure investment. It doubles network capacity, making the transmission of everything from voice calls to video pictures more efficient. HSDPA can boost download speeds as much as fivefold (box 2.1). An estimated 44 HSDPA networks were in service, and a further 70 networks were planned, in deployment or in trial by August 2006[5].

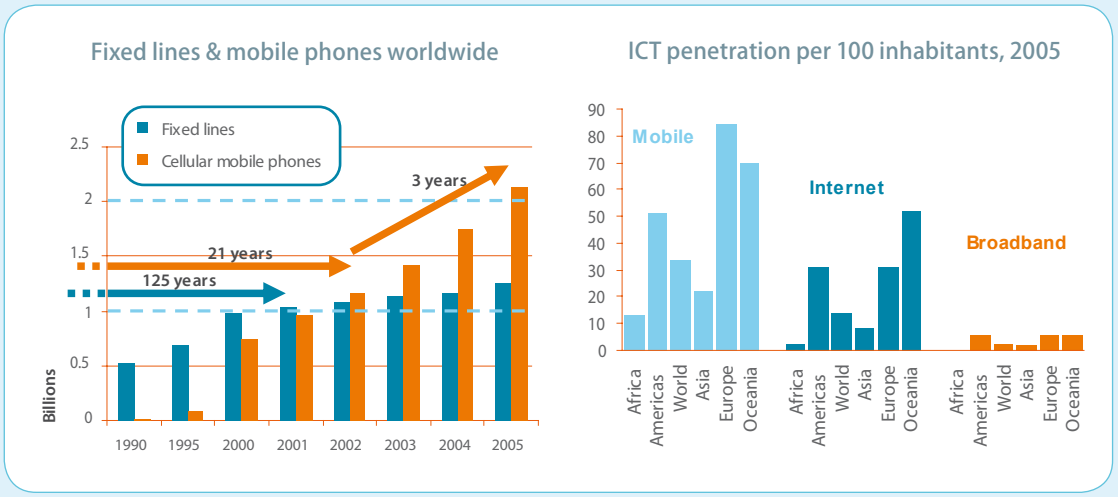
As the download speed of networks increases, user demand for higher speeds also increases, with users wishing not only to receive, but also transmit, more music and video. High-speed uplink packet access (HSUPA), as its name suggests, is the twin of HSDPA, offering uplink capacity of up to 5.76 Mbit/s. It provides a more efficient procedure for sending data through W-CDMA devices, ideal for data-intensive symmetrical data communications such as video over IP and interactive multimedia.

CDMA 2000 1x

In the same way that W-CDMA is perceived as the logical upgrade for 2G GSM networks, CDMA 2000 is the logical upgrade for 2G CDMA networks. CDMA2000 is also a member of the IMT-2000 family. The most widely deployed version—CDMA 1x—was the early winner in the race to 3G since the existing CDMA network, IS-95, can be relatively easily upgraded to CDMA2000 1x without requiring mobile network carriers to invest heavily in new infrastructure.

Figure 2.2: Beyond the first billion

Penetration rates of main fixed line and mobile networks, worldwide and by region



Source: ITU Information Society Statistics Database

Box 2.1: High-speed wireless internet: not the preserve of the rich world

HSDPA deployment in townships in South Africa where fixed-line connections are lacking

MTN, a mobile operator based in South Africa, is using HSDPA to provide a high-speed connection to a local entrepreneur's payphone shop in the Alexandra township near central Johannesburg—one of the first 'internet cafes' in the world to use HSDPA. People renting time on the computers situated in the booth will be able to access the internet at speeds of up to 1.8 Mbit/s. Another nine sites are connected to the internet via a GSM EDGE network, allowing download speeds at about 120 kbit/s.

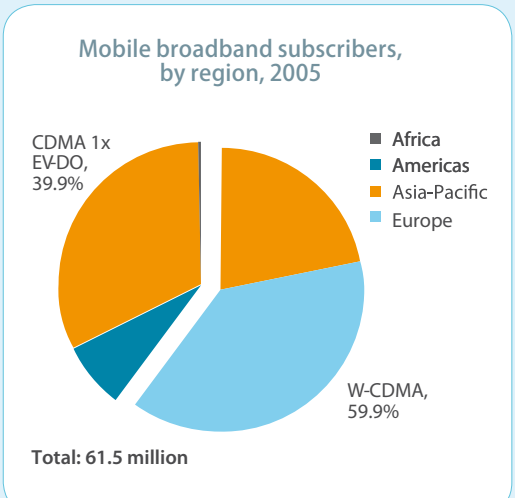
The early rollout of high-speed internet services by South African mobile operators demonstrates that technologies, such as HSDPA, are not solely the preserve of affluent developed countries and that mobile networks can bring far more than voice and text services to people in developing countries. To help accelerate the take-up of 3G in both the developing world and the developed world, the GSM Association recently launched a '3G for all' programme designed to make 3G services and handsets more affordable.

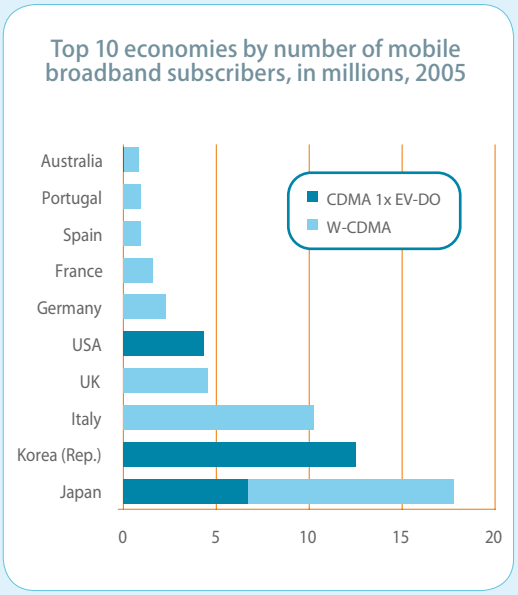
Image source: sxc.com

Source: mobileafrica.net

Figure 2.3: Broadband goes mobile

Breakdown of mobile broadband networks, by technology, and top ten mobile broadband economies, 2005





Note: Mobile broadband is defined here as services offering a minimum speed equal to, or greater than, 256 kbit/s in one or both directions.

Source: ITU Information Society Statistics Database

The world's first commercial IMT-2000 (3G) system was launched by SK Telecom (South Korea) in October 2000 using CDMA20001x. According to the CDMA Development Group, by mid 2006 there were some 164 commercial CDMA2000 systems serving more than 275 million users worldwide[6].

CDMA 2000 1x EV-DO

Although CDMA 1x is a part of the IMT-2000 family, it does not qualify as a mobile broadband system in that it offers capacity of below 256 kbit/s (see table 2.1). In order to compare the CDMA family with W-CDMA, it is more accurate therefore to compare CDMA 1x EV-DO (Evolution Data-Optimised). All of these networks require a major system upgrade or a radio overlay network, covering both hardware and software, and offer similar transmission speeds. ITU estimates that CDMA 1x EV-DO constitutes around 40 per cent of the global market for mobile broadband, and is currently the dominant technology in the USA and the Republic of Korea (figure 2.3). More information about CDMA 1x and the various releases is available in Table 2.1.

Table 2.1: The CDMA 1x family
CDMA 2000 1x standards and data rates

Standard	Data rate	Description
1x	Max. 153kbit/s (Release 0) or 307kbit/ s (Release 1) in a single 1.25 MHz channel.	Nearly doubles the voice capacity of 2G CDMA networks.
1xEV-DO Release 0	Theoretically up to 2.4 Mbit/s. In commercial networks it delivers 300-600 kbit/s on average in a single 1.25 MHz channel.	Supports advanced data applications, such as MP3 transfers, video conferencing, TV broadcasts, video and audio downloads. Commercially available since 2002.
1xEV-DO Revision A	Up to 3.1 Mbit/s on the downlink and 1.8 Mbit/s on the uplink, with quality of service (QoS) controls to manage latency on the network.	With Rev A, operators are able to introduce advanced multimedia services, including voice, data and broadcast over all-IP networks in commercial service now.
1xEV-DO Revision B	Forward link: 73.5 Mbit/s; Downlink: 27 Mbit/s. Combines fifteen 1.25 MHz carriers in a 20 MHz band. A single 1.25 MHz carrier and an aggregated 5 MHz carrier in the forward link will deliver a peak rate of up to 4.9 Mbit/s and 14.7 Mbit/s, respectively.	In addition to supporting mobile broadband data and OFDM-based multicasting, the lower latency characteristics of Rev B will improve the performance of delay-sensitive applications such as VoIP, push-to-talk over cellular, video telephony, concurrent voice and multimedia, and massive multiplayer online gaming. Rev B will be commercially available in 2008.

Source: CDMA Development Group

TD-SCDMA (time division synchronous code division multiple access)

The third main 3G mobile standard, which is recognised by ITU as part of the IMT-2000 family of standards, is TD-SCDMA (Time division synchronous code division multiple access). Time division multiplexing alternates time slots for sending and receiving data. As of October 2006, there were no commercial deployments of TD-SCDMA, but China has endorsed the standard. China has the world's largest mobile market, with some 395 million users at the end of 2005. This gives China tremendous bargaining power in shaping future mobile standards worldwide. It also means that Chinese manufacturers can achieve economies of scale just by serving their domestic market. A home-grown standard also benefits local equipment vendors by reducing the payment of royalties and patent fees.

2.1.3 Fixed broadband

The proliferation of new internet services, such as audio and video streaming, has boosted commercial and household broadband demand, stimulating infrastructure investment for fixed broadband, just as it has for mobile, albeit in a different way. The number of fixed broadband users surpassed the 200 million mark worldwide in late 2005, and broadband subscribers now outnumber narrowband internet subscribers (e.g. dial-up) on a global basis (figure 5.2). The preferred technologies are xDSL and cable modems which together accounted for around 94 per cent of the fixed broadband market at the end of 2005 (see data table 6). However, some of the fastest growth is now in other broadband technologies, in particular fibre to the home, office, curb and so on (FTTx).

Digital subscriber line technologies (xDSL)

The dial-up modem is being made obsolete by its speed limitations (typically 56 kbit/s). The Integrated services digital network (ISDN), at speeds of up to 144 kbit/s, offered some improvement, but generally not sufficient to make up for the higher price. Instead, an increasing number of users are moving directly from dial-up to digital subscriber line (DSL) technology, which uses the same twisted-pair copper telephone lines, but offers much higher speeds, suitable for multimedia and video applications. DSL deployment began in 1998, with the Republic of Korea taking an early lead which it has since maintained. The term xDSL covers a number of flavours of DSL technology, including ADSL, SHDSL and VDSL (see table 2.2).

The most popular DSL technology is ADSL (asymmetrical digital subscriber line) which has the bandwidth provision slanted in favour of downstream traffic. This asymmetry, combined with always-on access, makes ADSL ideal for web-browsing, file downloads, video-on-demand, remote LAN access etc. These applications typically have much greater download traffic than upload.

Basic ADSL can transmit at up to 6 Mbit/s to a subscriber, and a further 640 kbit/s for uplink, depending upon the distance of the subscriber from the nearest exchange, although these high speeds are rarely offered commercially (typically, commercial ADSL speeds are below 3 Mbit/s). In 2002, ITU-T completed the revision of new international ADSL standards, introducing ADSL2 (ITU G.992.3 and G.992.4) and bringing new features and functionality to improve performance and interoperability. ADSL2+ (G.992.5) doubles the downstream bandwidth and increases the data rate on telephone lines up to almost 3 kilometres. ADSL2+ specifies a downstream bit rate of up to 16 Mbit/s, resulting in a significant increase in data rates for subscribers close to the exchange. ADSL2+ also includes an optional mode that doubles the upstream data rate.

Cable modem service

Cable TV service has been widely available since the 1950s in the United States, Canada and some other countries, where it has a high penetration rate. Cable modems use the existing cable TV networks and coaxial cable to give subscribers

Table 2.2: The flavours of DSL
Description of selected xDSL technologies with data rate

xDSL	Description	ITU Recommendation	Net data rate
SHDSL	Single-pair high-speed digital subscriber line	G.991.2	192 kbit/s to 2.312 Mbit/s
ADSL	Asymmetric digital subscriber line	G.992.1	1.5 to 6.1 Mbit/s downstream 16 to 640 kbit/s upstream
ADSL2	Asymmetric digital subscriber line	G.992.3	up to 8 Mbit/s downstream up to 800 kbit/s upstream
ADSL2+	Asymmetric digital subscriber line 2+	G.992.5	up to 16 Mbit/s downstream up to 800 Mbit/s upstream
VDSL2	Very high-speed digital subscriber line 2	G.993.2	up to 100 Mbit/s downstream up to 100 Mbit/s upstream

Source: ITU

internet speeds of up to 1.2 Mbit/s theoretically. Cable modems account for around 30 per cent of the installed base of broadband users worldwide and they are the dominant technology for fixed broadband in North America.

However, as a means of providing broadband internet, cable modems have several shortcomings. First, cable networks are not widely available in most countries. Furthermore, the maximum speed claimed for cable is purely theoretical. In practice, cable modem services operate on the same principle as local area networks, i.e. the available capacity is shared between all connected users at any one time, to the cable head end. This means that performance is highly variable.

Fibre (FTTx)

The maximum upstream speeds delivered by DSL diminish as local loops gets longer. In view of the growing demand for bandwidth-hungry applications, some operators are now turning to very high-speed internet technologies, deploying fibre optics (already the technology of choice for the inter-urban network) in the access network. Fibre in the access network may either reach directly to the subscriber or to a nearby node (e.g. curb), with the last part of the link still over going twisted copper pair (see table 2.3).

FTTH (fibre to the home) was introduced in Japan in 1999, and by 2005 new FTTx subscribers outnumbered new DSL subscribers in that country. In the United States, 2.3 million households had access to FTTx at the end of 2005[7]. In Germany, Deutsche Telekom has announced plans to invest around USD 3.8 billion to deploy FTTN (fiber to the neighbourhood). One important regulatory issue is whether incumbent operators should be obliged to unbundle fibre in the access network and allow market entry by competitive service providers, as has happened in many countries with DSL unbundling. There is a fear, on the one hand, that unbundling fibre would deter fresh investment, and on the other hand, failing to oblige unbundling would create a new natural monopoly, in that it is hard to foresee residential applications that would require more than one fibre network supplier.

There are a number of other ways of providing broadband from fixed connections, including metro ethernet (also known as apartment LANs), broadband by satellite, fixed wireless access and so on. The most promising of these alternative technologies use wireless means, but without the use of cells to support roaming. They are neither strictly "fixed" nor "mobile" and can better be described as being "portable". These are discussed further below.

2.1.4 Portable internet

Wireless local area networks (WLAN)

In general terms, 3G cellular mobile services provide a high level of user mobility but a lower speed of connection, while fixed-line broadband services provide only limited mobility but a higher speed of connection. Between these two, "portable internet" technologies provide a better level of mobility than fixed services but a higher level of connectivity than cellular services. One of the first portable internet technologies was the wireless local area network (WLAN), based on the IEEE 802.11 family of standards (see table 2.4). The most popular is based on IEEE 802.11b and is known as Wi-Fi (wireless fidelity).

Wireless LANs use electromagnetic waves to transmit and receive data over short distances. In a typical WLAN configuration, mobile devices connect to a fixed broadband network via radio links with an "access point". However, as the technology develops, it is possible that some parts of the fixed network could be replaced with wireless technology. Also, in isolated regions, WLAN connectivity could be provided in tandem with a VSAT, a very small aperture terminal (box 2.2).

WLAN technology is particularly popular with home users, where it allows a broadband connection to be shared among several computers and devices scattered around the house. WLAN hotspots can also be found in airports, cafés and other public places. Although originally designed for short-range network connection, in developing countries WLANs are increasingly being used as backbone telecommunication infrastructure[8].

However, WLANs have a number of limitations, mainly related to their restricted geographical coverage. The growth of WLAN usage has also

made network security a problem. WEP (or wired equivalent privacy) was the original security scheme, but it could be cracked in less than a day of heavy traffic, using freely available programs such as AirSnort or WEPCrack. The Wi-Fi Alliance has since released an enhanced security scheme called Wi-Fi Protected Access (WPA), using much stronger encryption. Still, even this is not immune from hacking.

Wireless metropolitan area networks (WMAN)

Driven by the interest in WLAN hotspots, a number of more ambitious projects linking a metropolitan area with WLAN hotspots have been launched.

Wireless metropolitan area networks (WMANs) provide broadband internet access for fixed and mobile devices via base stations connected to a core network. They offer a low-cost, uncomplicated alternative to fixed-line infrastructure. To extend coverage, there are several approaches. One is to use numerous WLAN access points to cover a city. Another is to increase the signal power of the base stations greatly so as to reach mobile devices even at a considerable distance. This is the concept behind WiMAX and WiBro, which offer an interesting perspective for the future ubiquitous network.

IEEE 802.16 (WiMAX)

The initial specification for WiMAX (worldwide interoperability for microwave access or IEEE 802.16) was published in March 2002. WiMAX has been designed to transmit up to 70 Mbit/s over a maximum range of 50km. The service aims to offer users with laptops, PDAs or mobile handsets a high-speed internet link. It was in December 2005 that the IEEE ratified the 802.16e amendment to the 802.16 standard. Currently, there are more than 200 WiMAX trials underway around the world. WiMAX promises a cost-effective fixed wireless alternative to cable and DSL, allowing countries with limited fixed-line infrastructures to achieve broad connectivity with a high-speed network, without the need for large infrastructure investments. Although WiMAX is of particular interest to developing countries, as an alternative to fixed-line infrastructure, it can also be attractive in industrialized countries, particularly in densely populated areas like large urban centres (box 2.3).

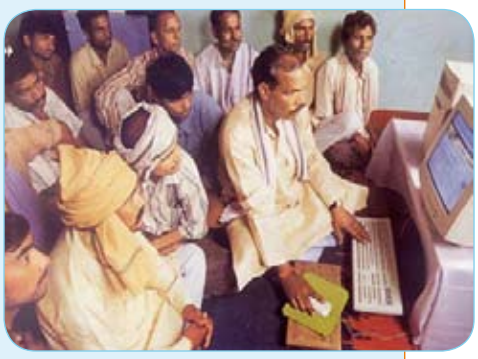
WiMAX is expected to be complementary to other wireless and wire-based technologies. For instance, it can complement WLAN networks, which are more suitable for high-volume indoor use, by providing wider coverage when outdoors. The specification has been enhanced to allow vendors to incorporate dual-mode chipsets in mobile devices, to support both technologies. In addition,

Table 2.3: The IEEE 802.11 family
A selection of different IEEE 802.11 technologies

Protocol	Release date	Frequency	Bandwidth
IEEE 802.11	1997	2.4 GHz	1, 2 Mbit/s
IEEE 802.11a	1999	5 GHz	6, 9, 12, 18, 24, 36, 48, 54 Mbit/s
IEEE 802.11b	1999	2.4 GHz	5.5, 11 Mbit/s
IEEE 802.11g	2003	2.4 GHz	6, 9, 12, 18, 24, 36, 48, 54 Mbit/s
IEEE 802.11n	expected mid-2007	2.4 GHz	540 Mbit/s

Source: Adapted from Sampalli Srinivas, October 2005

Box 2.2: Using satellites to bring connectivity to rural areas
ITC's eChoupal project uses VSAT technologies to get Indian farmers online



The International Business Division of ITC, one of India's largest exporters of agricultural commodities, has developed the eChoupal initiative to tackle the unique challenges facing Indian agriculture, with its fragmented farms, weak infrastructure and extensive chains of intermediaries.

Each village internet kiosk is managed by a farmer called *sanchalak*, who has a computer, typically in his or her own house, and an internet connection via a phone line or, increasingly, a VSAT connection. These kiosks serve an average of 600 farmers in 10 villages within a five kilometer radius. The *sanchalaks'* kiosks provide farmers with ready access to information, in their language, on weather, market prices, scientific farm practices and risk management. They facilitate the purchase of farm materials and the direct sale of farmers' produce.

The eChoupal projects allows farmers to take their own decisions, reacting to market demand and protecting quality and productivity. By pooling their requirements for farming materials and equipment, they are able to obtain more favourable conditions from vendors. In the future, a combination of VSAT and WLAN will further democratize internet access in the villages.

Image source: Digital Dividend Organisation

Source: eChoupal.com

WiMAX could eventually be combined with 3G mobile broadband to provide a customized high-speed environment whatever the location of the user.

2.2 Connected computing

In everyday life, there are always a number of routine, repetitive and mundane tasks to be carried out. Digital technologies have made some of these tasks easier and more efficient, e.g. paying bills. But a larger revolution may be at hand, one which will extend the power of digital technology beyond the mobile phone and the personal computer, to everyday items. In the future, all of the world's things may be connected to the global internet, through sensors, actuators and radio-frequency identification tags. Although the timescale of this revolution is yet unclear, the shape and scope of human activity is undergoing a radical transformation.

2.2.1 RFID (radio-frequency identification)

Radio-frequency identification (RFID) is a good example of an unobtrusive technology that has the potential to play a crucial role in creating a ubiquitously networked environment capable of transforming our daily lives. RFID uses electromagnetic radiation to identify a person or object[9]. The basic technological concept is a simple one, and its origins date back to the 1950s. An RFID system is made up of a transponder (tag) located on the person or object to be identified, and a reader (typically fitted with middleware) that forwards the data received to another system such as a desktop computer or database. When used in combination with sensor technologies, these systems can detect and control changes in their environment (see section 2.4.6). As such devices and tags become increasingly commonplace, a world of "ubiquitous computing" (as first described by Mark Weiser[10]) comes closer to realization, as does a global "internet of things", the subject of last year's ITU Internet Report[11].

RFID tags can be smaller than a square millimetre in size, and thinner than a sheet of paper[11]. Developments are ongoing to shrink their size further. Meanwhile, prices are also falling. In 2006, Hitachi announced that it had finally created the USD 5 cent tag[12], which is widely recognized as the magic price for mass deployment. At that price, RFID could compete with the traditional bar code, taking over many of its present day applications. In the past, comparatively higher tag costs largely restricted their use to high-value items. The cheapest and most widespread tags are passive tags, which are powered by energy they scavenge from the interrogating radio wave. By contrast, active tags have their own power source, and can generally transmit, as well as respond to data. Some tags are read-only, and others can be read-writable and even re-writable.

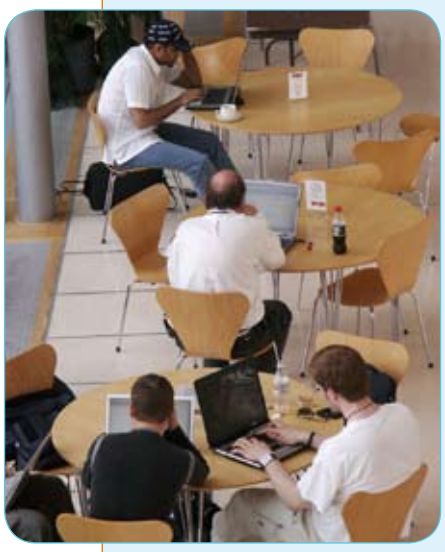
One of the early uses of RFID was in supply chain management. In supply chain management, tags can perform much more sophisticated functions than the traditional barcode. Since RFID does not require line-of-sight, it is much easier for manufacturers to identify and track stacked or piled items through the supply chain, and constantly monitor their status. Since each RFID tag is unique, each item can be tracked separately, in contrast to traditional barcodes, which cover only entire categories of items.

Retailers, too, have begun discovering the potential of RFID systems for front-end applications, e.g. to provide information about a product, such as washing instructions for an item of clothing, cooking or care instructions. A report from IDTechEx[13] estimates that, by 2008, retailers will account for over USD 1.3 billion of a global USD 7 billion RFID market (box 2.4).

Other sectors in which the potential of RFID has been recognized are transportation (RFID systems are already in operation for the collection of road tolls, for example), medicine and pharmaceuticals. Widespread tagging of medications through RFID can be used to fight drug counterfeiting - the tags help identify damaged, tampered, outdated medication for recalling. It can even be combined with sensor technology to monitor and maintain medical equipment and supplies, or to monitor the health of individual patients. RFID has been

Box 2.3: High-speed London

A WiMAX service for businesses in Westminster



A £4.4m (USD 8.8m) investment by Urban WiMAX is bringing wireless connectivity to businesses in central London, UK. Over 250 businesses volunteered to test-drive the high-speed wireless connection based on the WiMAX 802.16d-2004 standard. The first customers were connected in April 2006. Participants in include major corporations, media businesses and financial companies as well as members of the UK Parliament..

Initial sites were chosen with an eye to the application needs of the trial participants, so as to prove the technology's capabilities, including wireless 10 Mbit/s download and upload, closed-circuit television, voice and video.

Trial participants can use the pilot service free of charge. The full commercial launch of Urban WiMAX's service was planned for the third quarter of 2006. Urban WiMAX used advanced mapping software–the result of ten years of research and development–to solve the problem of non-line-of-sight delivery in urban areas.

Image source: flickr.com (Stuart Yeats)

Source: Digital Media Asia

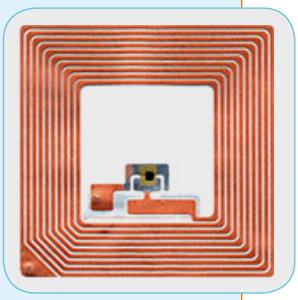
used to store individual patient information on wristbands. Precedents also exist for implanting RFID tags[14] in humans. As tags are typically the size of a grain of rice, they can be injected under human skin. Such implants are not dissimilar to identification chips used for pets or livestock.

The applications of RFID are already quite varied. RFID tags have been attached to the shoes of marathon runners to track their progress and used for monitoring the whereabouts of small children in theme parks. As it does not require contact, RFID is a key enabler of wireless contactless systems for payment: in Japan, users can pay for taxi fares using RFID-enabled mobile phones. The potential of RFID has been recognized outside the private sector, too. Governments are exploring the use of RFID for enhancing security, through tags in drivers' licenses, national passports, and even currency notes. The use of RFID is already cutting across many sectors, and the world market for this technology is likely to expand considerably over the coming years. The technology can be applied to existing processes, such as the supply chain, but can also open up entirely new markets. The combination of falling costs, shrinking size and computing power make RFID a technology to watch.

2.2.2 Sensors, actuators, and their networks

Sensors are devices that detect stimuli in a physical environment. They can detect changes in the environment and either indicate these directly (e.g. a stand-alone mercury thermometer) or pair with other indicators through an analogue to digital converter, to enable these results to be read and analyzed by humans. A sensor network is formed when there is more than one sensor feeding results back to a central server. Sensors in a network can also communicate with each other. When sensor networks operate without the use of cumbersome wires, information about environmental stimuli

Box 2.4: The RFID retail experience
Grocery shopping the RFID way



Both customers and retailers benefit from RFID technology. The journey starts in the factory, where RFID tags are employed throughout the supply chain to track items and manage supplies and deliveries.

Retailers can also analyse RFID tracking data to study consumer behaviour and purchasing patterns. They can use this information to streamline store layout and help shoppers find their way to the desired products (e.g. repeat purchases) faster and more efficiently. Additionally, RFID tracking can be used to better manage the movement of perishable goods and protect valuable items from theft.

For customers, shopping thus becomes easier and more convenient. At the checkout, RFID eliminates the need to unload and individually record each item purchased, by registering an entire basket or trolley full of RFID-tagged goods in an instant. Alternatively, the trolley itself could contain a reader, with a display showing the customer a running total of the items taken so far. The trolley can be personalized: after 'recognizing' the customer (from an RFID tag, mobile phone or key fob), the smart trolley would take known shopping preferences trolley into account and provide advice on special offers and promotions.

RFID in conjunction with contactless payment systems (see section 2.5.1) could greatly streamline and accelerate retail shopping. But it doesn't end there – on the way out the door, the customer's RFID-enabled phone exchanges codes with a reader on the car's dashboard, identifying the car's legitimate owner.

Image source: Barcode Solutions

Source: Adapted from ITU Internet Report 2005: "The Internet of Things", available at www.itu.int/internetofthings

can be transmitted over the air to a wide array of actuators and processing units. Sensors and their networks are already playing a vital role in medicine, industrial operation, environmental monitoring and robotics.

The constituent parts of a sensor network, namely the sensor nodes, are essentially tiny computers, very basic in terms of their interfaces and components. They are usually equipped with a processing unit with limited computational power and memory size, a sensor mechanism, a communication device and a battery as power source. A sensor network may have one or more base stations, possessing computational and communication power, thereby acting as gateway between sensor nodes and those responsible for the sensor monitoring.

Various applications have already been proposed for wireless sensor networks. In industry, for instance, they can be used to monitor hazardous, inaccessible environments. They can also be deployed in wilderness areas, monitoring the state of the environment autonomously without needing to be recharged or replaced. They can be used to form a dense security net around valuable objects, monitoring and tracking intrusions. In the digital world, wireless sensor network technology will be an important part of the coming "internet of things".

2.2.3 Robotics

The interaction between robots and humans has always inspired writers of science fiction. The dream that machines could help humankind with unpleasant, dangerous or simply tedious work is inherently appealing. The current renewal of interest in robotics outside the world of fiction is due mainly to the increasing maturity of robotic technology and falling costs. Today's wireless and sensor technologies also enable an unprecedented level of interaction between robots and the world around them.

Robots in the real world generally lack the glamour of their fictional paragons: they are machines designed to execute one or more tasks repeatedly, with speed and precision. There are as many (if not more) different types of robots as there are tasks for them to perform. A robot can be under the direct control of a human operator, or fully automated. The branch of engineering called robotics contains elements of electronics, mechanical engineering, computer science, artificial intelligence, nanotechnology and bioengineering.

Robots that are mobile can be classified as either androids or humanoids. Androids are usually fitted with wheels or tracks, robot legs being inherently unstable and difficult to engineer. They can be used for activities in extreme environments, rescues, or other onerous tasks. They can also serve as pets, such as the well-known Sony AIBO[15]. Humanoids, on the other hand, are designed to closely resemble human beings in form. Ideally, humanoids can walk and perform some basic human activities, such as carrying an object or recognizing speech (box 2.5). In order to make humanoids more accessible, a start-up company in France, for example, is planning to build an inexpensive, Wi-Fi-enabled humanoid robot, for the consumer market by early 2007[16].

Given the renewed interest in robotics, demonstrations of robots and robotic skills are multiplying across the globe. An exciting annual event for humanoids is the RoboCup soccer championship, held in 2006 in Bremen (Germany), at which teams of humanoids demonstrate how they master the complex skills needed for the sport, particularly as dexterity does not come easy to them.

2.2.4 Media convergence

As human work becomes ever more automated, and broadband technologies provide access anytime anywhere, people are beginning to consume an increasing amount of digital media. In particular, personal video recorders, MP3 players, and digital cameras combined with the wave of media convergence is changing the way we experience entertainment.

With the rapid growth of mobile phones, new technologies such as digital video broadcasting and digital multimedia broadcasting let viewers watch streamed content on mobile devices. Radio listeners have not been left out: digital audio broadcasting has led to tremendous quality improvements and transformed the listening experience, too. IPTV

technologies introduce an interactive dimension into television, giving viewers more control over what they watch, and when.

DAB (digital audio broadcasting)

Listeners to the BBC in the United Kingdom, and worldwide, can now record one BBC broadcast while listening to another live. Using a new digital radio system called DAB (or digital audio broadcasting), all national BBC radio stations are transmitted together using one carrier frequency, instead of many frequencies, as in the past. The audio data from different radio stations is transmitted in sequential slots, and the receiver filters them into different streams, corresponding to stations. This makes the system flexible enough for users to time-shift the programming. In addition, audio-on-demand is now possible on a number of radio stations and radio broadcasting websites: users can listen live to radio programming, or to archived material on the internet. This is also known as "internet radio".

DVB (digital video broadcasting)

In parallel to the changes re-shaping the radio world, there is also a global shift away from the analogue system that has dominated television during its first 45 years. An industry-led consortium called the Digital Video Broadcasting Project (DVB), formed by over 270 broadcasters, manufacturers, network operators, software developers and regulatory bodies in some 35 countries, is working on common standards for the global delivery of digital television and data services.

The DVB consortium has developed standards for cable, satellite and terrestrial digital TV. The terrestrial standard, DVB-T, was the subject of discussion at the Regional Radiocommunication Conference hosted by ITU in 2006 (RRC-06)[17], where participating countries from Europe, Africa and the Arab States agreed on a new frequency plan. As a result, DVB-T services will be offered in at least 114 countries, with a harmonised series of dates for the switchover from analogue to digital services.

DVB-T can be used to deliver multimedia programs to handheld devices, although power consumption remains an issue: currently, handheld battery-powered receivers do not have enough energy to receive a normal DVB-T signal for an extended period. Another standard in the same family, DVB-H, may be more appropriate for handheld devices and also lends itself to IP datacasting, thereby facilitating the interoperability of telecommunications and broadcasting networks (box 2.6).

DVB-H faces competition from 3G networks operators, however, who are also capable of providing mobile television services, such as MBMS (multimedia broadcast multicast service) offered by 3G networks. But in their present state (without the HSDPA upgrade), 3G networks may have difficulty in providing affordable real-time broadcast TV services. For this reason, it is more likely that 3G handsets will be offered with multimodal capabilities.

Box 2.5: Musical robot

Japanese car maker Toyota builds a trumpet-playing robot

"He" stands 120 cm (four feet) tall and still doesn't have a name. So far he knows only one song on his trumpet, "When You Wish Upon A Star". But he is learning…

This talented robot is the latest in a series developed by Japanese companies to showcase humanoid robotics. Sony, too (like Toyota) has created Aibo, a robot dog with engagingly authentic canine habits, and the all-singing, all-dancing Qrio, which can jog along at a top speed of 14 m/min. Another car maker, Honda, has developed a walking humanoid called Asimo, which has been a travelling sensation all over the world. Robot development is a highly competitive business in Japan—the market is estimated to be worth around USD 4.5 billion. Japanese companies find the humanoid models to be excellent ambassadors and status symbols.

Image source: Toyota

Source: Various company websites, including sony.com and toyota.com

DMB (digital multimedia broadcasting)

As its name suggests, DMB is a digital transmission system for sending data, radio and TV to mobile devices. Users can enjoy TV programmes as well as audio and data services on DMB mobile phones, portable DMB receivers, or in DMB-enabled vehicles. However, the primary target market is the mobile phone user. DMB comes in two forms: satellite-based (S-DMB) or terrestrial (T-DMB). The main difference between the two in practical terms is that S-DMB provides broader geographical coverage.

The Republic of Korea inaugurated the world's first S-DMB service. TU Media, founded by the leading mobile carrier SK Telecom, received a license from the Korean Broadcasting Commission (KBC) in December 2004. In March 2005, T-DMB was launched in the Seoul metropolitan area. Japan is also at the forefront of the introduction of DMB technologies. Taxi passengers already watch television using S-DMB services (box 2.7). The S- DMB business model is based on subscription. By contrast, T-DMB relies solely on advertising, and provides popular television programming free of charge. Receivers of T-DMB can be integrated in car navigation systems, mobile phones, personal video players, laptops and even cameras. This flexibility is likely to give T-DMB the edge over S-DMB[18].

Although DMB technology promises mobility for television viewers, there are inherent limitations associated with screen size. Both its satellite and terrestrial versions provide video quality suitable for screens of 18 cm, adequate for taxi use, but nonetheless deemed small by some users. Projection onto a larger screen, however, results in unacceptable quality loss and would not substitute for existing technologies indoors.

IPTV (internet protocol television)

IPTV is set to radically change the entertainment landscape. The delivery of programming over a versatile IP network will mean that users can benefit from interactive services, while the market will be exposed to increased competition. IPTV describes a system capable of receiving and displaying a video stream encoded as a series of IP packets. An IPTV service is one where users can watch many different high-resolution programmes through a secure managed network. For residential users, IPTV is now being provided together with video on demand, or bundled with web access and VoIP telephony ("triple-play" or "multiple play" services)[19] using a single infrastructure. With the spread of IPTV, cable and telecommunication operators are increasingly turning to this new market for diversifying their revenues.

Box 2.6: 3 Italia kicks off!

First mobile TV service using DVB-H technology launched in Italy

The world's first commercial mobile TV service using DVB-H technology was launched in Italy on 5th June, 2006, just ahead of the FIFA World Cup. 3 Italia, the mobile network operator, claimed to have signed up 111'000 users in the first six weeks of operation. The operator is aiming to have 500'000 clients by the end of 2006. The rapidly-growing service is already available in over 2'000 Italian towns and cities.

Pay-as-you-go users can access the mobile TV service at EUR 3 (USD 4) per day, EUR 12 (USD 15) per week or EUR 29 (USD 37) per month. Alternatively, subscribers can pay EUR 49 (USD 63) per month for unlimited mobile TV services, one hour of calls per day and one gigabit worth of downloads per month.

Image source: DVB Project Office

Source: DVB Project Office at www.dvb-h.org

Box 2.7: Tokyo unveils satellite multimedia service for taxis

Japan launches MobaHO!, the world's first satellite multimedia broadcasting service for taxis

Two Japanese companies, Mobile Broadcasting and the taxi operator Daikoku Kotsu, have introduced MobaHO!, a satellite digital multimedia broadcasting service intended specifically for taxi passengers. Taxis are equipped with LCD monitors, which come with an internal speaker and are placed on the headrest of the passenger seat.

The S-DMB service provides taxi customers with 30 audio channels, and 8 video channels offering news, music, overseas FM radio, sports and entertainment, interspersed with taxi commercials.

Image source: MoBaHO!

Source: JCN Network, "World's first satallite digital multimedia service for taxis", 20 July 2006

IPTV provides two-way transmission capabilities that are absent from traditional TV distribution technologies. This allows viewers to take advantage of interactive services, e.g. selecting camera angles or commentary streams when watching a sports event, or by voting for contestants in a reality TV show. The interactivity can even include user-generated content, whereby individuals or organizations can produce and distribute their own content, either publicly or to selected groups. IPTV can therefore create the potential for point-to-point content distribution and full video on demand (time-shifting). It also gives subscribers video stream control (e.g. pause, fast-forward, rewind etc.), emulating hard-drive based digital video recorders (DVR) such as TiVo.

As broadband becomes more popular and affordable, convergence will only gather pace. Major telecommunications providers are exploring IPTV as a way of generating new revenue from their existing networks, and to defend against encroachment from cable operators. In Hong Kong, China, the incumbent telecommunication operator, PCCW, was the first to launch IPTV commercially and already has a large portion of its subscriber base signed up to IPTV. It is expected to overtake the local cable television service provider in 2006, in terms of number of subscribers (box 2.8).

IPTV demonstrates how conventional entertainment services (TV is 75 years old) are being transformed by the internet, thereby increasing consumer choice with *à la carte* programming and personalisation options. Being IP-based, IPTV is an obvious choice also for viewing away from home using devices like Slingbox[20]. Thus, this wave of media convergence is seeing traditional media, like radio, music, video and TV broadcasting, moving to other platforms, giving the consumer better quality and more variety.

2.2.5 User devices

The desire for increasingly personalized devices is central to maintaining the sales of consumer electronics devices such as digital music players and laptop computers. The mobile phone market is no exception. Users now choose their own ring tones and screen wallpapers. They are also becoming more discriminating about the design and physical appearance of their handsets, so much so that the rate of replacement of such devices is no longer merely dependent on functionality. The mobile phone has moved from being a practical accessory to becoming a reflection of a user's personality or social status.

A study from the Mobile Content Forum found that 70 per cent of Japanese mobile users keep their mobile within one metre of their body during the day time, and 40 per cent during the night as well. The mobile phone can thus be considered as an extension to the user's physical self, and the rate of replacement in Japan is accordingly very high. Anyone contemplating replacement is faced with an almost overwhelming choice of handset, and manufacturers have been quick to create niche markets, including the luxury, female, sporty and

Box 2.8: NOW, it's IPTV!

IPTV in Hong Kong, China

IPTV, or "Internet Protocol Television", is on the verge of conquering the Hong Kong television market. The city's fixed-line telephone incumbent, Pacific Century CyberWorks Limited (PCCW) is leading the charge with its NOW Broadband TV service, which has been growing vigorously ever since its inception in 2003.

By 2005, NOW TV subscribers numbered more than half a million, up 52 per cent over the previous year. The company predicts a further 36 per cent growth in 2006, as the number of subscribers rises to 750'000. NOW TV is thus likely to overtake the current television market leader, iCable Communications, which had a customer base of 738'000 in 2005 but nowhere near NOW TV's meteoric growth rate.

At the time of its launch, NOW TV operated only 23 channels; that number now exceeds 100. Channels are categorized into sports, entertainment, movies and news and infotainment groups respectively, along with on-demand adult programming. Certain channels are free to non-subscribers, being carried by advertising. PCCW provides customers with an "*à la carte*" subscription, allowing them to purchase individual channels, unlike the traditional bundled channels on cable. The company's success is partly due to the fact that Hong Kong is one of the most densely populated cities in the world, and has a high broadband penetration rate, bringing down the cost of the network infrastructure.

Image source: flickr.com (fatcontroller)

Sources: NOW Broadband TV, at www.nowbroadbandtv.com; and Daily IPTV, "PCCW's now broadband TU poised to beat cable", available at www.dailyiptv.com

'tweenager' markets (box 2.9). The luxury market, too, has spawned a whole variety of devices competing on materials, workmanship and extras. The female market, in particular, was characterized by Intel's resident anthropologist as the "canary bird of the technological mineshaft": if a product doesn't work for the female market, it is unlikely to make the grade in the mass market[21].

The personal computer (PC) has also evolved considerably since IBM first showcased its PC to the world in August 1981[22]. It came in three versions, the cheapest of which was a USD 1'565 home computer (about USD 3'500 at 2006 prices)—monitor and disk drives not included. The computer had a 4.7 MHz processor and 16 K of memory, and came with Microsoft's BASIC programming language. It was capable of displaying just four different colours for graphics and 24 for text, and ran only basic games and tools, such as a music tuition program. Today, there are over a billion personal computers worldwide. A typical hard drive, at 160 GB, has the capacity of over one million of the floppy disks used by the original IBM machine.[23] The last 25 years have also seen the personal computer become increasingly personal, as many people now own one or more computers, whereas in the past a "home computer" was typically just that: one that was shared between the members of a household. This change in ownership has precipitated changes in the way we use PCs—Wi-Fi coverage is increasingly becoming available on trains, in coffee shops and in tourist hotspots. A recent report from the UK ICT regulator, Ofcom, found that 16 to 24 year-olds in the United Kingdom are spurning television, radio and newspapers in favour of online services, fuelling a radical media shift.[24] Such shifts demonstrate just how dynamic the personal computer market is, and the demand for continued improvement and innovation in this field does not seem to wane. And some argue that the true personal computer of today is the mobile phone, with its mass penetration, individual nature and increased functionality. Will the mobile phone be the starting point for tomorrow's personal computer?

Portable music players are also subject to rapid innovation. As functionality is fairly basic, other factors, such as design, ease of use and branding, become more important for consumers. Apple's iPod is an example of such innovation (box 2.10).

Box 2.9: Kiddy cool meets parent power

Disney makes its move from films to phones

Walt Disney has a huge legacy of films, theme parks and fluffy toys, but the company may soon be able to claim a successful new addition to its business empire. It recently announced its decision to enter the mobile phone market, with Disney Mobile, a service designed for 10 to 15 year-olds.

The service gives parents the power to monitor and control their child's phone usage. A choice of two camera phone handsets is available, from LG Electronics and Pantech. Parental facilities include the setting of monthly limits for voice and text minutes, ring tones and other downloads, and the selection of times and days of the week when the child is permitted to use the phone. If any preset allowances are exhausted, the phone will still allow calls to designated numbers, such as to the child's parents or to the emergency services. GPS technology allows the parents to track the location of their child's handset from their phone or PC. To maintain the Disney theme, subscribers can download free and paid ring tones, wallpaper and graphics from a Disney "vault", either free.

Image source: flickr.com (pshan)

Source: USA Today, "Disney's phone lets kids talk at parents' discretion", 4 may 2006, at www.usatoday.com

A 'mere' MP3 player, it has become a phenomenal worldwide sales success, involving into an ever-growing family of products from calf leather accessories to sleek and sturdy speakers. The new release of the iPod presents users with the possibility of watching videos, too. But the iPod has started to face competition from mobile phones that have integrated MP3 players and mobile TV programme.

The future direction for user devices is important to ascertain: will users prefer a single device with multiple functions, or many different devices? It does seem that users are heading towards the all-in-one multi-functional device. Already, mobile phones are displacing other more mundane items. A 2006 Nokia study[25] of young people aged 18-35 found that 72 per cent had discarded their alarm clock in favour of the mobile phone, and 73 per cent no longer wore a wristwatch. A further 44 per cent of those questioned used their phone as their main camera, and 67 per cent expected their phone to eventually replace their MP3 player. However, the results did show some regional differences. Whilst 68 per cent of respondents in India used their mobile as their main camera, 89 per cent of Americans questioned preferred to keep two separate devices, and the global average of people expecting to use just one device was less than half, at 42 per cent.

This suggests that the answer to the question above is not quite as clear cut as one might expect, and may be subject to many different variables—for instance, it has been suggested that there is a 'gadget threshold' that needs to be overcome before users will accept multi-functional devices. Thus, for an internet-enabled mobile phone, ease of browsing might be a crucial factor. Manufacturers also have to contend with issues such as screen size and battery life limitations. Nonetheless, mobile phones have an undoubted importance in modern life, with a third of the respondents in the Nokia study claiming they would rather lose their wallet or purse than their mobile phone, and a fifth claiming they would sooner lose their wedding ring than their mobile phone. Manufacturers are pushing ahead with multi-functional devices, suggesting that their confidence in consumer acceptance is high. An example of such a device is Sony's 'Mylo Personal Communicator' (box 2.11), a portable wireless entertainment device combining instant messaging, voice over IP, e-mail and music.[26]

The evolution of user devices is both exciting and bewildering for the consumer, who faces an ever increasing variety to choose from. Ease of access and use will become increasingly decisive criteria, given the relentless pace of innovation and the attendant burden of choice for consumers. Vendors and operators will find themselves

Box 2.10: iPod therefore I am
A status symbol and corporate goldmine

Since its 2003 launch Apple's iPod has sold millions of devices (around 22.5 million in the 2004-05 financial year) and is credited with redefining the MP3 player market in a manner similar to the way IBM's PC redefined the personal computer market. The 60GB model is capable of storing 15'000 songs. The success of the iPod has encouraged Apple to further diversify the product portfolio. The company recently paired up with the mobile phone manufacturer Motorola to produce the 'ROKR' iTunes device—one of the first dedicated music phones to hit the market. Apple is also working on a widescreen video iPod that will let users download and read novels. There are rumours that Apple has approached some of the world's largest publishing houses, to convince them to commit their full libraries of books to electronic archives.

The strong sales of iPod players are supported by the success of the iTunes portal, which allows users to download music, videos, television and audiobooks, with prices starting from USD 0.99. Apple recently completed a deal with Warner Brothers to sell episodes of the popular TV series 'Friends' via the iTunes website. The iPod and iTunes generated almost half Apple's profits in 2006.

Image source: flickr.com (notic)

Source: BBC News, "Apple pulls in profits from iPods", 19 July 2006, available at http://news.bbc.co.uk; Daily Mail, "Now you can read books on your iPod", 3 August 2006, available at www.dailymail.co.uk

facing challenges of ensuring interoperability and compatibility, to keep pace with the evolution of their products and services.

2.3 Digital communications

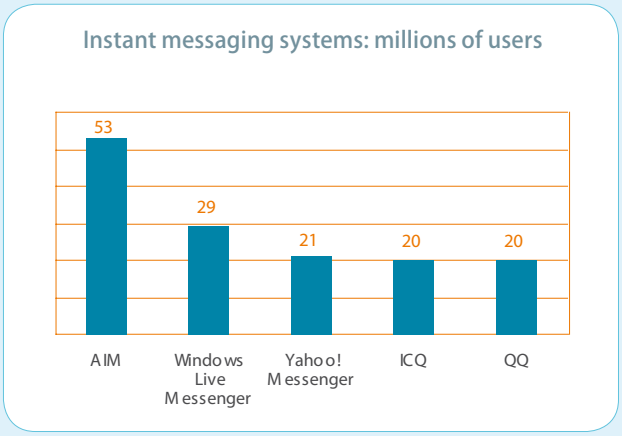
2.3.1 The evolution of voice

Voice communication has changed dramatically in the last two decades[27]. In the early 1990s, mobile phones were still a luxury reserved to business users, but the combined impact of handset subsidization, lower tariffs and the introduction of prepaid schemes all helped to create today's mass market, with over two billion mobile phone users worldwide (figure 2.2)[28]. The mobile phone has become such an integral part of many peoples' lives that in many cases it has supplanted the fixed phone entirely.

While mobile phones have tended to augment the total revenue derived from voice sources, another service, voice over internet protocol (VoIP), threatens to diminish it. VoIP involves routing telephone calls via IP-based networks, such as the internet.[29] VoIP owes its increasing popularity to a number of advantages that, together, constitute a highly appealing method of communication for many categories of users, from household to corporate. VoIP calls are often free, or at any rate far cheaper than similar conventional services. Users can take or make calls from any place where they are connected to the internet, and benefit from extras such as call forwarding and integration with other services (e.g. video conversation, conference calls and file exchange). Analysys, a telecoms consultancy, predicts that 32 million European workers will be using VoIP by 2010, and that spending in the sector will surge to USD 12 billion.[30]

VoIP services have existed since the 1990s, and were the subject of the third edition of the *ITU Internet Reports* series[31]. However, mass-market VoIP services have only become popular quite recently. Among the better-known services targeted at consumers users are Vonage and Skype. Skype was launched in 2003, and acquired by eBay in 2005. That acquisition has pushed several other internet giants to start experimenting with internet telephony. Thus, Microsoft recently acquired a VoIP company called Teleo, Yahoo! bought DialPad, and Google has launched "Google Talk", a service which lets users of its instant messaging program chat over the internet. Phone providers are also taking an interest in VoIP: BT and Nokia

Box 2.11: Instant messaging – the next big thing to hit the air?
IM boost from new wireless devices



Until recently, instant messaging (IM) was perceived as being tied to the desktop computer. Now, wireless operators and service providers are beginning to see its lucrative potential, and a host of new devices have been launched. For example, in mid-2006 Sony launched a personal wireless communicator device called 'Mylo' ('my life online'), targeting two categories of heavy text users: socializers and music fans. Mylo gives users access to instant messaging, HTML web pages, and e-mail, in addition to playing music and displaying photos. It comes with pre-installed IM software for Skype, Yahoo! Messenger and Google Talk. Despite the inhibiting effects of competing standards and platforms, forecasts for the worldwide growth of wireless IM are sanguine.

A recent Gartner study estimates that the corporate IM market will grow globally at an annual rate of around 20 per cent at least until 2009. Research from In-Stat found that in 2005 there were around 2.5 million wireless IM users worldwide, generating revenue of USD 54.5 million, and In-Stat forecast that revenues would reach USD 3.6 billion by 2009.

Note: Figure for QQ refers to peak online users and all other figures refer to active users.

Data source: Adapted from Wikipedia

Source: America's Network, "Wireless Instant Messaging Rises", 1 June 2006, available at www.americasnetwork.com. See also www.learningcenter.sony.us

are experimenting with intelligent handsets that switch seamlessly between cellular and VoIP calling, obviating the need for duplicate accounts and handsets, and resulting in cheaper calls for the consumer.

The market for VoIP is now being further expanded as manufacturers begin to offer wireless communications and entertainment devices that are equipped ready for wireless instant messaging (IM) and VoIP use. Thus, in February 2005, Skype announced a deal in which it would add its software to Motorola handsets. Later that year, the German mobile subsidiary E-Plus began to offer Skype calls on its network, responding to the growing demand for such services.[32] Unlike VoIP calls made using their home computers, for example, there is a small cost to the consumer - they pay EUR 39.95 (USD 50) for a package which allows unlimited VoIP calls over 3G data cards. But not all mobile operators welcome such developments, and Vodafone in Germany felt sufficiently threatened by the increasingly popularity of VoIP that it has taken measures to block VoIP calls over its mobile data networks, starting from July 2007.[33] However, even moves such as this are unlikely to significantly delay the rapid take up of VoIP on mobiles, in a similar way to fixed-line networks.

What might the future of voice services hold? Some observers believe that voice will soon be only an extra application, bundled in with more sophisticated data and video services, for no additional fee. The idea would be to develop a fully IP-based "next-generation network" (NGN) that accommodates, coexists with and eventually replaces current fixed and wireless networks, carrying voice streams as data packets. NGN standardization activities are being undertaken in the ITU Telecommunication Standardization Sector under the banner of the NGN Global Standards Initiative (NGN-GSI).[34]

2.3.2 Messaging mania

The transformation in voice communications in recent years has hardly, of course, led to the

demise of the written word. On the contrary , short messages, wireless e-mail and instant messaging clients are more popular than ever.[35] The boom in messaging has created enticing business opportunities the world over, as illustrated by the United Kingdom market (box 2.12).

Other countries have also seen a rise in the numbers of those using MMS services. Research from M: Metrics[36] found that the use of MMS in the USA rose by 32 per cent between February and July 2006, while France and Germany saw increases of 16-20 per cent. One of the factors driving this growth could be the improved resolution (and hence better picture quality) now available with mobile phone cameras. The study authors also found that there was a direct correlation between camera resolution and propensity to use MMS. For those whose camera resolution was higher than one mega pixel, 44.3 per cent had used the service (compared to the global average of 30.5 per cent). The number of people owning camera phones is also increasing. Across the UK, US, France and Germany, the number of camera phone owners increased by 22 per cent from February 2006 to July 2006, with the percentage of subscribers owning camera phones across the four countries standing at just over fifty per cent.

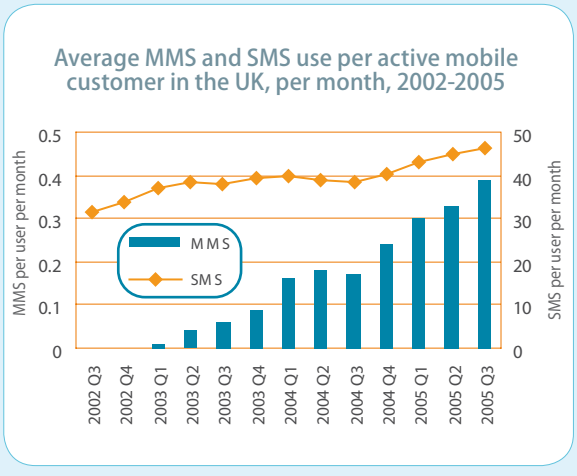
Box 2.12: Texting short and multimedia

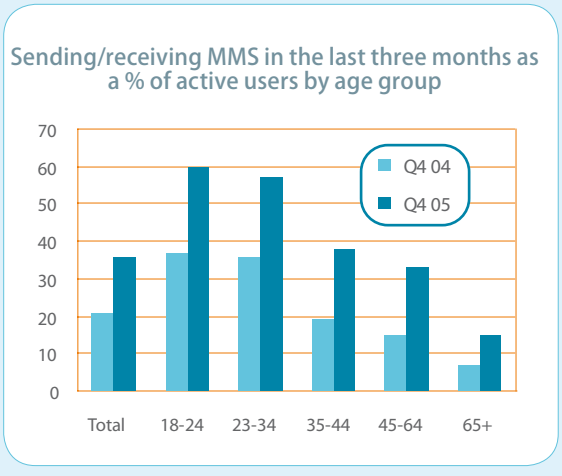
The popularity of messaging in the United Kingdom

The United Kingdom ranks in the world's top 15 countries for both mobile teledensity and total mobile subscribers (see data table 2)[37], and thus makes an interesting case study for the take-up of newer multimedia messaging services (MMS) which can also deliver pictures, sound clips and video. The popularity of the multimedia message is growing, particularly with the provision of new and innovative services, such as the MMS postcard (a postcard featuring a photo taken by a user, ordered by MMS). A recent report from Forrester Research[38] estimates that MMS will bring operators revenue of EUR 5 billion by 2010.

Figures from Ofcom in the UK show that MMS is set to become a mass-market (see left chart). Whilst the average number of SMS messages sent per user per month still dwarfs that of the number of MMS, there has been a significant increase in usage, and 36 per cent of consumers either sent or received a multimedia message in the last 3 months of 2005 – up from 22 per cent in the first three months of the same year. The breakdown of MMS usage by age group is particularly interesting: more than half the mobile users in the 18-34 age bracket use MMS. But it is the older age groups that have seen the highest increase in usage patterns: the percentage of users 45 years old and over using MMS more than doubled in a single year (see right chart).

SMS and MMS use in the United Kingdom





Source: Adapted from Ofcom

Despite the growing popularity of MMS, the SMS market is not short of innovation. Although a short phone call may still be cheaper than a volley of SMS messages, SMS remains popular because it is less obtrusive than a phone call, allowing the person to send and receive messages without regard for time and place. In the Philippines, where the cost of sending an SMS is substantially lower than making a voice call, an average of 250 million text messages are sent per day.[39] Computer and internet penetration remain low in the Philippines, so text messages serve as the equivalent of e-mail and instant messaging, and are used for everything from day-to day communications, to organizing political demonstrations, and reporting crimes. Recently, Geneva Software Technologies, based in Bangalore, announced that it has developed software to translate English text messages into other languages and send a translation to any mobile device in the world, regardless of the character set it is programmed to use[40]. There are hopes that this kind of service can be used to deliver disaster alerts, e.g. warning of impending tsunamis. And in China, which boasts the largest mobile phone market in the world, with almost 400 million users at the end of 2005, SMS has even created an entirely new form of employment: SMS stenography (box 2.13).

The popularity of e-mail and texting on the move has fuelled strong sales of devices such as the "BlackBerry" from the Canadian company Research in Motion (RIM). The company has seen spectacular growth recently, with final-quarter results 92 per cent higher in 2005 than in the previous year. This is largely attributable to handheld device sales (66 per cent). The total number of BlackBerry subscribers increased in that same quarter by nearly half a million, passing the 2.5 million mark – a 135 per cent increase over the previous year.[41]

2.3.3 The rise of social networking

The proliferation of methods of communication in the digital world inevitably has an impact on social interaction and networking. Digital communication channels do not just provide new means to support traditional social networks — they also stimulate new kinds of social interaction that may involve both real and virtual personalities. Digital technology and online environments enable participants to exercise their freedom and creativity anonymously by setting up synthetic personae complete with attributes such as age, race or religion. Digital social networking has given rise to some of the web's most active websites, such as MySpace (box 2.14), Bebo and Facebook[42], where users post profiles and share details of social events. The success of such sites does come at a price, however. The same anonymity that makes digital social networking so attractive makes it possible for users to engage in malicious impersonation, which fuels concerns about the protection of minors.

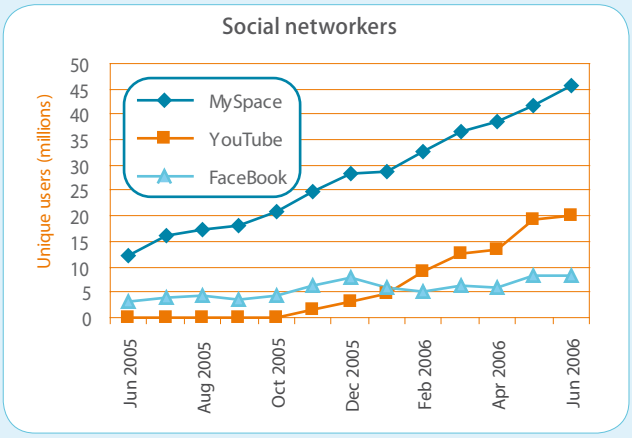
In the Republic of Korea, more than 90 per cent of young people in their late teens and early 20s are members of CyWorld, another popular social networking service.[43] Members design personalized rooms and decorate them with their favourite furniture and other goods. Digital wares, purchased using the CyWorld currency of *dotori* (acorns), are the main source of income for CyWorld. The items range from stacks of paper to couches and TVs, and typically cost less than one US dollar. CyWorld members can even send digital gifts to their cybuddies. While many social networking sites are struggling to make profits, the parent company of CyWorld, SK Communications, expects revenues of USD 140 million, the bulk of which (70 per cent) is in rental fees for digital items.[44] Other revenue sources include fees for sending instant messages, a recent addition to the service. The fact that CyWorld's instant messaging service is incompatible with MSN Messenger, once the dominant messaging service in Korea, seems inconsequential given the overwhelming popularity of CyWorld.

2.4 Digital content

Services are the lifeblood of telecommunication networks. Consumers use networks to interact through voice, text messages, instant messaging, personal websites and so on. However, telecommunication networks, in particular broadband networks, are also utilized by operators and media companies to bring information and audiovisual services to consumers, and, where permitted, gambling and gaming services. The traffic flow

Box 2.13: Famous for 15 minutes on MySpace

The phenomenon of social networking sites



MySpace (www.myspace.com) is an immensely popular social networking website in the United States with over 100 million members, a heavy proportion of whom are in their teens or twenties. The acquisition of MySpace by News Corp., in July 2005 for USD 580 million[45] was widely seen as the "coming of age" of social networking. Part of the MySpace phenomenon is the emergence of MySpace celebrities. To illustrate the novel approach to reaching celebrity status, the Wall Street Journal reported the case of a cosmetologist called Christine Dolce, one of the earliest adopters. Having achieved online fame after setting up a company to sell her jeans, Dolce found her life completely transformed by her status as a MySpace celebrity, to the extent that she stopped her work in order to concentrate on this new activity.

Concerns over emulators, and in particular the danger posed by adult 'predators', has led to the US legislature taking measures to limit or ban access to MySpace-like websites, especially from publicly funded educational facilities such as schools and libraries.

Data source: Adapted from the Financial Times using Nielsen/Net Ratings figures, 23 August 2006

Sources: Wall Street Journal, "Moguls of New Media", 29 July 2006; CNET News.com, "Chat Rooms Could Face Expulsion", 27 July 2006, available at http://news.com.com

is increasingly bi-directional, with consumers disseminating home-spun digital content via the same networks, asserting their identity and claiming their piece of cyberspace. Digital content has become such an indispensable part of life, that it is easy to forget that it has only been a mass phenomenon for slightly more than a decade.

2.4.1 The global knowledge web

Nobody really knows how big the web is today. Yahoo! estimates the size of the public web to be about 40 billion pages. But the "deep web", which includes documents and company intranets behind firewalls, is estimated to be many hundred times larger.[46]

News and information services

The world wide web has brought about a colossal change to the way we access news and information, and might be better perceived as a global knowledge web. With the spread of the internet and other network systems, traditional news media have found a new niche market. Via their websites, the very latest news content can be immediately posted online or sent to subscribers' e-mail accounts. Written news articles and also audio and video streaming services can be provided from websites, adding to the choice available to users. Daily newsletters can be customized to meet personal preferences for certain categories of news. Similar bulletins can also be received in SMS form on mobile devices. Readers are invited to post reactions and their own views.

The distribution of information has been central to the utility of the web from the outset, and web content has become immeasurably richer since the early days. Public transport schedules, local information, cooking recipes, author biographies and so on, have migrated from paper to the web. People can check the opening times of the Louvre in Paris or the Forbidden City in Beijing,

and even browse the online picture galleries. Many consumers search for the lowest airfares or hotel packages on the web. Children use Google images to find illustrations for school projects, and high school students download application forms for universities. Even the venerable Old Farmer's Almanac, first published in 1792, has now made the transition to the web and even offers podcasts. Even though it is only 15 years old, the web is now taken for granted as an indispensable and universal information resource.

Dictionary, encyclopaedias and libraries go online

It was not long ago that we had to flip through prestigious bound volumes to look up meanings of unfamiliar words. Albeit bulky, dictionaries by their very nature, reflect a long-term view of language and etymology. Still, they are unlikely to include the most recent street talk. Consisting essentially of unadorned text, they are not always easy for readers to comprehend. Encyclopaedias, while they contain more visual content, tend to be even more cumbersome, not to mention expensive for the average user.

In the digital world, the definition of an unknown word is generally only as far away as the nearest web browser. Online resources, often free, provide a wealth of information in addition to word definitions, such as synonyms, sample sentences, conjugation, pronunciation, word origins, and so on. Some sites even deliver educational daily newsletters. The Merriam-Webster Online Dictionary[47], for instance, provides podcasting services, including a "Word of the day on your iPod". Moreover, online dictionaries can be continuously updated, and made as specialized as necessary. Recently, search engines like Google and Yahoo! have incorporated dictionary and translation functions in their search pages, allowing users to look up words and even translate entire web pages, thereby increasing the usefulness of the results. Although many of these services provide crude translations, instantly knowing the approximate meaning of a foreign word or sentence still holds great value.

Traditionalists point to the fact that libraries are made up not only of dictionaries, thesauri and encyclopaedias, and that the contents of most library books are not accessible online. This is about to change, however, with projects such as the Google Library Project, intended to digitize books in major libraries, making them available through Google Search (box 2.15). Though this ambitious initiative still faces challenges, including copyright issues, it responds to an ever-growing demand for finding information quickly, accurately and cheaply.

Box 2.14: Occupation—full-time SMSer

Making a living from short messages in China

It may be a Singaporean who holds the World Record for "fastest SMS thumbs", but it is in China that the art of SMS writing has turned professional. The SMS stenographers are paid according to how many times their short messages, or 'Duan Zi' as they are known, are sent. The messages range from political satire to adult humour. SMS also provides Chinese users with a portal through which they can access information not normally available in the public media.

Image source: flickr.com (bennylin0724)

Sources: Singtel, "SingTel SMS Shootout 2005 unveils Singapore's fastest thumbs", 20 November 2005; ITU, "The Regulatory Environment for Future Mobile Multimedia Services: The Case of Hong Kong SAR and China", June 2006 (at www.itu.int/multimobile)

Engines for searching the digital world

Search engines have become the key starting point for finding information on the internet, but also on computers and private corporate networks. There are numerous web search engines in existence, and in many different languages. Some of the more popular ones are Google, Altavista and Yahoo! For convenience, consumers sometimes set the search page to be the default page of their web browser, as they tend to start many online activities with a search. To attract users, search engines often offer complementary web services, such as e-mail, instant messaging or VoIP phone calls. For all their power,

search engines are confronted with a number of challenges. The fundamental problem is that the web is growing at a tremendous rate and it is difficult to map it rapidly and accurately. As a result, search engines have to continuously revise their indexes to ensure that their map of the web is up-to-date. Theoretically, there are no limits to the growth of the web, but there are limits to the amount of indexing information search engines can store. Thus, recently added, less-connected, pages may be less visible than older ones. Moreover, even the most ingenious search algorithm can be manipulated so as to give more prominence a website than it may deserve.

As the number of mobile subscribers soars worldwide and the mobile internet becomes available to more people, search engines will become increasingly popular on mobile devices, too. Mobile search portals are made simpler and shrunk to work with mobile browsers and small screens. Consumers can use their mobile devices to perform searches just as they would from a desktop computer, whether it be to read the news, look up prices for a product, settle a trivia question, or verify their knowledge of history.

Global geographical knowledge

For the traveller, maps and guide books have always been a trusted aid. But they did have their limitations. They can very easily be out of date. It is not always convenient to carry around a world atlas. And moreover, most publications could not provide a global overview and detailed local information at the same time.

Seizing the opportunity that the internet provides, map publishers have put their geographical information online. Internet map services can be regularly updated, and made accessible to large numbers of users who retrieve information specific to the area they are interested in. Users can search directly for the district, street or shop name they want, and use the zoom to obtain the best map scale for viewing. Banks, post offices, parking lots, schools etc. can be located easily. Among the numerous map services available on the web are MapQuest, Google Maps and Yahoo! Maps, all of which are supported by web search engines. In addition to traditional two-dimensional maps, search engines are also opening up access to the huge databases of geographical data, transforming the map user's experience. In 2005, Google launched Google Earth, combining geographical depictions with satellite pictures of the earth (box 2.16). With its innovative and functional approach to displaying global information geographically, Google Earth was an instant hit.

As the number of mobile handheld devices grows, the demand for map services on the move is also growing. Map service providers offer essentially two kinds of service: users can either install a program onto their mobile device and then periodically purchase map updates, or they can use mobile web-capable devices to access map-based websites. The former option can function in standalone mode, whereas the latter requires an internet connection, typically in the form of a Wi-Fi hotspot or through the mobile service provider. This can be a handicap when travelling in remote areas where coverage is poor. Some mobile devices also have GPS functionality that makes them effective navigation aids when used in conjunction with maps.

The vast global knowledge web enables users find the information they need more easily and efficiently. While the web continues to grow at a staggering pace, it still represents only a small fraction of the content offered in the wider digital world. Entertainment content—for instance in the form of music, video, adult-only content, gaming, user-generated and context-aware content—is beginning to play a powerful role in shaping our new digital lifestyle.

2.4.2 Sights and sounds

The music industry was considered to be in decline in the late 1990s: users downloaded songs free of charge from the web (using semi-legal file-sharing systems) while sales of pre-recorded tapes and CDs fell. But now, the music industry is bouncing back as it finally embraces MP3 compression technology and creates legal ways to download music.

The future of music is certainly digital. Music can now be downloaded to a fixed device, or can be streamed directly from the internet. For mobile use, audio files can be copied to a compatible music player or phone. Because of the low transfer speeds on 2G mobile networks, music downloads have been

Box 2.15: Digital Knowledge
The Google Library project

The end may be in sight for the outdated search engines still used in many university and public libraries. Librarians can look forward to more targeted inter-library loan requests.

On 14 December 2004, Google announced the launch of Google Library Project. The company is scanning books from the libraries of Harvard, Stanford and Oxford University, the University of Michigan, the New York Public Library and elsewhere. As the digitized material is indexed by Google's search engine, it becomes searchable online. For books under copyright, users will see only a few sentences around the search term, to avoid copyright infringement.

Google Scholar is a closely related service for academic journals. Since 2005, it provides links to university libraries, online databases and subscription services, for the use of students and researchers.

Nonetheless, publishers are worried with many claiming that the industry will be harmed. Other analysts suggest that, on the contrary, the project will be good for book sales, and cite the case of Amazon.com, which found that sales increased when selected pages and content were made available online. Although some issues remain unresolved, Google is undoubtedly helping users find the most relevant information, as quickly as possible. In the next few years, as the Google Library Project enters full operation, we will experience a new stage in the evolution of search technology.

Image source: Google

Sources: Jonathan Band, "The Google Library Project: Both Sides of the Story", Information Outlook, Vol.10, Issue 9, June 2006; Google Press Center, "Google Checks Out Library Books", 14 December 2004 (at www.google.com/press)

prohibitively expensive. With song files taking up 3 to 4 MB each, music lovers needed to be patient, and relatively wealthy, to download them. The advent of 3G networks and mobile phones with a hard drive, is changing all this. Users can now purchase and play their favourite music when on the move, or swap it between devices. A leader in this field, as discussed above, has been Apple's iPod (box 2.10).

As music technology is finding its digital way, the video and TV broadcasting industry is also looking to develop a digital strategy. It may be difficult to imagine mobile devices ever replacing the plasma TV in living rooms; nonetheless, wireless carriers, broadcasters, handset manufacturers and content producers are all betting on the future of mobile TV and video. According to research firm IDC, by 2010 around 24 million US consumers, representing 9.2 per cent of cellular subscribers, will watch TV or video on mobile handsets, up from about 7 million. Revenue is set to quadruple to over USD 1.5 billion in 2006.[48]

As 3G networks enable mobile operators to bolster the quality of video provided to handsets, DVB-H technology (discussed above), which operates like broadcast TV without straining the capacity of the cellular network, is beginning to reach maturity. This is strong motivation for the media providers to make their content mobile, and to adjust it for different formats (e.g. live or on demand, full-length or abridged, streamed or downloaded, broadcast or one or to one). A new word, *mobisodes*, has entered the dictionary to refer to short mobile TV episodes. Last year, Fox launched its mobisodes "24: Conspiracy", each about a minute long and carrying parallel story lines to the TV series "24" starring Kiefer Sutherland. Another mobisode released by Fox is "Prison Break: Proof of Innocence" in April 2006[49]. Fox claims that it had more than 2 million downloads of its various mobisode series.

Still, the smooth delivery of video content, whether through 3G or DVB-H, remains technologically

Box 2.16: A mapping revolution
A map you can drive

It is probably safe to say that map sites have redefined the way we use maps. Like other online map services, Google Earth is designed to present geographical information on request. What makes Google Earth special is the way it presents that information.

Google has mapped virtually the entire earth by pasting images obtained from satellite imagery, aerial photography and global information systems onto a three-dimensional globe. Upon launching the program, the user sees a virtual globe from the perspective of a spaceship approaching the Earth. One can go directly to a destination at any level, by typing in a country name or a street name, or simply by double-clicking on a point, and zooming in. Google Earth also has digital terrain model data collected by NASA's Shuttle Radar Topography Mission. This means that the Grand Canyon or Mount Everest can be viewed in three dimensions. For some major cities, Google has provided a layer allowing one to see even buildings in three dimensions.

Epidemiologists, meteorologists and urban planners are discovering the magic of an aerial view of the globe. For them, one of the most attractive features is the ability to graphically depict many different types of data on the digital planet. They can set position markers for volcanic events, cases of bird flu, the locations of crimes, for example. A mouse click on a volcano marker opens a window containing images and explanatory text, or even a web camera shot of the smoking crater. Maps of ocean temperatures, for example, can be layered over the globe.

Google Earth also played an unexpectedly valuable role in the summer of 2005, following the disastrous flooding in New Orleans caused by Hurricane Katrina. After the hurricane struck, Google Earth rapidly added 8'000 post-disaster aerial photographs of flooded areas obtained from the US National Oceanic and Atmospheric Agency (NOAA). The images allowed disaster relief workers to scan areas on the computer to find passable roads, for example.

Image source: Google Earth

Source: Google Earth and Der Spiegel International

challenging. The ability of consumers to flip channels quickly is an important hurdle. There are also tradeoffs to consider between screen and device size, image resolution and battery life. Since the higher resolution screens consume more power, content providers have to make do with the small screen of most mobile devices. ESPN customizes sports highlights for mobile devices by showing close-up reactions of players and fans and tight shots of the action, making the best use of the small screen. Not surprisingly, sports is being seen as an important driver for mobile TV (box 2.17).

Yet, although almost everyone carries a phone, consumers ultimately may decide to use other portable devices for TV-type programming, such as a video iPod, a device for TV place-shifting such as a Slingbox, or a gaming device like a Sony PlayStation Portable (PSP). But despite the limitations of today's technology, it seems that as they go digital, audio and video service offerings are set to converge.

2.4.3 Adult content and gambling

One of the telecommunication industry's worst-kept secrets is that the early adoption of media-driven technologies can often be credited to the demand for adult content[50]. The list of technologies that were given an early boost by the sex industry is impressive: VHS, CD-ROM, DVD, pay-per-view TV, PC games, BBSs, premium-rate telephone lines and, even the World Wide Web. Mobile phone technology should be no exception, especially given its wide reach. As mobile providers try to

Box 2.17: Sports go digital

Living it large and seeing it small at the FIFA World Cup 2006 in Germany

Major global sporting events, such as the football World Cup or the Olympics, tend to act as triggers for the development of the ICT sector. For consumers, the urgency of following the event can justify a purchase while for manufacturers and service providers, it acts as appropriate timing for the release of an new product or service and a focus for marketing efforts.

For instance, many countries timed the introduction of colour television with the 1970 World Cup in Mexico, where Brazil beat Italy in what many consider to be the greatest ever final. Somewhat later, as Brazil and Italy met again in the final of the 1994 World Cup in the United States, fans had the chance to follow what was arguably the most tedious ever final on the World Wide Web, perhaps while browsing elsewhere for more exciting fare. In 1998, when the event was hosted and won by France, SMS was used both for score flashes and for French fans to coordinate their celebrations on the *Champs Elyssée*. By 2002, when Japan and the Republic of Korea jointly hosted another highly memorable tournament, 3G mobile services were formally launched in Korea during the Opening Ceremony. Thus landmarks in sporting history coincide with milestones in technological progress.

And so to Germany ⋯. Like all of the World Cups in the post-war period, the event provided a boost for the consumer electronics industry, especially for sales of HDTV-ready television sets and plasma screens. But it was what was happening outside the home, and at opposite ends of the spectrum of screen sizes, which marked the more significant innovations this time. Germany 2006 saw the launch of mobile TV services in a number of countries, including Italy (box 2.6) and the host country itself. Fans had been able to download and watch clips of games on their mobile phones for a couple of years, but now it was possible to watch near-live action delivered using DVB-H technology, at least in certain cities.

Available to far more fans was the experience of watching crystal-clear pictures on huge screens in cinemas and so-called fan-fests in host cities.

Using a technology developed under the auspices of ITU[52], called Large Scale Digital Imagery (LSDI), screens of up to 144 m2 broadcast live action to thousands of fans. Several screens were set up along *Strasse des 17 juni* in Berlin, close to the Brandenburg Gate, and two were constructed in the middle of the Rhine in Frankfurt. For those fans unable to get tickets for the sold-out games, here was a chance to participate in an event with family and friends and to enjoy the action which was almost as good as being at the game (and certainly cheaper). As a result, the number of fans attracted to Germany was far higher than could be accommodated in just the stadiums, to the delight of shopkeepers and tournament sponsors alike.

It was not only in Germany that the phenomenon of fan fests was experienced. In Hong Kong, shopping centres stayed open all night for the games. In Italy, the national team's victory on penalties in the final game was watched by around 180 000 people on the *Circo Massimo*, extending the live experience to far more than could afford to follow the team to Germany. And what was the lasting memory of the game? Zinedine Zidane's infamous headbutt on Italian defender Marco Materazzi in the closing minutes of extra time shocked and mystified those who saw it live. But within a few hours, it was being analysed on blogs, and posted on social networking sites and video-clip sites like YouTube. Indeed, within a few days, the short video clip had been animated by amateurs in many amusing and bizarre ways to bring humour and social comment to help demystify Zidane's actions. Such clips were sent around the world in forwarded e-mails and now probably fill more capacity on computer hard drives than existed in the whole world at the time of the 1954 World Cup, the first to be broadcast live on television. Technology and sport make a perfect marriage with sport, providing a commercial drive for technological development while ICTs help football to become the beautiful game once more.

Image source: sxc.hu

Source: ITU

reduce their dependence on voice and grow their data revenues, sexual content has invaded SMS, ring-tones, logos, wallpapers and games. For instance, a strip poker game can be played via mobile phone against both real and virtual opponents, with the real players paying in credit to gamble, while their glamorous opponents provide a sequence of ever-more revealing downloads[51]. The longer the game lasts, the higher the revenues for the service provider.

Now that colour screens are the norm on mobile phones and video streaming has advanced sufficiently to run comfortably (if not always smoothly) even on 2.5G systems, mobile adult content appears to be ready for takeoff. Big-name media brands like Playboy, Penthouse, Hustler and Private Media have set up their own mobile content divisions. Content has evolved from wallpapers and SMS to more sophisticated forms such as interactive applications, Java downloads and video clips. The arrival of 3G and feature-rich handsets is creating even more possibilities, leading to some analysts referring to the 3G of "Girls, Gambling and Games"[53]. Strategy Analytics reported USD 400 million in sales for mobile adult content in 2004, with global market projections of USD 2.1 billion by 2009.

While technology becomes less of a challenge for video distribution, social taboos and, in many cases, legal issues, impede the distribution of adult video content. In Ireland, for instance, 3G mobile phones must be registered under the names of adult owners, in an effort to protect children from inappropriate content.

For service providers, age verification is one of the key concerns. This can be done through credit card verification, and bans on selling services to underage subscribers. Mobile operators are taking initiatives in this area, with European operators adopting a code of practice and the CTIA in the USA developing similar guidelines. However, as with the internet, adult content on mobile phones can come from many sources. Blocking young people from all adult content will be an uphill battle. A focus on digital identity management, as discussed in chapter four, may be the way forward.

Once the technology became available, gambling, too, went digital. Users can choose from a large variety of online gambling services today, ranging from online casinos and sports betting, to bingo and poker. In Europe, credit or debit cards can be used to top up gambling accounts and receive the winnings. In the United States, these cards cannot be used for online gambling. But offshore electronic money services such as Firepay, Neteller, and Moneybookers provide accounts for avid gamblers. In July 2006, the Chief Executive Officer (CEO) of BetOnSports, a London-listed betting company, was arrested by US authorities. Along with 10 associates, he was charged with criminal racketeering and wire fraud. The indictment targets some USD 4.5 billion in holdings of the company. Stock prices of other big online gambling companies plummeted. Prosecutors are now getting tougher in response to recent draft US legislation forbidding internet gambling sites knowingly accepting payment from US citizens. The bill also called for criminalizing the processing of payments for online gambling by financial institutions.[54]

As the legality of online gambling varies between jurisdictions, there is often cause for dispute in a borderless digital world. For instance, the government of the island nation of Antigua and Barbuda, which licenses internet gambling entities, filed a complaint with the World Trade Organization (WTO) about the US government's efforts to impede online gaming. The Caribbean country won the preliminary ruling, but WTO's appeals body partly reversed the ruling in April 2005 – in particular, it ruled that the United States may be violating global trade rules because its laws regulating horse-racing bets were not applied equitably to foreign and domestic online betting companies.

Despite the legal hurdles, online gambling holds great potential for revenue generation, even more so than online adult content. It already represents a USD 12 billion industry that is expected to double in size by 2010, in part thanks to mobile technology. In addition to attracting customers from the United States and Europe, operators are turning to Asia and its sizable customer base. However, Asian governments may follow the United States in strictly regulating online gambling to reduce the social impact of this highly lucrative business, or at least for the purposes of taxation.

2.4.4 Online gaming

Broadband internet access has been a boon to fans of computer games. Early computer games were typically single-player activities involving a virtual opponent, or multi-player activities with opponents or partners who had to be in the same room. Today, multiplayer online games can take place over digital networks, across the world, and can involve flexible and complex configurations of players.

An important type of online game is the "massively multiplayer online role-paying game" (MMORPG), which can support hundreds or thousands of players simultaneously. The MMORPG takes place in a giant, always-on virtual world, with players competing or cooperating on a grand scale. The type of dedication that MMORPGs demand from players is very intense, and often requires some degree of withdrawal from the real world (box 2.19).

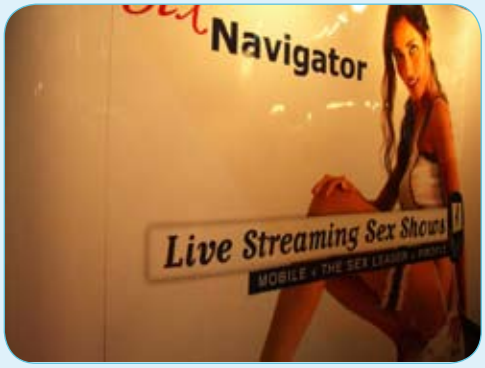
To support a very large number of players, MMORPGs need large-scale game worlds. In some games, large areas of the map are interconnected, so that a player can traverse vast distances without having to switch servers manually. For example, the *Tribes* game requires a number of large maps, and to enable a smooth gaming experience, each server plays in rotation. In PlanetSide, on the other hand, all map-like areas of the game are accessible (by flying, driving, or teleporting). MMORPGs typically charge players a monthly fee for access to the servers, and players are able to progressively build up their level, or to "buy" ready-made characters, with attractive skill-levels or other assets, from other players. Indeed, a new career is emerging for teenage gamers, particularly in China, who spend hours building digital characters before selling them on.

Recently, games consoles, such as PlayStation 2, have also begun to support internet and LAN gaming. Console gamers can use their television as the display unit. Many mobile phones also support wireless gaming through Bluetooth or similar technologies; however, their popularity is limited, due to speed restrictions, the small display screen and limited battery life. Instead, other types of gaming are being developed for mobile phones that exploit the potential of moving around in the

Box 2.18: No sex please, we're third generation

An Asian government expresses concern over 3G

Concerns about the social impact of adult content are not new. But in an unusual twist, the government of Cambodia has decided to ban 3G services completely, on the grounds that they can be used to send and receive pornographic pictures and video. The decision represents the successful culmination of a campaign led by the wives of prominent government officials. The Cambodian prime minister argued that 3G technology is too advanced for the Cambodian people, and explained that voice and SMS should be enough for the time being.



In Singapore, there are already over 360'000 3G subscribers and the high-speed phones are ideal for youngsters who want to browse and download information—including questionable content. With this in mind, the National Internet Advisory Committee (NIAC) of Singapore recently proposed measures allowing parents to monitor their children's online behaviour. NIAC recommends that telecom operators allow parents to screen what their increasingly tech-savvy children are viewing with their mobile phones and examine their browsing history. SingTel, the operator with the largest share of the 3G mobile market, welcomed initiatives to protect children from obscene online content and promised to study the recommendations.

Image source: flickr.com (Héctor Milla)

Source: "No 3G, please", Wireless Asia, 28 June 2006.

Box 2.19: Start your next life online

Second Life is an online game that gives you a new life in a virtual world

Bored with your life? Start a new one, on the internet! Design your new appearance, home, friends. This virtual utopia can be as detailed as you like, and you are the sovereign – down to details of currency, economy and government.

This is all possible in games such as Second Life, launched in 2003 by San Francisco-based Linden Lab. The Second Life "world" resides in a large array of Linden Lab servers. Subscribers ("residents") run the Second Life client program which allows them, via the internet, to view and modify the Second Life world and participate in its economy. Most of the content is resident-created; indeed, residents retain the intellectual property rights.

Second Life residents are represented by an avatar (see box 4.1), which may be customized in a variety of ways. The basic avatar is a humanoid in shape and, through a series of graphical user interface (GUI) controls, can be modified by adjusting parameters such as size, build, colours and hair style. Residents can also create or buy clothing, and fit out their avatars with accessories.

Second Life has its own economy, and a currency called Linden dollars (LUSD). Residents receive an initial amount of LUSD when they open an account, and a weekly stipend thereafter, the amount depending on the type of account. Additional currency can be acquired by selling objects or services within the environment. Residents can purchase LUSD directly, or convert between Linden currency and US currency through Linden Lab's currency brokerage, the LindX Currency Exchange, with a rate that fluctuates daily. Interest groups can be created for a fee of LUSD 100. After three days an additional two members must have been recruited, otherwise the investment is lost and the group is deleted.

Second Life has become very popular. Many real-world celebrities have confessed to "living" their second lives in the virtual world. Problems also exist in this utopia. Some residents are malevolent; thus, groups of residents are actively trying to damage the world, by creating self-replicating objects that may eventually paralyse the server. Second Life speculators buy land at low costs in hopes of earning quick profits when it appreciates in value. There have even been real-life lawsuits against Linden Labs for loss of virtual property. A virtual second life may not be such a utopia after all.

Image source: secondlife.com

Source: secondlife.com

real world while playing a game. These generate revenues through transactions (e.g. sending and receiving SMS) in addition to subscriptions[55].

As a form of entertainment, online gaming is here to stay, though it seems that overindulgence may be hazardous. Every hour spent gaming is an hour away from the 'real' world, and too many hours at play have been seen to lead to physical and psychological health risks. An exaggerated example is the gamer in South Korea who died after playing an online game for 50 hours with hardly a break[56]. A minority of gamers do develop a dependency, spending as many hours as possible online or with video games each day. With no social life to speak of, and no friends outside the cyberworld, these young refugees from the non-virtual world may raise social problems that go beyond their own physical health.

2.4.5 User-generated content

Recent years have seen a large increase in user-generated content, spurred not only by growing numbers of users but also by the increasingly

active and diverse nature of user involvement in the digital sphere. There has been a natural evolution of the user's role, from passive observer to active contributor. Many forms of user-generated content can be seen as a natural extension of individual expression, e.g. the blog can be seen as a continuation of the conventional diary. Two of the most successful examples of user-generated content are the video sharing website YouTube (box 2.20), and Wikipedia, the online encyclopaedia.

A blog is essentially a web-accessible journal that is intended to be shared with friends, family or the general public. It can include text, images, video and audio, all assembled with standard, easy to use blog creation software. The usual superlatives apply: it is estimated that new blogs are being created at the rate of one per second[58]. Their importance in the realm of public discourse has led to the coining of the word 'blogosphere'. Blogs are a relatively persistent form of user-generated content, with 55 per cent of all new bloggers still posting three months after they started.[59] Many blogs are created with the purpose of tracking or chronicling particular events, or as an attempt to attract a wider audience. Blogs have been created to comment on the war in Iraq[60], terrorist bombings in Mumbai and London[61], and natural disasters such as Hurricane Katrina in 2005[62]. Blogs allow users to keep track of rapidly evolving situations, as part of the wider concept of "citizen journalism", or to coordinate campaigns (such as the 'Free Our Data' blog run by the Guardian newspaper[63] in the United Kingdom). Institutional blogs have also sprung up, as governments and businesses search for a more informal voice in which to communicate with the general public[64]. Still other blogs are created in hopes of generating income through advertising packages tied to websites such as Google.

Podcasting is an audio variant on blogging: the term is a combination of iPod (the name of Apple's popular portable audio device) and broadcasting. Podcasting consists of making regularly produced audio shows available on the web. It frees listeners from the constraints of a broadcasting schedule by allowing them to listen to programming when and where they like. Podcasts can cater to highly specialized listening markets, unlike traditional radio, which is subject to the discipline of listener ratings[65]. Podcast website iPodder.org lists categories such as food, games, beer, business and automotive. Even the Vatican has its own podcast—the "Catholic Insider" podcast show[66]. Most podcasting is free of charge for the listener, and comes without any commercial advertising. The highly individual character of podcasts makes them an ideal medium for targeted advertising. This is being exploited in a commercial spin-off of podcasting known as nanocasting.

Another prominent example of user-generated content are wikis, made popular by websites such as wikipedia.org. Wikis are collaborative websites in which users (not necessarily registered) are able to read, but also create, modify and even remove public content (a subset is the corporate wiki, which is beginning to replace the static corporate intranet). Wikipedia, launched in 2001, is an online encyclopedia that is entirely user-generated. Nonetheless, a much-discussed survey by Nature found that the accuracy of Wikipedia's science entries compares favourably with those in traditional peer-reviewed publications, such as the *Encyclopaedia Britannica*[67]. Most wikis have a system that records changes, so that at any time, a page can be restored to any of its previous states. This feature is useful in guarding against vandalism, to which wikis are particularly susceptible due to their open philosophy. Generally speaking, though, the community aspect of wikis seems to encourage user responsibility, and studies by IBM have found that most vandalism to Wikipedia is removed in five minutes or less.[68] There are times, however, when pranks are welcome in the digital world: a large proportion of user-generated content on the internet has to do with homegrown humour, like the Asian phenomenon of kuso (box 2.21).

2.4.6 Towards context-aware services

Imagine walking through a shopping district when the mobile phone rings. It's your favourite shop, which has registered that you are in the vicinity and automatically called to promote a new item that you might be interested in (according to their data on your previous purchases). Suppose you enter the shop, and find a shirt you like, but size 10 is out of stock. A quick scan with your mobile phone over the shirt's label tells you which other branches have a size 10 in stock, and provides you with directions on

Box 2.20: Broadcast yourself

User-posted videos fuel debate

YouTube, a video sharing website, has become part of the mainstream in a very short time. The website attracts more than 100 million visitors per day, accounting for 60 per cent of videos watched online, far ahead of competing sites on MySpace, Google, Yahoo!, AOL, and MSN. Although many of the video clips are pirated, the site has become a mainstream fixture. So much so, in fact, that Google announced it would purchase the video-sharing site in October 2006.[57]

Video images posted on YouTube are complementing traditional news coverage. Thus, media organizations such as BBC and *The New York Times* ran background links to online video postings from people affected by the July 2006 fighting in southern Lebanon. Similarly, a five-second video posted on YouTube, showing the US president massaging the German chancellor's neck during the G8 Summit, sparked a lively debate in the German and US press as to whether this was appropriate behaviour. In the words of a political science professor quoted in the *China Daily*, "Today, public figures have to be more careful in 'a thousand ways'".

The sheer volume of video postings, and the user-oriented nature of websites such as YouTube, makes the issue of control problematic. Users are encouraged to flag harmful content, and the host may then take steps to remove it; the volume and pace of posting outstrips efforts to control it. At any rate, what is harmful is often a matter of opinion. For example, military authorities have been embarrassed by clearly news-worthy material posted by soldiers from the front lines. Video posters also create a problem when they ignore intellectual property rights. In Japan, where the number of YouTube users is very high, JSRAC, a pro-intellectual property rights agency, has been asking YouTube to remove protected content.

Websites such as YouTube, for all their rough-and-ready nature, are an important social and business phenomenon. Mainstream media closely scour them for newsworthy postings; public personalities are painfully aware of their vulnerability to the all-seeing video eye; and those who have a stake in protecting intellectual property are just waking up to the implicit challenge of video sharing. The debate is just beginning.

Image source: YouTube

Source: Various, including *Daily Telegraph*, "Pentagon declares war in internet combat videos, troops told to stop oploading films which make the US look anti-Arab", 26 July 2006.; *Guardian Unlimited*, "Bush rubs Merkel up the Wrong Way", 26 July 2006; The *New York Times*, "Anne Frank 2006: War diaries online", 24 July 2006; *China Daily*, "Bush back rubs magnified on internet", 22 July 2006; BBC News, "YouTube hits 100m videos per day", 17 July 2006.

how to reach them. After finishing your shopping, you get in the car to drive back home. You're low on fuel, so the car's satellite navigation system discreetly suggests a fuel station around the corner. The next morning, as you leave for work, your umbrella and raincoat prompt you with a whistle: the forecast is for rain. At work, sensors in your computer mouse and your telephone handset detect an abnormally high body temperature; you're coming down with the flu, and your monitor flashes up a warning, along with healthcare advice and information. Though these ideas might sound futuristic, they are merely examples of the kind of context-aware services that will become routinely available in a ubiquitously networked world.

Marc Weiser's vision of ubiquitous computing is one in which people and their environments are augmented with computational resources to

provide information when and where it is needed.[69] Context-aware computing can be defined as applications that have the ability to detect and react to environmental variables[70]. It can be seen as the analogue to a human assistant, making our interactions with everyday services and things even smoother. It is certainly a powerful concept, but is it really what people want? In a truly ubiquitous networked system, users themselves are not outside the system - they are part of it. Thus, the level of user control is of considerable importance, as are the number and type of interactions between users and enabled devices.

Analysts have identified three different levels of interactivity between a mobile device and a user: personalization, passive context-awareness and active context-awareness.[71] Each successive level takes from the user some of the customary control over the services. A pull-oriented framework is one in which the user defines the services they wish to use, while a push-oriented framework has unsolicited services 'pushed' at the user. Location-tracking provides a good example. A personalized service might allow the user to manually keep location data for a list of friends; a passive context-aware service would track their location automatically; and an active context-aware system would automatically alert the user when friends are detected nearby. Not surprisingly, users lose more control when using passive and active context-aware applications, than when personalizing their own applications. Despite this, users may prefer context-aware applications over personalized systems, due to the potential for added convenience.

Mobile telephones are the most widely used ICT device today, so RFID–enabled and sensor-enabled mobile networking will be a significant step towards the ubiquitous networked environment, and increased context awareness. As discussed earlier, sensors are particularly useful in situations where human involvement would be dangerous, impractical, or prohibitively expensive, such as monitoring an accident-prone zone or inspecting the physical condition of a bridge or a railway line. Camera phones already have built-in sound and visual sensors. But developments are ongoing to provide additional sensor capabilities for mobile phones, from blood glucose testing to a sense of smell[72]. Biometric sensors can enhance the security of a phone and prevent unauthorized use. Mobile phones could also alert their owners to a change of status in their environment, for instance with a built-in smoke alarm.[73]

Despite their great potential, context-aware services will have some unintended repercussions, such as the invasion of privacy. A balance must be struck between convenience and public interest. The implications of new technologies need to be explored early in the design phase, so that steps can be taken in good time to protect sensitive data and consumer privacy (see discussion in chapter four).

Box 2.21: KUSO!

Japanese word takes on a new digital meaning

'Kuso' (based on a scatological interjection in Japanese) is a word that has come to refer to internet parodies of pop songs, movies, comics etc. The term—like the phenomenon—has spread around Asia. A lively kuso community is now busy exchanging these digital parodies.

One of the best-known examples of kuso is the "Back Dorm Boys". This Chinese male duo became famous for their lip sync music videos to songs by the group Backstreet Boys. Their many other productions, captured on a low-quality web camera in their college dormitory room, were distributed rapidly on the internet within mainland China and eventually overseas. The two boys, Wei Wei and Huang Yi Xin, were signed up by *Sina.com*, one of the largest internet portal websites in China, after graduating from Guangzhou Arts Institute in June 2006.

Image source: YouTube

Source: Richlyi.com

2.4.7 Digital homes

Increased convergence—for instance between fixed and mobile telecommunications, technology and media, internet and television, and so on—has finally brought the digital home within grasp. Convergence allows devices and technologies to communicate seamlessly, enabling consumers to combine devices from different manufacturers. In the past, consumers were "locked in", compelled to stick with one manufacturer, in order to avoid compatibility problems. Moreover, the cost of installing and maintaining digital homes was high, making consumers reluctant to build or buy them. In recent years, however, compatibility problems have been greatly reduced as communication technology advances and manufacturers increasingly focus on collaboration (e.g. the Digital Living Network Alliance[74]).

There are, however, a number of technical and social concerns associated with digital homes. A major hurdle is the conversion of conventionally designed houses. Adoption of digital home technologies is likely to take place in an incremental and disjointed fashion[75], at least in the initial stages. In digital homes, owners will most likely have to act as system administrators, working to ensure that all domestic appliances run smoothly. Experience suggests that installing and managing a single appliance may be feasible, but making several devices interoperate will be a challenge for most people. Moreover, the impact of new technologies tends to be hard to predict, and the social dynamics and relationships within the home may make it a more sensitive environment, than for instance, a place of business. The question that remains is how intelligent a home should be, and how can innovation and convenience, on the one hand, and domestic comfort and stability, on the other, be properly balanced?

2.5 Digital transactions

With the growth of the internet and always-on access, the number of transactions conducted digitally has grown significantly over the last decade. As such, the field of electronic commerce has been the subject of much study and speculation. One of the main stumbling blocks to electronic commerce has been the lack of an effective and secure payment system. Today, most people use the traditional credit card for digital transactions, with security being provided by firms such as PayPal. But digital transactions is now an area ripe for change. Credit cards may remain the norm for some time to come, but micropayments, too, may be making a comeback. And the rapid take-up of mobile phones, together with the use of RFID, has created great anticipation about possibilities for mobile transactions on the go.

2.5.1 Contactless payment systems

A contactless payment system allows the user to pay for goods and services using a smart card that may either contain a pre-loaded cash balance, or is linked to a bank or credit account to which the payments are charged. Smart cards, based on RFID technology, look and feel exactly like a regular bank card, but offer both the end-users and retailers a number of additional advantages. The primary benefit is that transactions can be carried out more swiftly, reducing congestion in the stores and obviating the need for consumers to carry around large quantities of cash. Contactless payment systems are in use across Asia, Europe and North America. According to IDTechEx, contactless payment systems represent the single largest market by value for RFID, although this is likely to be eclipsed in 2007 by the market for item-level tagging.[76]

There are a number of different technologies for contactless payment, but the RFID standard ISO 14443 is the most common for business to consumer transactions, accounting for more than 80 per cent of contactless credit card transactions worldwide. Data transmitted by ISO 14443 chips is encrypted, and the transmission range is designed to be very short, at around 100 mm or less.[77]

Contactless systems are certainly a step beyond traditional bank cards, or paper tickets on public transport systems (box 2.22). But if the user has to carry a different contactless card for each application—one linked to their bank account for store purchases, another for use on one city's public transport network, and yet another for a different city—then any gain in convenience is reduced. Manufacturers are therefore looking at ways to use the technology in a form that can be more easily combined and transferred.

2.5.2 Mobile payments

Examples of mobile payment systems include the SMS-based pre-payment metering schemes for electricity and gas that have been developed by LogicaCMG and Iskraemeco ECL in the United Kingdom[78]. One of the most advanced and cutting-edge economies in terms of e-commerce development is Japan. A Eurotechnology study[79] estimates that the Japanese mobile commerce market is already worth some USD 10 billion per year. Japanese mobile commerce revenue exceeded that of mobile content in 2004, and Eurotechnology predicts that it will hit the USD 100 million mark in the not-too-distant future.

A study by Royal Philips Electronics and Visa International[80] found that retail purchases with a mobile phone were well received by consumers, who praised the ease, convenience and speed of the contactless payment system. In Japan, customers of NTT DoCoMo have been able to take advantage of a "digital wallet service" since early 2005[81]. The service operates using RFID technology, enabled by the integration of a SONY FeliCa contactless smart chip into the customer's mobile phone. Just five months after the introduction of the service, over a million individuals had already signed up. The main services on offer are:

a) withdrawing cash at ATMs;

b) shopping at kiosks and vending machines;

c) buying train or air tickets;

d) buying tickets for concerts, cinemas and theatres;

e) doubling as a member card for sports clubs and shops;

f) key/ID for security doors (both corporate and residential);

g) shopping online.

Most mobile phone payment systems operate using the Near Field Communications (NFC) standard, a short-range wireless technology operating at 13.56 MHz[82]. A study from ABI Research[83] predicts that, of the estimated 830 million new phones that will be constructed worldwide in 2009, 30 per cent will be NFC compliant. Consultants Booz Allen Hamilton[84] reported in August 2006 that mobile payment solutions have realistic prospects of successful market penetration worldwide. The authors identified the drivers underlying the interest in mobile payment systems:

a) Device manufacturers are looking to position the mobile phone even more firmly in the heart of everyday life, by looking at additional sales drivers, like mobile payment;

b) Credit card associations are looking to contactless payments, due to an increasing marginalization by the card issuers;

c) Banks would like to promote cashless payment transactions, in order to cut costs;

d) Retailers are attracted by the prospect of reducing per-payment transaction costs through mobile payment systems.

2.5.3 The revival of micropayments?

Micropayments are financial transactions involving such small amounts of money that collection with conventional payment systems is impractical, essentially because of the disproportionate cost[85]. A micropayment system will usually accumulate a number of different micropayments, and then collect the cumulative amount as a single payment.

First-generation micropayments systems were introduced around 1994, but failed to thrive and disappeared when the *dot.com* bubble collapsed. A second generation is now emerging, and appears to be benefiting from lessons learned first time around. Micropayments have been used for purchasing music and video downloads, and for online games, where the basic game is provided for free, but the user pays for enhancements. Among online individual content payments, the share of micropayments increased from 7.4 per cent in 2003, to 17.9 per cent in 2004, with almost USD 50 million paid using micropayment systems in 2004. This increase in the use of micropayment systems has been mirrored by the share of content subscriptions dropping from 89 per cent to 84.6 per cent over the same period.[86]

First-generation systems, which included systems such as DigiCash, eCash, MilliCent and CyberCoin,

Box 2.22: Buy faster, board faster

RFID ticketing for the world's major transport systems

Some of the world's busiest transport systems have turned to contactless payment systems. In London, Hong Kong and Japan, where many millions of people use the public transport systems every day, contactless tickets significantly speed up ticketing and boarding.

Japan's JR East railway operator introduced "Suica" in 2001. The Super Urban Intelligent Card uses a Sony FeliCa RFID chip, and is pre-loaded with a balance against which travel costs can be debited. Some Suica cards double as credit cards, and can be used even in shops where the Suica system is not supported. The cards also recharge themselves from the credit card account automatically when the balance runs low.

Hong Kong's Octopus is one of the most successful electronic cash systems in the world; the number of cards in circulation is nearly twice the Hong Kong population, and over nine million transactions are processed per day. Launched in 1997 as a fare collection system, it proved so successful that it is now used for virtually all public transport in Hong Kong, as well as payments at supermarkets, fast food stores, car parks and service stations. It even has a feature for donating money to charity. Like the Japanese Suica card, Octopus uses a Sony FeliCa RFID chip, and data is transmitted at up to 212 kbit/s. The range is between 3 and 10 cm. Payment is made by holding the card in close proximity to a card reader, which beeps to acknowledge payment, and displays the card's remaining balance. The Octopus card is anonymous, with no personal information, bank card or credit card details stored on the card. An automatic add value service (AAVS) allows the owner to specify a bank account or credit card from which to automatically add funds to the card if the balance should fall below zero.

The Oyster card is London's solution for contactless payment. First issued in 2003, the cards are now used by over 5 million people. The card is based on Philips' MIFARE chips, and likewise has a range of about 10 cm. Owners can load the card up with a pay-as-you-go balance, or use it in a restricted mode as a dedicated transport pass. Travellers 'touch in' and 'touch out' at the start and end of each journey. Like the Suica and Octopus, the Oyster card can be set up to automatically top-up when the balance runs low.

Image source: Oyster

Source: Smart Card Alliance, "Contactless Payment at the Retail Point of Sale: Applications, Technologies and Transaction Models", March 2003, available at www.smartcardalliance.org; CIO Insight, "How Safe Are the New Contactless Payment Systems?", 20 June 2005, available at www.cioinsight.com

had a number of disadvantages. These systems were mostly token-based rather than account-based, meaning that users purchased tokens or "e-coins" which they could then use to buy items. Token-based systems are less readily scalable than account-based systems, given the need for a central administration to issue and redeem tokens or e-coins. First-generation systems also had very cumbersome interfaces that were anything but user-friendly, requiring a solid grounding in encryption, digital signatures and transport protocols on the part of the users. In some cases, special hardware was also needed. Payments took a long time to complete, and because most systems required customers to install wallet software, payments had to be made from the same computer each time, meaning that systems were not portable.

Second-generation micropayment systems are almost uniquely account-based systems, so they are more readily scalable. They have also achieved greater coverage than first generation systems, partly because customers are more used to working on the internet, and to the concept of paid content. Second-generation systems are also for the most part free of charge for the user, unlike some first-generation systems that charged a set-up fee,

monthly maintenance costs, and a further fee for each individual transaction.

Over the last few years, the number of merchants using second-generation payment systems has significantly increased. Click&Buy has over three million customers and 2'500 merchants; PaySafeCard has over 2'000 merchants, and in early 2005, Bitpass had registered over 1'900 content merchants. Online music retailers, such as Apple's iTunes and Yahoo! Music and Amazon, are good examples of successful second-generation micropayment websites. Apple's website consolidates multiple micropayments into a single credit card transaction, thus avoiding one of the primary drawbacks associated with micropayments: the disproportionate size of the credit card transaction fee for a single transaction.

Although second-generation systems appear to be more enduring than their first-generation counterparts, neither first nor second-generation micropayment systems have successfully addressed the issue of interoperability. The World Wide Web Consortium (W3C) set up a Micropayment Markup Working Group which went on to develop a Micropayment Transfer Protocol (MPTP 1995), as well as the common mark-up for micropayment per-fee-links language. However, neither the protocol nor the language became full standards, and the group was terminated around 1999. The issue of interoperability therefore remains unresolved, but the success of second-generation systems should encourage the industry to return to the issue.[87]

All digital transactions, whilst offering end-users convenience and in many cases the ability to more easily and closely track their payments than for non-digital transactions, also raise the issue of security and privacy. As the number of digital transactions increases, criminals will search for vulnerabilities in the system which they can exploit. Because of this, digital transaction systems need to be developed in tandem with digital security and identity schemes.

2.6 It's all about convergence

The long-anticipated wave of digital convergence is likely to be driven by consumers as much as suppliers[88]. Mobile and fixed-line networks had appeared to be drifting apart as they developed different features and targeted different markets, but today they are increasingly targeting the same applications. Similarly, convergence between the telecommunication sector, the broadcasting sector and the internet means that both competition and collaboration are crucial.

Connected computing technologies are giving shape to a future internet of things. Multi-functional and personalized user devices are becoming an inseparable part of our lives, as the transition from analogue to digital continues apace.

Telecommunications networks, especially broad-band ones, are opening our lives to digital content to an unprecedented extent. Information, entertainment, gambling and gaming services are more easily available than ever before. Users themselves are able to publish self-generated content and compete directly with the media giants.

Given the extent to which digital technologies have invaded our real world lives, it is hard to remember that the world wide web and the digital mobile phone are only 15 years old, and the PC only slightly older at 25 years. What does the next 25 years hold in store?

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chapter three
business.digital

3.1. Deriving value

3.1.1 A huge market (however you slice it)

How big is the market for digital lifestyles addressed by this report?

- At one level, it is a huge market representing digital industries such as telecommunications, computing and broadcasting with a combined sales turnover equivalent to around 7 per cent of global GDP (Box 3.1).
- At another level, it is a market of one person ("me"), who is just as likely to value services delivered free-of-charge as those for which a price is demanded.

Therefore, building a business model to derive value from digital lifestyles involves seeking common elements among the six billion plus "me" markets and combining free-of-charge and paid-for content into a 'must-have' package. It is a market in which conventional distinctions—for instance, between business and residential services, or between urban and rural areas—bear less relevance than in the past, but in which new, more meaningful types of segmentation are needed but remain elusive.

Traditionally, markets have been viewed in terms of supply and demand, in which vendors and service providers create value for which consumers are willing to pay. But, in the emerging digital world, it is just as likely to be the consumers themselves that create the value. The classic examples of this are the massively multi-player online role-playing games (MMORPGs), or the social networking websites explored in chapter two, where the majority of content is created by users, but within a broad set of parameters and rules established by the service provider. More conventional businesses, such as telecommunication operators, have also begun heading in this direction. In the 19th Century, telegraph messages were typed and decoded directly by employees of the telegraph company. By the 20th Century, users could send and receive messages themselves, but most of the equipment comprising the network was owned and operated by the telephone company. In the 21st Century, equipment owned directly by the user is increasingly being used to transmit messages (for instance, via P2P networks such as those used by Skype, or via inter-locking Wi-Fi networks).

This trend towards making the users of a service participate in its provision is sometimes called "McDonaldization", after the famous fast-food chain that invites its customers to serve themselves and clear their table after they have eaten.[1] Similar trends can be noted in computing (for instance through the free and open source software (FOSS) movement and in broadcasting (where reality TV and phone-in programmes use ordinary people and viewers to create content). Perhaps the biggest success that telephone and broadcasting companies have made in persuading users to create their own value is in the growing market for SMS (box 3.2).

Box 3.1: Digital business is big business

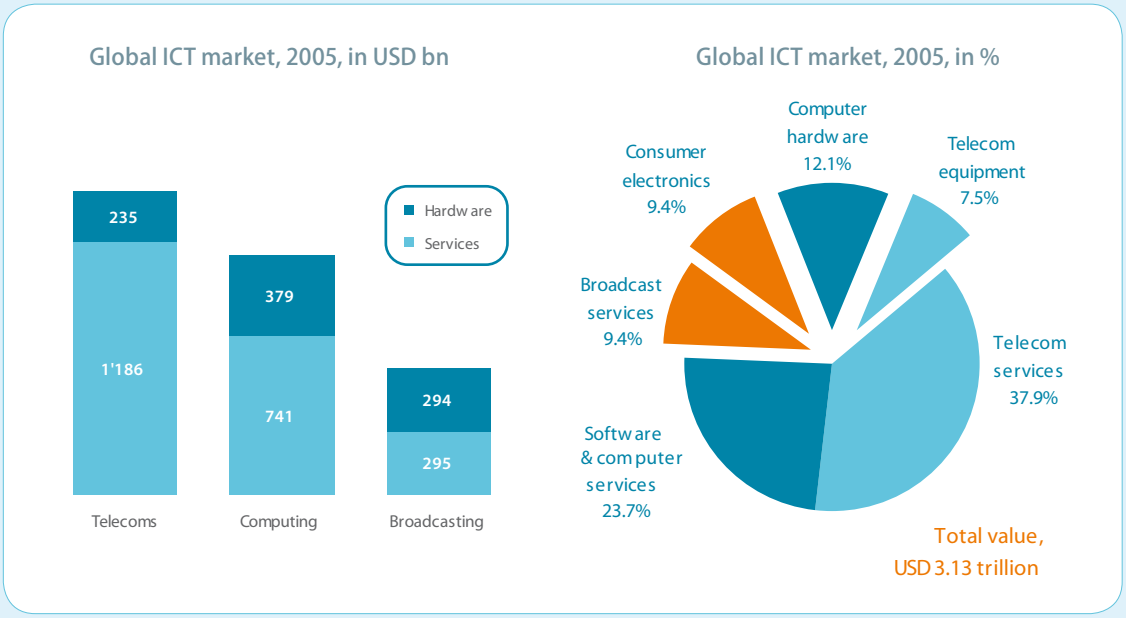
Estimating the ICT market size

The market addressed in this report may be interpreted as the combined sectors of telecommunications, computing and broadcasting which together constitute the sector for information and communication technologies (ICTs). This is a global market worth some USD 3.13 trillion in 2005, equivalent to around 7.6 per cent of Gross Domestic Product (GDP). It is a market that continues to grow at a slightly faster rate than global GDP, at around 6 per cent during 2005.

Just over two-thirds of the market comes from sale of services, with telecom services being the main component. Of the remaining 29 per cent, which derives from equipment sales, computer hardware is the major component, despite the continuing fall in the price of semiconductor chips for a given level of performance following "Moore's Law"[2]. Telecoms is the largest sector overall, but has the lowest ratio of equipment to services sales (at 1:5). By contrast, in the broadcasting market, the ratio between sales of broadcast services to sales of equipment is approximately 1:1, with the majority of service sales income coming from advertising rather than directly from end-users.

Of course, there can be endless debates as to how the market is defined: should semiconductors or music be included, for instance? Should consumer electronics be left out? Does "internet" constitute a whole market segment in its own right? Such queries are normal in a sector where technological change is a driving force.

The global market for ICT hardware and services, broken down by percentages and USD values



Note: These figures are expressed in USD values at 2005 levels. They cannot be compared directly with comparisons published in earlier years because of currency fluctuations.

Source: ITU Information Society Statistics Database, IDATE

The trends towards personalisation of services and user-created value in digital lifestyles are shaping the market in a number of significant ways:

- Customers are now generating a higher share of network investment than in the past. More and more equipment is owned directly by customers (e.g. PCs, mobile phones, broadband routers and Wi-Fi networks, etc.), while for service providers, the costs of market entry have fallen. This is especially true in those countries that have adopted unbundling of the local loop, or infrastructure-sharing on wireless masts, meaning that it is no longer necessary for new entrants to construct a network from scratch. Thus, vendors looking to create new market openings are increasingly having to

Box 3.2: Short messages, big profits

SMS—a great success for operators in both developed and developing markets

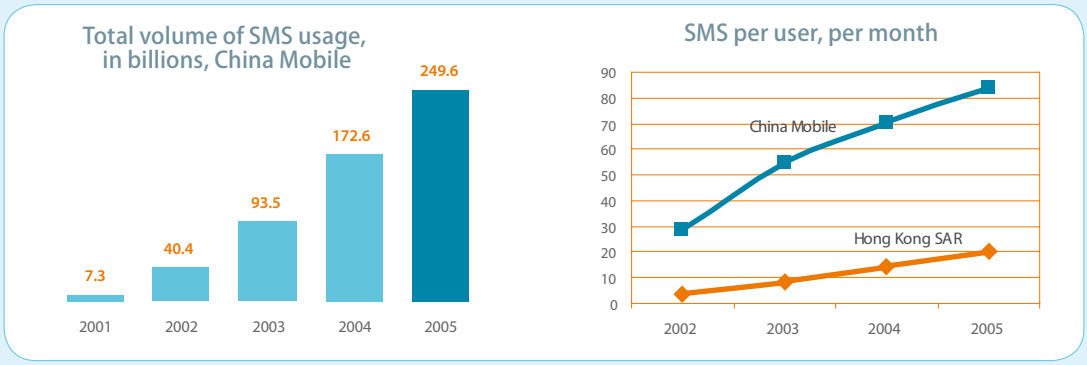
Short Message Service, or SMS as it is better known, is a curious market in which users, rather than operators, take the initiative. The capacity to send messages of short duration (around 160 characters) was built into the technical specification of the second-generation (2G) mobile system called GSM (Global System for Mobile communications) which was launched commercially in July 1991. But mobile operators did not perceive that such a cumbersome system for composing and sending messages between users would ever become popular. It took a few years for users to discover the hidden capacity to send text messages, and when they did, it was users in the Philippines who first popularized the service. A large number of free SMS messages were included in pre-paid packages, and when the credit to make outgoing voice calls ran out, SMS messages started to be used for soliciting incoming calls. During a brief period at the start of the Millennium, the Philippines' volume of SMS exceeded that of Europe, the USA and China combined.[3] Europe and China have caught up rapidly, but the USA still lags behind.

Globally, the volume of text messages sent from mobile phones is worth around USD 80 bn per year and continues to grow, especially in developing countries and for premium-rate services. An example of the latter is the enormous success of reality TV programmes, like American Idol or Big Brother, that combine live action with interactive texting from viewers to determine the outcome. The final of the 2005 UK edition of Big Brother generated some 6.4m texts in a single night, at a premium-rate of 50p each, generating revenues of £3.2m (USD 5.9m), to be split between the production company (Endemol), the broadcaster (Channel 4), the different mobile network operators and a charity.[4] Perhaps it is no surprise that Endemol, which pioneered this model, is owned by a telephone company (Telefónica de España).

However, the biggest potential revenues for SMS come from the developing world where, ironically, it is often seen as a cheaper alternative to mobile voice calls. An illustration of this comes from a comparison between Hong Kong SAR and mainland China. In Hong Kong, with a wealthy, sophisticated and young user base, and an intensively competitive market, one would imagine that conditions were ideal for the spread of SMS. But take-up has been slow, with a monthly volume in December 2005 of around 20 per user per month. In China, by contrast, this usage level was already attained five years earlier, and in 2005, SMS usage totaled around 250 billion SMS, or 84 per user per month. Nevertheless, this still pales into insignificance compared with Singaporean usage, which is over 110 per user per month.

Why the difference in popularity of SMS? Price is one factor, but not so much the absolute level as the relative price. An SMS in Hong Kong SAR, at around 2.6 US cents, is less than a third of the global average. But, more significantly, a mobile voice call is only marginally more expensive than an SMS in Hong Kong, and usage packages typically contain around 1'000 minutes of use, whereas in China, a user can send up to eight SMS for the price of a single minute of voice (with costs shared between user and receiver) Internet usage and answerphone ownership are also relatively low in China, so some SMS usage substitutes for e-mail and voice-mail, with the latter being, in any case, culturally unpopular in China. Whatever the reasons, SMS is financially significant for China Mobile, contributing some RMB 24.7 bn (USD 3.1bn) or around 10 per cent of 2005 revenues.

SMS in China and Hong Kong SAR



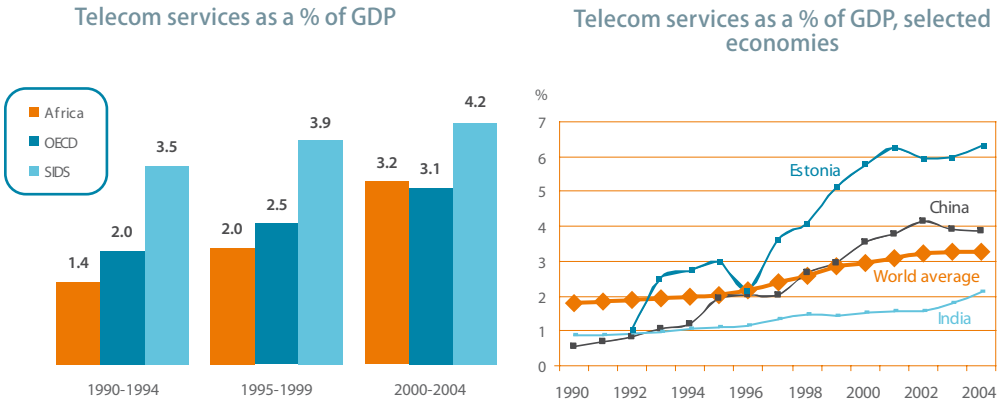
Note: For China, figures represent the results of only China Mobile (i.e. excluding results for China Unicom), while for Hong Kong SAR, the figures include SMS sent for all mobile operators.[5]

Source: China Mobile Annual Report, available at: www.chinamobileltd.com/. OFTA statistics, at www.ofta.gov.hk/en/datastat/main.html[6]

address the consumer market directly, rather than only their traditional market of networks and service providers, as explored in section 3.1.2.

- A higher percentage of revenue now derives from subscription charges and advertising, and less from usage charges. As a general rule, telephone service providers used to make around one-third of their revenue from fixed charges (subscription and connection) and two-thirds from usage charges, but this ratio has progressively reversed, especially as internet use has shifted from dial-up to broadband. For mobile phone companies, too, the introduction of pre-paid subscriptions, which account for the lion's share of the market in most countries, has shifted the balance towards flat-rate payments. This phenomenon is explored further in section 3.1.3.
- Inter-modal competition (between different technologies) is now just as significant as competition between companies in the same market. The battle for voice traffic that was fought between fixed-line telephone providers, cable TV companies and mobile service providers is now being re-fought, but this time it's all about data traffic. Mobile networks are progressively undergoing a broadband makeover to enable them to compete with DSL and cable modem networks in the delivery of high-speed internet services. Inter-modal competition, resulting from technological convergence, is examined in section 3.2.1.
- Markets are increasingly global, with an increasing share of both revenue and innovation coming from outside the home market of the service provider. The internationalisation of ICT products and services is proceeding apace, with much of the new growth occurring outside OECD member countries. In some cases, new services are being pioneered in developing countries before they take-off in developed markets. Nevertheless, the pace of growth is uneven, and not all developing countries are benefiting. This theme is explored further in section 3.2.2.
- As a result of these trends, policy formulation requires an increasingly integrated approach, rather than one based on traditional sector-specific regulation. The three sectors that constitute the ICT market (telecommunications, computing and broadcasting) have very different regulatory regimes, ranging from regulation of carriers to regulation of content

Figure 3.1: The growing contribution of telecommunication services to the global economy
Telecommunication services as a percentage of Gross Domestic Product (GDP), in selected regions and selected economies, 1990-2004.



Note: Based on an analysis of telecom services as a proportion of GDP, for those economies where data for both series are available for the period 1990-2004.
OECD = "Organisation for Economic Cooperation and Development"; SIDS = "Small Island Developing States"

Source: ITU analysis, based on the ITU Information Society Statistics Database

and competition policy. As the three sectors converge, a new approach is required. Policy-making is therefore becoming more consumer-oriented and less carrier-oriented. It is also less driven by scarcity, as discussed below in section 3.3.

3.1.2 Value creation

The two big waves of changes over the last decade—the expansion of mobile communications and the internet, led by the World Wide Web—have both created a number of potentially massive new market openings. In the early days, it was predicted that the main impact of these two technologies on the ICT sector would be to replace existing revenues for fixed-line voice services and for data leased lines, and this has to some extent happened. But while some revenues have undoubtedly been lost, new market openings, particularly in the area of content provision, have greatly exceeded the revenues lost.

The clearest evidence for this is at the macro-economic level, where the contribution of ICTs to the general economy has grown rapidly, despite falling prices. As figure 3.1 shows, in 2004 telecommunication services contributed some 3.3 per cent of Gross Domestic Product (GDP) worldwide, compared with just 1.8 per cent in 1990, with virtually every single economy enjoying growth. This implies that the telecommunication sector has grown, on average, at twice the rate of the global economy during this period. But there are some interesting variations. For instance:

- **Small island developing states (SIDS)**, particularly those where tourism makes a major contribution to the national economy, are generally much more dependent on telecommunications (especially international telecommunications) as a source of revenue, with an average of 4.2 per cent of their GDP coming from this source in 2000-2004. SIDS are particularly vulnerable, therefore, to changes in the international telecommunications regime, and the terms of trade have turned against them as a result of the progressive dismantling of the international accounting rate system over the past decade. This is one reason why they have not grown their ICT sectors as rapidly as other regions.
- The leading industrialised economies of the **Organisation for Economic Cooperation and Development (OECD)**, which provide a combined total of more than 80 per cent of global telecommunications revenue, have seen this contribution to GDP increase by more than half, as a proportion of their GDP. Among OECD economies, the economies of the former Eastern bloc have seen the most spectacular growth: for instance, in Hungary, the share of telecommunications revenue has risen from 1.1 per cent of GDP in 1990 to a peak of 7.3 per cent in 2001, while the Czech Republic and Poland have similarly witnessed peaks of 4.9 per cent and 4.5 per cent of GDP, respectively.
- The economies of **Africa** started from a position well below that of the OECD, but have recently overtaken it, with 3.2 per cent of their GDP coming from telecommunications in 2000-2004. This turnaround is almost entirely due to the rise of mobile communications on the continent, which is integrating African economies more closely into the global information society. The fact that Africa's citizens pay as high a percentage of their national wealth on telecommunication services as the global average suggests that lack of affordability is not as great an issue as it was in the past, although excessively high tariffs may still be a problem.
- However, the most dramatic changes have occurred in **individual economies** (figure 3.1, right chart). In China, telecommunications revenues as a percentage of GDP have grown from less than half the global average in 1990 to overtake it since 1999. In Estonia, since its re-creation as an independent state, the ICT sector has been prioritized by the government and this is exemplified by a telecom sector which contributes more than 6 per cent of national wealth. India is an equally interesting case, because its telecom boom had a major impact only relatively recently, with a sudden upturn in spending since 2002, following moves to liberalise the sector. India is now in a similar position to China seven years earlier, and can be expected to enjoy rapid growth of its ICT sector in the near future.

Although macro-economic data provide comprehensive proof of the new market openings that are being created, trends at the micro-economic level, i.e. relating to individual companies, and how their prospects are rated by the financial markets, are perhaps even more compelling. As of mid-2006, the financial markets rated the top five companies in the ICT equipment, ICT services and digital content sectors at similar levels, with a market capitalisation of around half a trillion dollars each. But when one compares these market valuations with the annual revenues of the companies in the different sectors, it can be seen that the three sectors are quite different (figure 3.2). The financial markets assign a market capitalisation to the equipment sector equivalent to 21 months of annual revenue. For the services market, the market capitalisation is worth 27 months, but for the content sector, it is worth more than seven years of revenue. In other words, the big five companies in the internet/media content sector (Microsoft, Google, Yahoo!, eBay and Amazon) are expected to grow at a substantially faster rate than the top five companies in either the equipment manufacturing or service provision sectors.

This valuation of digital content companies is all the more remarkable, when one considers that market capitalisation is at least partly based on assets. Whereas the service providers have assets comprising networks, switching centres and billing systems, and the equipment manufacturers have factories and R&D laboratories, the assets of the digital content companies comprise mainly their staff, software and brand names. Google stands out, with a market capitalisation of USD 118 billion equivalent to 19 years worth of revenue. This puts it on a par with the annual GDP of an economy such as Malaysia. Google's main assets are its search engine technology and its brand name. It makes 99 per cent of its revenue from advertising. Although it has a solid track record of revenue growth and profitability, this only stretches back as far as its creation in September 1998.

One major advantage of the high valuation afforded by the markets to the digital content sector is that it means these companies can grow by acquisition, as well as through organic growth. During 2005, for instance, Google acquired some 15 companies for a purchase price of USD 130.5 million, mainly to acquire technology, but also patents, business models and creative staff. In 2006, Google paid USD 1.6 billion for the video-sharing website YouTube, founded as recently as February 2005.

Similarly, eBay, another highly-valued content company, used its high market capitalisation to acquire Skype, a market-leader in the field of peer-to-peer VoIP in October 2005 for USD 2.6 billion; PayPal, a global payments platform, for USD 0.4 billion; and six other companies during 2005.

Of course, it is tempting to speculate that we have "seen it all before", in that market valuations reached unsustainable levels in the early 2000s, before the bursting of the *dot.com* bubble (box 3.4). Certainly, the potential for wildly inflated expectations, over-investment and "creative" accounting remains today, but some of the basic conditions that prevailed in the late 1990s are different from those that prevail today. Crucially, the internet of the late 1990s was a slow-speed, dial-up version—little removed from the basic telephone network. Digital subscriber line (DSL) technology, developed at ITU, has now added more than a quarter of a billion broadband subscribers across the world, and the internet is finally capable of delivering the visions that were proudly presented as the business models of the *dot.com* generation.

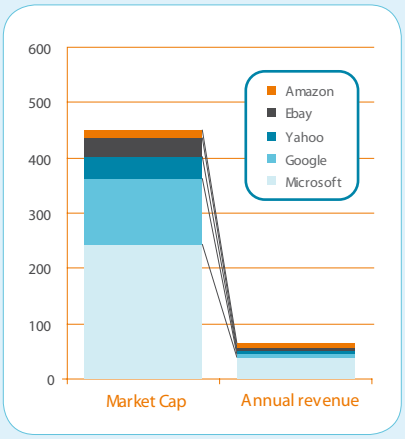
A further difference, on the mobile side, is that the exorbitant prices paid for 3G licences do not seem quite as extortionate as they did in the context of the collapse of the IT bubble, given the ongoing expansion of the mobile sector to reach 2.17 billion subscribers worldwide at the end of 2005, of which just over one tenth have already shifted to 3G. The reality is that, despite the severity of the crash that affected the technology sector between 2000 and 2003, the underlying networks have simply kept growing with barely a hiccup.

As well as leading companies and national economies, small companies and entrepreneurs are also exploiting the benefits of digital markets. One of the reasons for this is that the internet has greatly reduced barriers to entry in numerous sectors. With a website, an eCommerce server and some astute marketing, even the smallest company in the remotest part of the world can potentially build a global business. Rates of new firm formation in the technology sector are as high as they have ever been and, as the example of Google shown

Figure 3.2: Tracking the "Big Fives"

Market capitalisation and annual revenues for the top five companies in the digital content, telecom services and ICT equipment manufacturing sectors

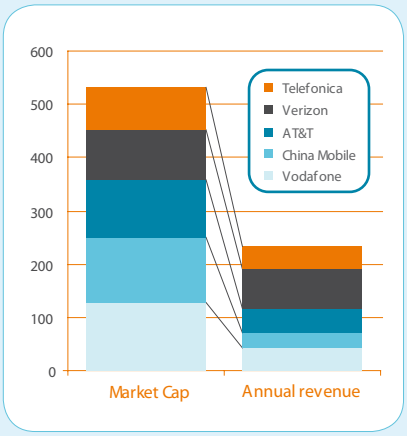
Top 5 digital content companies



Company	Market cap (USD bn)	Annual revenue (USD bn)	Year-to-date
Microsoft	244.8	39.8	31/06/ 05
Google	118.5	6.1	31/12/ 05
Yahoo!	38.0	5.3	31/12/ 05
Ebay	35.4	4.6	31/12/ 05
Amazon	14.3	8.5	31/12/ 05
Totals	451.0	64.2	

Ratio of market capitalisation to revenue=7.02

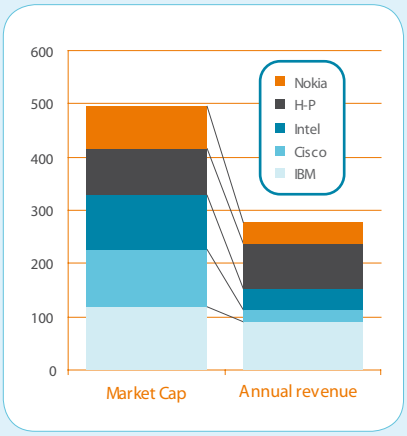
Top 5 telecom service companies



Company	Market cap (USD bn)	Annual revenue (USD bn)	Year-to-date
Vodafone	128.4	41.3	31/03/ 06
China Mobile	120.6	30.9	31/12/ 05
AT&T	108.0	43.9	31/12/ 05
Verizon	95.1	75.1	31/12/ 05
Telefonica	78.3	42.6	31/12/ 04
Totals	530.3	233.8	

Ratio of market capitalisation to revenue=2.27

Top 5 ICT equipment manufacturers



Company	Market cap (USD bn)	Annual revenue (USD bn)	Year-to-date
IBM	117.8	91.1	31/12/ 05
Cisco	109.6	22.0	31/07/ 04
Intel	101.7	38.3	31/12/ 05
HP	86.7	86.7	31/10/ 05
Nokia	80.8	40.5	31/12/ 05
Totals	496.5	278.7	

Ratio of market capitalisation to revenue=1.78

Note: Market capitalization data is for 21 July 2006. Annual revenue is for latest available year. Companies are ranked (top five) according to market capitalization rather than annual revenue.

Source: ITU, adapted from Company reports, Finance.Yahoo!.Com and Edgar Online

above illustrates, it is possible to build a billion-dollar company in just a few years. In the case of YouTube it took less than 18 months. But the critical element remains getting the business model right, including the pricing of services.

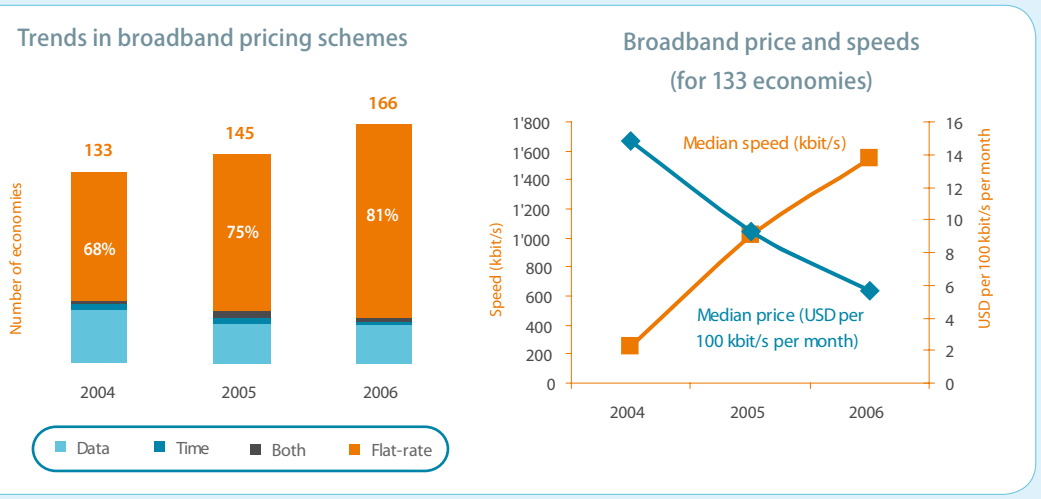
3.1.3 Is the price right?

Although there are only a relatively limited number of pricing formats for ICT services, there seems to be an apparently infinite number of variations on them, which often makes it difficult to compare one company's offerings with another. Of course, this is partly deliberate, as most service providers would prefer to avoid "beauty contests" where price schedules can be compared directly. But the complexity also reflects the increased scope for bundling that emerges through convergence, as previously distinct services are bundled together under "multiple play" type offerings that combine voice (fixed and/or mobile), video and internet services.[7]

There are four basic pricing models in the ICT sector:

- **Time-based, metered pricing** has traditionally been the mainstay in the telecommunication sector, with calls being billed according to the duration of the call, geographic distance and/or the time of day or week, when the call was placed. Although geography is now less important, metered pricing is still used for local calls on fixed-line networks in most of the world (North America, Hong Kong, Australia and a few other markets are the exceptions), for long-distance and international calls on fixed-line networks, and for mobile networks virtually everywhere.
- A variation on time-based pricing is **volume-based pricing**, with time metering being replaced by a measure of content throughput. Volume-based pricing is a way of rationing capacity, particularly on data-based networks (e.g. leased lines, broadband, 3G cellular), but it becomes less relevant, once bandwidth is not so scarce. Both time-based and volume-based

Figure 3.3: Broadband pricing trends
Trends in pricing and price models for fixed-line broadband services, worldwide, 2004-06



Note: "Data" refers to price packages that impose an upper limit ("bit cap") on the volume of data that can be downloaded per month for a fixed price. "Time" refers to price packages that use time-metering (e.g. 20 hours use per month). "Both" refers to price packages that have thresholds for both a bit cap and time usage. "Flat-rate" implies unlimited monthly use.

Source: See Biggs, Phillippa (2006) "Broadband Update", in ITU News, 2006 vol. 5, p21, available at www.itu.int/itunews/manager/display_pdf.asp?lang=en&year=2006&issue=05. Data is based on the annual broadband price survey carried out by ITU (see data table 7)

Table 3.1: Broadband prices: halving each year

Lowest prices for broadband, per 100 kbit/s per month, April 2006, and change 2005-06

	Economy	Company	Speed Mbit/s	Price per month USD	Price per 100 kbit/s	Change 2005-06
1	Japan	Yahoo! BB	51.2	31.19	0.07	-12.5%
2	Rep. of Korea	Hanaro	51.2	40.59	0.08	...
3	Netherlands	internet Access	20.4	27.97	0.14	-81.3%
4	Taiwan, China	Chunghwa	12.3	22.67	0.18	...
5	Sweden		24.6	56.08	0.23	-6.5%
6	Singapore	Starhub	30.7	73.17	0.24	-85.0%
7	Italy	Libero	12.3	37.23	0.30	-73.8%
8	Finland	Elisa	24.6	85.64	0.36	-51.4%
9	France	Free	10.2	37.29	0.36	-90.1%
10	United States	Comcast	4.1	20.00	0.49	...
11	Germany	Freenet.de	6.0	30.95	0.52	...
12	United Kingdom	Pipex	8.1	50.89	0.63	-53.6%
13	Hong Kong, China	Netvigator	6.1	51.17	0.83	...
14	Portugal	Sapo	8.1	75.82	0.93	...
15	Canada	Bell	4.0	41.26	1.01	-3.9%
	Unweighted Average		18.3	44.33	0.42	-50.8%

Note: The broadband prices were sampled in July 2005 and April 2006. Price change is shown only for those companies for which equivalent services were available in both periods.

Source: ITU research (see also data table 7)

pricing lend themselves to pricing packages that set specific thresholds. For instance, for mobile networks, packages offering a specific number of minutes of use per month are popular, while for broadband networks, a bit-cap may be set on the monthly volume of usage.

- The third main pricing model is **flat-rate, unmetered pricing**, which offers a certain bundle of services for a fixed monthly rate. This pricing model has typically been used for cable TV where a certain number of channels are offered for a basic fee, with premium services offered in higher-price tiered payments. Flat-rate is also increasingly popular for broadband. Indeed, pre-payment, now the dominant pricing model used for mobile communications, can be considered a form of flat-rate pricing.
- The final type of payment model is **advertising-funded**, which is the most common model used by free-to-air television. It is also commonly used for internet content. The end-user may not make any direct payments at the point of use, but indirectly pays for ICT services through increased usage of those products and services that are advertised.

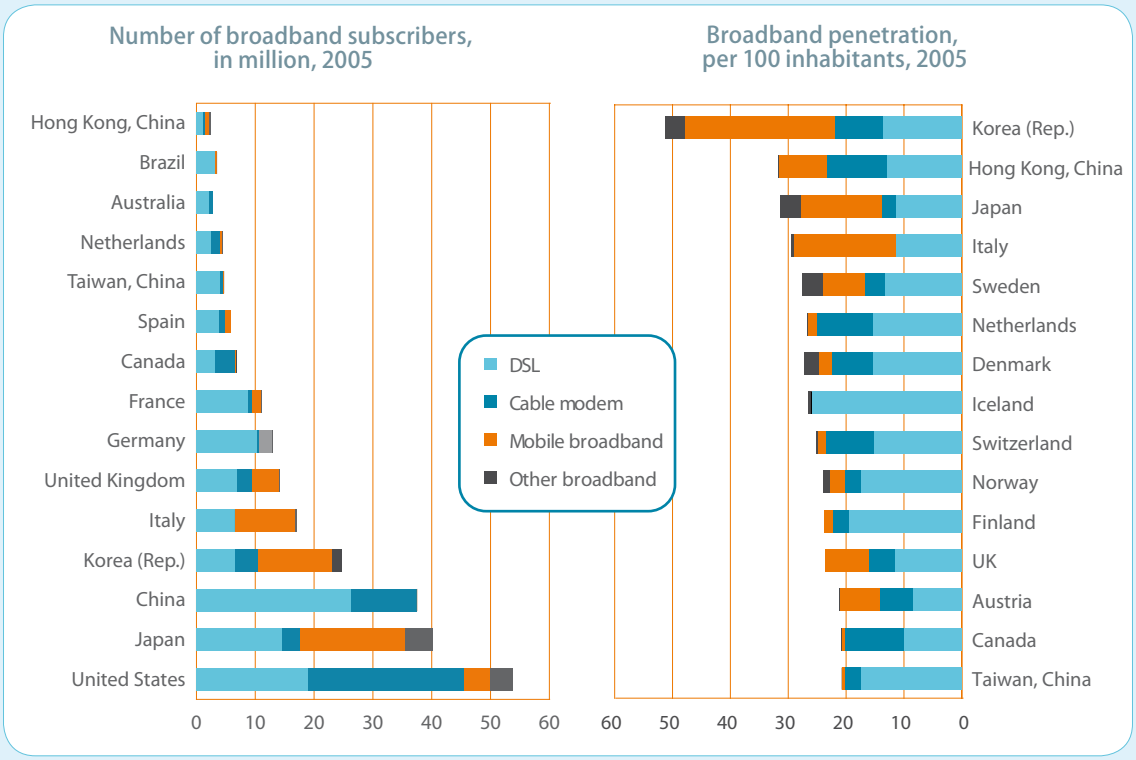
The first two of these pricing models are driven by scarcity and the need to ration the use of available capacity. As higher-capacity fixed networks are deployed, including higher-speed broadband (e.g. VDSL, fibre) and mobile broadband (e.g. W-CDMA, HSDPA, CDMA 1x EV-DO), scarcity is less of an issue and flat-rate pricing is being adopted more widely (figure 3.3, left chart). In July 2004, only two-thirds of the 133 economies that offered broadband services worldwide had flat-rate tariffs available. By April 2006, the number of economies

where operators offered commercial broadband service had increased to 166, with flat-rate pricing available as an option in 81 per cent of them. Time-based pricing had almost completely disappeared and the number of economies where operators still imposed bit-caps had shrunk to just 28, though this includes some major economies such as Australia, South Africa and Italy (figure 3.3, left chart). However, alternative pricing schemes, without bit-caps, are now available in most of these economies.

Furthermore, broadband offers are improving at a truly remarkable rate, in terms of both the price and speeds available. In July 2004, the median speed available worldwide was around 256 kbit/s (the bare minimum to be defined as broadband, according to the definition used by ITU), but within 22 months, this had improved to over 1.4 Mbit/s (figure 3.3, right-hand chart). By 2006, some 29 economies had service offerings with speeds of greater than 3 Mbit/s available. Similarly, the median price per 100 kbit/s of data per month had fallen over the same period from USD 15 to just USD 5. In the ICT sector, the familiar vector of change is the so-called Moore's Law (box 3.1), which specifies that semiconductor capacity is expected to double, for a similar price, every 18-24 months. However, in broadband economics, the price/performance ratio appears to double every 12 months or so while the price halves every 15 months—at least that has been the experience to date. As an illustration of this, Table 3.1 tracks prices for leading companies in the major broadband economies. It illustrates that broadband prices per 100 kbit/s per month have fallen by 50 per cent, on average, over just 10 months.

Figure 3.4: Top 15 broadband economies

Top 15 economies for broadband (both fixed-line and mobile), ranked by total number of subscribers (left chart) and penetration rate (right chart), at 31 December 2005



Note: "DSL" = Digital Subscriber Line technologies. "Cable modem" = broadband services delivered over a cable TV network. "Mobile broadband" = 3G cellular services offering services in excess of 56 kbit/s. It includes Wideband CDMA, HSDPA, CDMA 1x EV-DO and EV-DV. "Other broadband" includes other technologies delivering broadband access in excess of 200 kbit/s, including fibre to the home/office, metro ethernet, satellite broadband, fixed wireless access, public Wi-Fi etc.

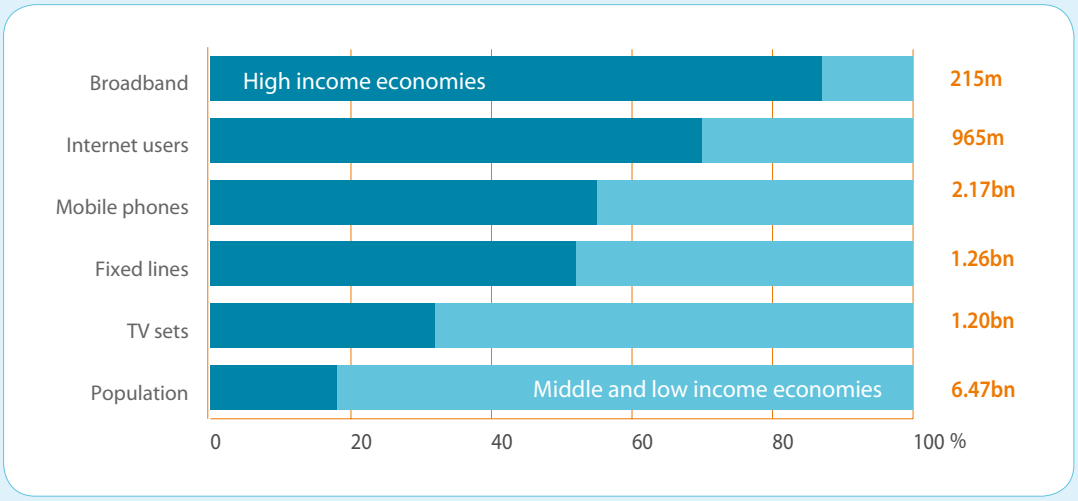
Source: ITU Information Society Statistics Database

Although mobile broadband has been slower to take off than fixed-line growth, it is now beginning to show comparable growth, with just over 60 million subscribers at the start of 2006 (see data table 4).[8] Although this represents only one third of the level of subscribers for fixed-line broadband, and the speeds on offer commercially are generally much slower, the gap between fixed and mobile broadband has been narrowing over recent years. Indeed, in some economies, such as Italy, Japan and the Republic of Korea, mobile broadband now constitutes more than half of the total broadband subscribers (figure 3.4).

Key factors driving growth in mobile broadband include the introduction of higher-capacity, easier-to-use services and a shift towards flat-rate tariff models. For instance, in Japan, NTT DoCoMo offers subscribers to its FOMA 3G mobile service a billing package (*pake-hodai*, or packet flat-rate service) that offers unlimited use of i-mode and e-mail for ¥4'095 (USD 35.80) per month, including tax.[9] But the more common practice is for mobile broadband vendors to offer a series of packages with bit-cap data thresholds for certain levels of usage. For instance, 3 in the UK offers a 3G data card with packages ranging from 100 MB to 512 MB per month at prices ranging from £20 to £45 per month (USD 37–84).

The mobile broadband services currently on offer have many of the same limitations and deficiencies as fixed-line broadband, when it was first introduced at the turn of the millennium. They are complex to use and the quality of services offered (e.g. video clips, live TV streams) can sometimes be poor, due to capacity constraints. They also remain relatively expensive compared to equivalent fixed-line broadband services. The rationale behind bit caps and pricing packages is partly to maximise revenue, but also to ration the available bandwidth until higher-bandwidth offerings become available. For these reasons, mobile broadband is priced much more highly than fixed-line services at present and can only be considered as substitutable over a narrow range of applications, for instance, for downloads of music, where the ability to download directly to mobile handset might be considered more convenient than access over a PC and a fixed-line broadband service. Problems relating to price, speed and quality should be resolved as CDMA networks shift W-CDMA to HSDPA and as CDMA 2000 1x networks are upgraded to EV-DV and EV-DO (see discussion in section 2.1). Furthermore, the development of fixed-wireless services (e.g. WiMAX), dual-mode handsets and data cards that can use both mobile and fixed internet access will progressively blur the differences between different

Figure 3.5: The digital divide reduces with age of technology
The distribution of usage between high income and other economies, among different technological platforms, 2005



Source: ITU Information Society Statistics Database

platforms. Ultimately, the goal is to deliver access to consumers more cheaply and conveniently. Improving the technical capabilities of mobile networks will help increase the overall range of delivery platforms available, as explored in the next section.

3.2. Delivering access

3.2.1 Platforms for delivering services

What can be considered as a basic ICT service today? Twenty years ago, it might have been defined as a "telephone in every home". Ten years ago, with the rise of mobile phones and the internet, that might have been modified to "each individual having access to a phone" or "a PC in every home". Now, it is not just the availability of devices or services that matters, but the quality of the connectivity that they offer. "Broadband" is now the essential service offering, whether over fixed or mobile networks, and in some countries it is even being regarded as part of the incumbent carrier's universal service obligation[10]. And yet, wide differences are emerging between broadband offerings in different countries, for instance between those services that are "symmetrical" (i.e. having the same capacity in both directions) or "asymmetric" (i.e. with typically a faster speed for downloading than uploading). One of the driving forces underlying the spread of broadband is the major upgrade of existing fixed-line and mobile networks to an IP-based platform. "Best practice" at present comprises the so-called 100/100 networks that offer symmetrical download and upload capacities of 100 Mbit/s.[11]

Each country has a different mix of players and networks which, in turn, reflect different regulatory environments, corporate strategies and user habits. Figure 3.4 illustrates the broadband networks of the top 15 broadband economies, ranked by number of subscribers and network penetration. Although no two countries are identical, it is possible to identify a number of patterns:

- Economies with at least **three** different broadband network platforms (e.g. DSL, cable and mobile) competing for the market, with each having a significant market share (of at least 10 per cent). This category includes the market leaders by penetration of the Republic of Korea, Japan and Hong Kong SAR, as well as the UK and Sweden, at more modest levels of penetration.
- Economies with **two** main broadband technologies competing for the market. Typically, this means DSL competing against cable modems, which is the case in the United States and Canada (where cable is dominant) as well as in China, Netherlands and Switzerland (where DSL is dominant). However, in the case of Italy, the two technologies competing for the market are DSL and 3G mobile. The same is true also for Portugal and South Africa, although they do not feature in the top 15 economies.
- Economies with only **one** dominant broadband technology, usually DSL. As a general principle, these economies have not, to date, grown their broadband markets fast enough to enter the top 15, although Iceland is one exception. At lower levels of penetration, Brazil, Poland and Ireland also have more than 90 per cent of their broadband subscribers on DSL networks.

As a rule of thumb, the greater the level of competition (or the perceived threat of competition, according to the theory of contestable markets), including inter-modal competition between different platforms, the faster the rate of growth. In those economies that have historically done best in terms of broadband, potential users generally have the most choice. The Republic of Korea, which has the highest level of broadband penetration in the world (including mobile broadband) benefits from having market competition not only from DSL, cable and mobile, but also from fibre-to-the-home, public Wi-Fi services, metro ethernet and satellite.[12]

3.2.2 From digital.life to digital.world

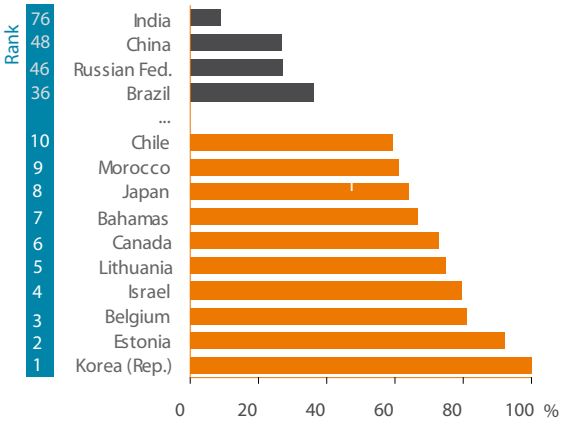
The World Summit on the Information Society (WSIS), which was held in two phases in Geneva (10-12 December 2003) and Tunis (16-18 November 2005), concluded with a bold commitment "to build

Box 3.3: Measuring the digital divide

Using the Digital Opportunity Index (DOI) to measure the digital divide

One way of measuring the digital divide is by using the Digital Opportunity Index (DOI)[13], a new statistical tool, approved by the WSIS, as a part of an approved methodology for tracking progress in implementing the WSIS outcomes[14]. Specifically, the "Gini coefficient", which is a statistical tool that ranges between 0 (equal distribution) and 1 (inequality), can be used to measure the level of inequality in nine of the eleven indicators that comprise the DOI and for 180 economies. In the 2005 release of the DOI, the distribution was most unequal for mobile broadband (for which the Gini coefficient was 0.96) and for fixed broadband (0.68). For cellular mobile phones it was a more reasonable (0.51) and lower still for fixed lines (0.43). The lowest Gini scores were for measures of "opportunity" such as mobile coverage (0.18).[15] This suggests that mobile communications, in particular, represents the best hope for reducing the digital divide. The next release of the DOI, in May 2007, will show whether the divide is increasing or decreasing for these indicators.

Broadband subscribers, as a % of total internet subscribers



Average DOI and Gini scores

DOI Indicator	Ave-rage	Gini Score
Mobile population coverage	75%	0.18
Households with fixed line	44%	0.43
Mobile per 100 inhabitants	37%	0.41
Households with internet	14%	0.67
Mobile internet per 100 inhabitants	5%	0.84
Households with PC	20%	0.59
internet users per 100 inhabitants	16%	0.59
Fixed broadband as % of total internet	28%	0.68
Mobile broadband as % of total mobile	2%	0.96
Overall DOI Index	0.37	0.28

As well as using the index as a whole to track the digital divide, it is also possible to use the individual indicators. The composition of the basket has been designed in such a way as to avoid disadvantaging developing countries in these measures. For instance, for broadband use, rather than measuring the absolute number of subscribers, or the level of penetration, instead the indicator selected is "fixed broadband subscribers as a percentage of total fixed internet subscribers". Interestingly, the "top ten" economies in this indicator include a number of developing countries, such as Morocco or Chile, as well as transition economies, such as Estonia or Lithuania. Similarly, among the so-called BRIC economies (Brazil, Russian Federation, India and China) their rankings on this indicator are generally higher than would be predicted by, say, their GDP per capita[16]. These economies can be interpreted as carrying out a technological leapfrogging strategy, in which users move directly to broadband (DSL, cable modem etc) and missing out the dial-up stage of internet evolution.

Note: In the table, the Gini index ranks between 0 (perfect equality) and 1 (full inequality). The two other indicators in the DOI (for which the Gini coefficient may not be the best measure of inequality) are internet and mobile affordability.

Source: ITU Information Society Statistics Database and Cho, Cheung-Moon (2006)

Table 3.2: Scarce resources: How technology and deregulation are helping to stretch them further
Examples of how technological and regulatory change are easing the scarcity of ICT resources

Resource	Technological assistance	Regulatory assistance
Spectrum	• Development of digital signal processing and spread spectrum techniques, such as Code Division Multiple Access (CDMA) or UltraWideBand (UWB). • Development of technologies that can make economic use of spectrum at higher frequency ranges. • Development of new types of cognitive and software-defined radio techniques for transmission. • Design of new antenna arrays.	• Use of market mechanisms, such as auctions or spectrum trading, that create incentives to use spectrum more efficiently. • Managed "farming" of spectrum to bring under-used portions back into economic usage. • Creation of license-exempt parts of the spectrum for "experimental" use (including bands currently used by Wi-Fi). • Allowing for (or mandating) the sharing of spectrum bands between different types of use.
Numbering & identification	• Development of computer-based algorithms for converting alphanumeric input (e.g. E-mail addresses) to numerical format, and *vice versa*. • Design of IPv6 numbering system to supersede IPv4 and the design of other numbering systems (such as barcodes and the newer electronic product code (EPC) and ucode). • Development of authentication and user identification technologies, e.g. for billing. • Development of RFID tags and readers and other contactless card systems.	• Adoption of global standards (based on ITU-T Recommendations) for telephone numbering. • Competition among registrars for internet domain name registration, and creation of additional top-level domains. • Separation of responsibilities for management of domestic numbering plans from the incumbent operator to regulatory agency or another independent body.
Rights of way (wayleaves)	• Development of wireless transmission to supplement and replace wireless transmission. • Development of technologies to extract higher capacity throughput from copper cabling (e.g. DSL) or to replace it (e.g. fibre optics). • Development of mini-trenching and similar techniques to optimise creation of ducts for cables with minimum of disruption.	• Local loop unbundling (LLU) and similar policies designed to ensure fair access to the incumbent's basic infrastructure. • Development and enforcement of procedures for sharing of basic wireless infrastructure, including high sites, transmitter masts etc. • Urban planning processes designed to coordinate requests among many players and services for digging up roads and cable-laying.

Note: These examples are intended to be illustrative, of trends in many countries, and not exhaustive or specific to a particular country.

Source: ITU

a people-centred, inclusive and development-oriented information society, where everyone can create, access, utilize and share information and knowledge" (*Geneva Declaration of Principles*, para 1)[17] and to "turn the "digital divide into a digital opportunity" (para 10). But how can these worthy goals be achieved if the developed countries are always moving further ahead in terms of the quality of the networks they are installing?

The reality is that there is a much greater digital divide in terms of the newer, more advanced services—such as broadband or 3G mobile—than for the older, basic ICT services. The extent of the digital divide for a particular ICT therefore is related to the diffusion process, with the divide being greater for newer, less diffused services than for older, more diffused ones (figure 3.5).

However, this analysis also suggests that the nature of the digital divide is shifting from a primarily quantitative phenomenon (some countries and some regions have more ICTs than others) to a qualitative one (users have access to better quality, more affordable ICTs in some countries and regions than in others). In this context, the narrowband/broadband divide is a key measure. Two of the indicators used in the Digital Opportunity Index, a composite index for measuring the digital divide (box 3.3) capture this divide:

- Fixed broadband users as a percentage of all fixed internet users;
- Mobile broadband users as a percentage of all cellular mobile users.

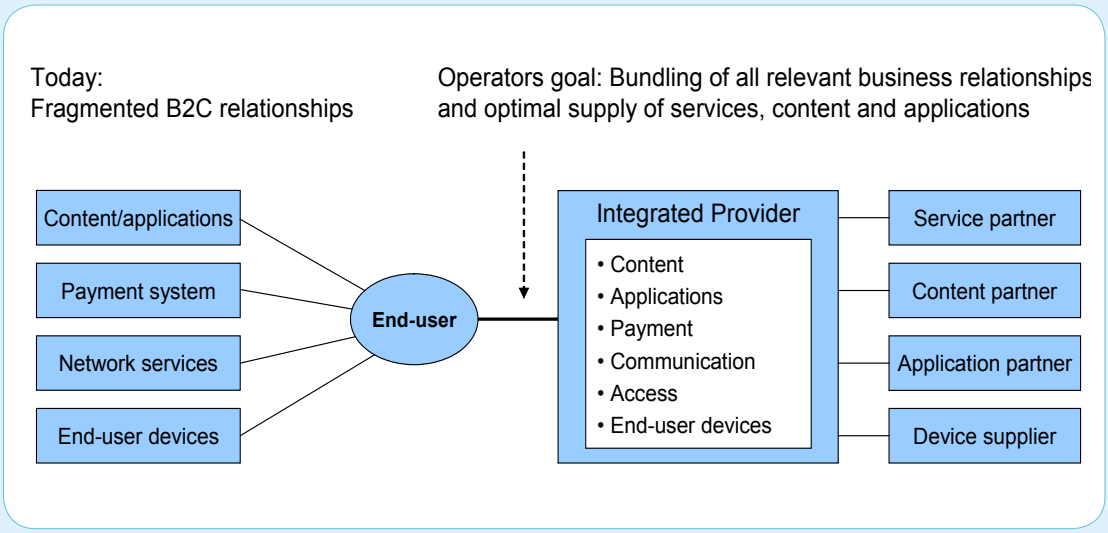
Box figure 3.3 (lower chart) shows the leading ten economies for the former of these two indicators together with the so-called BRICs (Brazil, Russian Federation, India and China), which are among the major developing countries. Although the BRICs still have a long way to go in developing their domestic internet and IP-based services, they are catching up with, and even overtaking, developed countries in terms of upgrading to broadband.

3.3 Defining policies

3.3.1 From "command and control" to "live and let live"

Perhaps the most valuable non-human resource, as we head towards living the digital world, is one that

Figure 3.6: Simplifying end-user relationships
Moving from fragmented to unitary end-user relationships in a next generation network



Source: ITU (2006) "Regulating new and emerging markets in the telecommunication sector", background paper prepared by Wey, Christian et al (available at www.itu.int/osg/spu/ngn)

we take for granted, namely the air around us. This provides the basic platform for services delivered wirelessly: the radio spectrum. Another resource, without which the digital world would still be an analogue one, is the base ten numbering system that provides the means of identification for users, either directly (for the telephone and mobile networks) or indirectly (for the IP addresses that underlie the internet). A third resource to which we hardly give a second thought is the highways and byways between human habitations. They started as physical communication networks and have latterly become information superhighways. "Rights of way", or more correctly "wayleaves", are also a scarce resource, insofar as digging up a road to improve electronic communications may impede the physical communications or building a radio antenna on a high site might impair environmental amenity.

"Living the digital world" means that we are obliged to share the scarce resources that humanity holds in common. These three resources—spectrum, numbering plan and wayleaves—lie at the heart of the digital world and help to explain why the establishment of the first telecommunication company was followed quite quickly by the establishment of the first government department with responsibility for regulating the industry.[18] All three resources are scarce, in the sense that they are finite. However, in each case, technological advances and policies based on deregulation have helped to stretch the resources further and reduced the effect of bottlenecks that might create natural monopolies.

As illustrated in Table 3.2, this combination of technological and regulatory change has permitted a move away from a system of centralised "command and control" which has characterised traditional regulatory regimes, particularly for spectrum management. The newly emerging regime does not have a specific name, but might be better described as "live and let live". It is a critical part of the digital world because it creates the basis for innovation and diversity and also of greater security. Although the offices of government may no longer be directly controlling these resources (e.g. through ownership of the incumbent operator or through direct exploitation of the spectrum), nevertheless the framework of light-handed government regulation, backed up by consumer protection and competition policy, provides assurance for users.

3.3.2 Next-generation regulation

At one level, the move from a "command and control" to a "live and let live" regulatory regime is making the regulator's job easier. If the problem of scarcity can be overcome, then there is less of a requirement for regulation, for licensing, for state ownership or for any other form of state intervention. One reflection of this is that a number of economies are combining together a variety of sector-specific regulatory functions. For instance, this can be done on the basis of network and transport utilities (e.g. Germany, Jamaica) or on the basis of information-related sectors (e.g. Hong Kong SAR, Malaysia, UK). Countries are also relying more on general consumer regulation and competition policy rather than sector-specific regulation.

However, at another level, a "live and let live" regulatory environment introduces a whole new set of issues and emerging problems, as technology creates the ability to bypass existing regulations and as regulatory distinctions become outdated. So-called next generation networks (NGNs) are likely to require next-generation regulation[19] as the problems of scarcity are replaced by dilemmas of abundance and complexity. The concept behind NGN is a shift away from an era of separate networks (such as narrowband fixed, broadband fixed, cellular mobile, cable TV), bearing different services (voice, video, text, data) to multiple devices, e.g. fixed handset, mobile handset, PC. NGN moves towards a unitary IP-based network in which the common features of the user environment (for example user preferences, contacts, databases, files and so on) are accessible as the user moves around, say between home, car and office, or between desk and meeting room.[20] This concept is expressed graphically in figure 3.6. The idea is to present a single interface to the end-user that is at once "portable" and integrated.

Although the implementation of the NGN concept is still some way off, the complexity of the new environment already exists today. For instance, today's most widely diffused IP-based network—

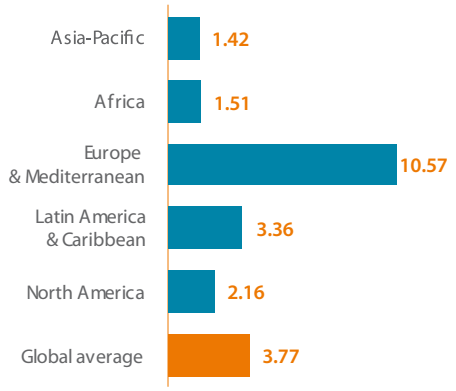
Figure 3.7: Spot the odd one out

International fixed and mobile call termination rates in different world regions, 2006

Termination rates in US cents per minute

Region	Average fixed rate	Average mobile rate
Asia-Pacific	11.69	16.58
Africa	13.62	20.57
Europe & Mediterranean	3.11	32.86
Latin America & Caribbean	4.88	16.43
North America	2.81	6.07
Global average	5.77	21.76

Ratio between fixed and mobile call termination rates



Note: The regions used in this analysis refer to the ITU regional tariff groups (TAS, TAF, TEUREM and TAL) and do not correspond precisely to those used for analysis elsewhere in the report. The "North America" region is not a regional tariff group, and this includes also jurisdictions and carriers regulated in North America.

Source: ITU-T Study Group 3 research, based on January 2006 questionnaire of ITU Member States

the fixed-line internet—can also be used to carry, voice, video, text and data. It does so without respecting international borders, and without necessarily being subject to national regulations, on advertising content, interconnection or taxation. However, tomorrow's most widely-diffused IP-based network is more likely to be one that is primarily accessed from mobile devices and may not have the open nature of today's internet.

A wireless-driven internet is likely to be a more commercially-oriented environment ("internet with billing") than today's primarily fixed-line internet, and the possibility to have access to it irrespective of location raises a new series of regulatory questions, primarily related to privacy and data protection.[21] For instance, in order to make use of location-based services, the user must, consciously or otherwise, be willing to be tracked and possibly have their location at different times recorded and stored. Who should have access to this data, and for how long should it be stored? Similarly, the multimedia capabilities of today's multifunctional mobile handsets mean that they can easily be used for taking candid snapshots or for recording private meetings. Not surprisingly, some organizations such as fitness gyms or lap-dancing clubs have taken steps to ban the use of camera phones on their premises.[22]

Furthermore, although it is fondly believed that the public internet is fundamentally a "neutral" network, in reality, this is far from the truth.[23] In many of its fundamental design characteristics—such as differentiated interconnection and connectivity or the ability for filtering and blocking to control abuse—the internet has never been strictly neutral and is becoming even less so. For instance, the results of internet searches, and even the speed with which they run, can easily be manipulated for commercial interests. Another fond belief is that the internet is somehow immune to the natural processes of capitalism whereby private businesses seek monopoly profits. Again, this comfortable belief can easily be challenged, for instance, in the market power exercised by Google in internet searches[24], or by the increasing concentration of ownership among tier one internet backbone providers.[25]

Box 3.4: Digital boom, digital bust?

Avoiding the next ICT bubble

The spectacular growth in the ICT sector in the late 1990s, followed by the equally spectacular collapse in the first part of the new millennium, has many causes that are not yet fully understood. What is not disputed, however, is that the consequences of the bubble were experienced well beyond the ICT sector, in terms of the collapse in stock market and investor confidence, job losses, bankruptcies and accounting fraud cases. But what caused the bubble in the first place and how can a similar pattern of events be avoided?

Bubble economies have been seen in many different fields and different periods but they are particularly common in the area of network industries and they are associated with the early development stages of a new technology. Examples include the railway bubble of the mid 1800s or the wireless bubble of the 1980s. The development of the World Wide Web in the early 1990s sparked a similar investment fever. Bubbles tend to be generated by over-exuberant investment and over-valuation of stock market assets. Although the bubble affected the technology sector as a whole, it was particularly acute among *dot.com* companies which seemed to spring up overnight, float on the stock market with great razzmatazz and then promptly disappear. Among the *dot.coms* that boomed briefly were companies like WebVan, eToys and ePets, but more established companies like WorldCom were also dragged under.[30]

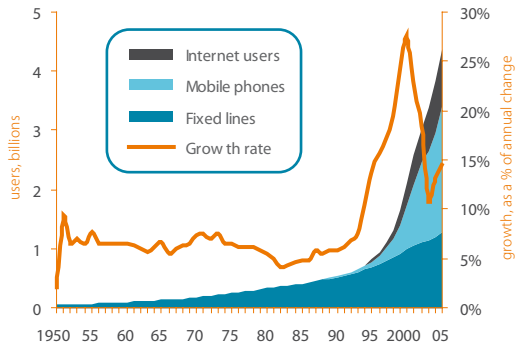
The peak of the boom, as measured by the US NASDAQ index, was around 10 March 2000, though the precise timing can be disputed. The contributory factors to the boom and subsequent collapse included:

- Unprecedented high levels of growth in the late 1990s in the ICT sector, particularly for mobile phones and internet users. As the left chart below illustrates, growth rates that had averaged around 5-7 per cent per year for most of the post-war period suddenly jumped to over 20 per cent as mobile and internet use expanded the overall ICT market.
- High levels of investment. In 2000, investment in ICT networks open to the public exceeded USD 200 billion for the first time. Investment was particularly high in international private lines, which carry most international IP traffic. As shown in the right chart below, international circuits to the US grew by 38 times between 1995 and 2004. More than half the available circuits were "idle", further forcing down prices, and this does not even take into account the so-called "dark fibre" that could be switched on as demand required.
- The high levels of investment were, in turn, founded on exuberant growth forecasts. In some cases, such as for e-commerce, these predictions turned out to be accurate, but in other cases (such as the myth that "Internet traffic was doubling every 100 days") they were based on false data and misleading claims.[31]
- In the UK, at least, the peak of stock market prices was actually 31 Dec. 1999 rather than the later date. It is possible that the ICT sector was sustained, in the lead-up to 2000, by the investment in preparing for the "Y2K bug", when it was feared that legacy ICT systems would collapse because of the change of date.[32]
- The period 2000-2001 also coincided with the spectrum auction licenses for 3G in many European countries. Some commentators felt that the winning bids overvalued the licenses available, especially as WRC-2000 had made additional allocations and because regulators were introducing the possibility of non-facilities based licenses (e.g. mobile virtual network operators) in many countries. Prices at subsequent auctions were lower.[33]

In reality, as shown in the upper chart, the decline in growth rates ended around 2003, and the subsequent growth (from a much larger installed base) has been at a level that is more than twice that sustained between 1950-1995.

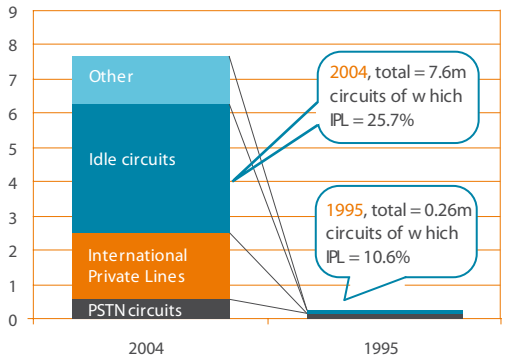
Source: ITU Information Society Statistics Database (upper chart); ITU adapted from FCC circuits status report, available at www.fcc.gov/ib/pd/pf/csmanual.html (lower chart)

The ICT bubble economy, 1950-2005



Note: Service totals are cumulative

Availability & status of international circuits from the United States (64 kbit/s, in millions)



Traditional regulation was concerned with the establishment of prices, either directly for retail customers (tariff control) or indirectly for wholesale rates (interconnection). Next-generation regulation is likely to be less concerned with price control directly (at least where markets are competitive) and more concerned with price transparency and ensuring that customers are aware of what they are purchasing. As indicated in Figure 3.6, the NGN vision foresees an integrated service provider acting as the single point of contact with the user, and therefore as the unified billing agency for a variety of different service, content and application providers. Users may like the simplicity of having a single bill for all their electronic communication services, but will it be possible to identify the price of individual services when they are all bundled together? Multiple play is an attractive proposition, but it also implies cross-subsidy between services and creates a potential monopolistic bottleneck, especially where a proprietary set-top box or conditional access system is used to "lock in" the customer to a particular service provider. Both of these are traditional regulatory concerns.[26]

Indeed, it is ironically the lack of price transparency and harmonization between different service regimes that is probably the biggest single barrier to realizing the NGN vision in the first place. For instance, a fundamental precept of the NGN is that is should be possible to move seamlessly between fixed and mobile environments. But as ITU research shows, there remain huge differences between the cost of terminating a call on a fixed-line device and on a cellular mobile device (figure 3.7). In the case of Europe, the average difference is a ten-fold order of magnitude. Thus, although fixed call termination in Europe is on average around US 3 cents per minute, mobile call termination is around US 33 cents per minute. In this context, it should be noted that the call termination rate is equivalent to the "wholesale" rate for the call and sets a minimum price level for the call origination price, which might be regarded as the "retail" rate. When the price of roaming, which is particularly high in Europe[27], is added to these already inflated charges for mobile call termination, it is apparent that Europe is quite out of line with the rest of the world.

Significantly, it is the Asia-Pacific region where the ratio between fixed and mobile call termination rates is lowest. This gives the carriers of this region a massive advantage in developing converged NGN services. It is likely therefore to be Japan or the Republic of Korea that will be the NGN test beds rather than Europe unless the problem of excessive mobile termination rates in Europe is addressed effectively.[28]

3.4 Drawing lessons

This chapter has looked at the evolution of business opportunities in the "*digital.life*" market, the subject of this report. It can be seen that the potentially addressable market is enormous, and that the world's stock markets currently place greater value on those companies concerned with digital content rather than with transmission or equipment manufacture. Given that the stock markets operate on the expectation of future, rather than current, value creation, it can be expected that digital content is where much of the future revenue growth will lie. The chapter has also shown that the platforms for future growth (i.e. broadband fixed and mobile networks) are already in place in developed countries and are quickly being deployed in developing countries too, though the digital divide is now expressed more in terms of differences of quality rather than quantity. Business models and pricing frameworks are also evolving. Finally, regulators are moving away from old regulatory models, based on the allocation of scarce resources, and are confronting new challenges, borne of abundance, such as the need to ensure pricing transparency or protect consumer privacy.

The biological ecosystem thrives through diversity and the constant creation of new niches. The same can be said of the digital ecosystem. Indeed, the market environment increasingly resembles a digital "ecosystem" in which companies must cooperate to provide jointly-provisioned services at the same time as they compete for resources and for markets. Equally, customers become suppliers and suppliers become customers in evolving relationships of bewildering complexity. An ecosystem in which resources are scarce, such as

a desert or a polar ice cap, is one where individual species dominate and where species elimination is a constant risk. But in an environment where resources are abundant, domination by a single species is unusual and there is much more scope for diversity, innovation, and for the creation of new species. The market described in this report is one characterised by abundance rather than scarcity.

But can we be sure that another slump similar to the bursting of the *dot.com* bubble is not just around the corner? Certainly there are some ominous signs, such as the high market valuations of some digital content companies such as Google or Yahoo! (figure 3.2) or the threat of trade wars in the light of growing ICT trade imbalances and the collapse of the latest round of World Trade Organisation negotiations (the Doha Development Round). However, the preconditions that led to the 2000-2003 slump were quite unique and are unlikely to be repeated anytime soon (box 3.4). Furthermore, the big difference is that the internet of 2000 operated at a maximum speed of around 56 kbit/s (the speed of a dial-up modem) whereas today's internet is increasingly moving at light speed, as growing investments in fibre to the home are added to existing DSL networks[29]. Perhaps the greatest reason for confidence is that more than around a billion new mobile phone users have been added since the start of the new millennium and they are all hungry for new services.

The rate of growth in the ICT industry may never attain again the heady heights of the late 1990s, but at the same time, it is likely to remain at a higher rate than during the previous fifty years. The "internet bubble" may not have been sustainable beyond a few years, but the impact of the "internet economy" will be felt for a long time to come. ITU TELECOM WORLD exhibitions tend to act as milestones which track the growth and decline of different business cycles in the ICT World. TELECOM WORLD 1999 in Geneva represented the height of over-confidence as the industry crested the *dot.com* wave. TELECOM WORLD in 2003 marked the nadir of that cycle following the bursting of the technology bubble and a fear that the mobile market in particular had become saturated. This report will be published in time for ITU TELECOM WORLD 2006, to be held for the first time outside Geneva, 4-8 December 2006. The signs are that the level of confidence of the industry is now much higher than in 2003, but not at the same levels as in 1999. The internet and the mobile phone have lifted the ICT industry as a whole on to a entirely new level. In today's digital world, growth opportunities abound.

Endnotes for Chapter three

1 See Ritzer, George (1993) "The McDonaldization of Society", Thousand Oaks, CA: Pine Forge Press.

2 Moore's Law is named after Gordon Moore, a co-founder of Intel, who first made the observation and prophecy in 1965 (see: http://en.wikipedia.org/wiki/Moore's_law).

3 See ITU (2001) "Pinoy internet: Philippines Case Study", 58 pp (available at www.itu.int/asean2001/reports/material/PHL%20CS.pdf).

4 See Toby Poston (16 May 2006) "Big Brother's Big Earners", on the BBC website (at http://news.bbc.co.uk/1/hi/business/4762375.stm).

5 For China, per month usage is based on the annual total divided by 12, whereas for Hong Kong, it is the average for December each year. For China, the total volume of SMS usage from China Mobile is measured, whereas for Hong Kong, only outgoing messages from users are registered (excluding messages sent by operators).

6 For more detailed analysis, see also Xu, Yan (2006), "The regulatory environment for future mobile multimedia services: The case of Hong Kong SAR and China" (available at www.itu.int/multimobile).

7 For an analysis, see OECD (2006) "Multiple play: Pricing and Policy Trends", 75pp (available at www.oecd.org/dataoecd/47/32/36546318.pdf).

8 In this context, "mobile broadband" is defined as cellular mobile services offering speeds of above 56 kbit/s. This covers Wideband Code Division Multiple Access (W-CDMA), CDMA 1x EV-DO (Evolution, Data Only) and CDMA 1x EV-DV (Evolution, Data Voice).

9 For details, see teh NTT DoCoMo website (at www.nttdocomo.co.jp/english/charge/discount/pake_houdai/index.html). The package specifically excludes usages such as voice communications, roaming or web-browsing.

10 In Switzerland, for instance, a requirement to provide broadband has been included by the Federal Council in the new definition of universal service, to be applied from 1 January 2008 onwards. See "Broadband in the universal service" (at www.ofcom.admin.ch/dokumentation/medieninformationen/00471/index.html?lang=en&msg-id=7308).

11 See, for instance, "100/100 going twice as far", in DSLPrime newsletter, 24 July 2006 (at www.dslprime.com/News_Articles/news_articles.htm).

12 For more information on Korea's intensely competitive broadband market, and the reasons for its pioneering success, see ITU (2005), "Ubiquitous Network Societies: The case of the Republic of Korea", 51pp (available at www.itu.int/osg/spu/ni/ubiquitous/Papers/UNSKoreacasestudy.pdf).

13 For more information on the ITU's Digital Opportunity Index, see www.itu.int/doi

14 The DOI is presented in the ITU (2006) World Information Society Report (available at www.itu.int/wisr).

15 See Cho, Cheung-Moon (2006) "Development of a DOI-based policy", presentation made at 2006 KADO/ITU Digital Opportunity Forum (vailable at www.itu.int/osg/spu/digitalbridges/materials/drcho-ppt.pdf).

16 Brazil ranks 36th globally on "fixed broadband as a % of total fixed internet", compared with 76th on the indicator "GDP per capita". Similarly the scores for Russian Federation are 46/76, for India 76/134 and for China 48/110.

17 The WSIS outcome documents are the *Geneva Declaration of Principles*, the *Geneva Plan of Action*, the *Tunis Commitment* and the *Tunis Agenda for the Information Society* (they are available at www.itu.int/wsis/promotional/outcome.pdf).

18 ITU itself, as the "club" of regulatory agencies, celebrated its 141st birthday in 2006.

19 For an analysis of the regulatory implications of NGN, see the results of the ITU New Initiatives workshop "What rules for IP-enabled NGN?" (available at www.itu.int/osg/spu/ngn/event-march-2006.phtml).

20 A formal ITU definition of a next generation network is provided in ITU-T Recommendation Y.2001 as: "a packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It enables unfettered access for users to networks and to competing service providers and/or services of their choice. It supports generalized mobility that will allow consistent and ubiquitous provision of services to users".

21 For a review of the issues, see ITU (2006) "The regulatory environment for future mobile multimedia services", (available at www.itu.int/osg/spu/ni/multimobile/papers/ITU_MMSissuespaper_60606.pdf); issues paper prepared by Srivastava, Lara et al for the ITU/BNetzA New Initiatives workshop on the same topic, held Mainz, Germany, 21-23 June 2006 (see www.itu.int/multimobile).

22 See "Furtive phone photography spurs ban" (at http://news.bbc.co.uk/2/hi/technology/2916353.stm).

23 See, for instance, the discussion in McTaggart, Craig (2006) "Was the internet ever neutral?" paper delivered at the 34th research conference on Communication, Information and internet Policy, George Mason University, US (available at http://web.si.umich.edu/tprc/papers/2006/593/mctaggart-tprc06rev.pdf#search=%22Craig%20McTaggart%22).

24 See, for instance, Markoff, John and Hansell, Saul (June 14 2006) "Google's quasi-secret power play" (available at www.signonsandiego.com/uniontrib/20060614/news_1n14supercom.html).

25 See, for instance, Buccirossi, P. et al (April 2005) "Competition in the internet Backbone market", available at www.cocombine.org/pdf/World%20Competition%20Accepted%20Version.PDF#search=%22Concentration%20among%20tier%201%20internet%20backbone%20providers%22

26 As an example of regulatory concerns over bundling of services and price transparency, see "On the question of bundling again", May 2005, on the website of the Hong Kong telecom regulator, OFTA, at www.ofta.gov.hk/en/dg_article/au_articles/article.html. See also the discussion in the 2006 edition of the OFCOM annual review of the UK communications market at www.ofcom.org.uk/research/cm/cm06/main.pdf

27 High roaming charges in Europe have recently been the subject of a European Commission investigation, which has resulted in a new proposed regulation (see: http://europa.eu.int/information_society/activities/roaming/roaming_regulation/index_en.htm).

28 Europe's Achilles heel in the form of excessive mobile call termination rates has been recognized for a long time. For instance, fixed-mobile interconnection was the subject of an ITU New Initiatives workshop as long ago as September 2000 (see: www.itu.int/osg/spu/ni/fmi/index.html).

29 In 2005, net new additions of FTTH subscribers in Japan outnumbered net new DSL additions for the first time, and a similar pattern is forecast for Europe by 2010; see for instance, "European municipalities lead FTTH charge" in September 2006 edition of Lightwave (at: http://lw.pennnet.com/Articles/Article_Display.cfm?Section=ARTCL&ARTICLE_ID=271114&VERSION_NUM=2&p=13&dcmp=FTTXNews).

30 See, for instance, "Top 10 *dot.com* flops" (at www.cnet.com/4520-11136_1-6278387-1.html?tag=cnetfd.sd).

31 The economist and mathematician, Andrew Odlyzko, has done much to explode this particular myth, See, for instance, his 2003 paper "Internet traffic growth: sources and implications" (at: www.dtc.umn.edu/~odlyzko/doc/itcom.internet.growth.pdf). He shows that the myth that "Internet traffic doubles every 100 days" may have been true for a period of a few months in the mid 1990s, but similar statements continued to be reported, without solid proof, for the next five years or so and were used to support the ambitious investment plans and inflated share valuations of some of the leading companies in the field, most notably WorldCom. Such exponential growth is rarely sustainable for more than a brief period.

32 At the time, estimates of the level of expenditure in preparing for Y2K were around USD 300 billion (see for instance: "Y2K: Overhyped and oversold" (at http://news.bbc.co.uk/2/hi/talking_point/586938.stm).

33 The US auction of 3G spectrum in 2006 raised some USD 13.8 billion compared with the more than USD 100 billion raised from similar auctions in Europe, 2000-2001. In terms of price per megahertz per capita, the US auction valued the spectrum at around 50 US cents compared with USD 4.22 in the United Kingdom or USD 3.86 in Germany. See, for instance, "Air Supremacy" in the 9 September 2006 edition of *The Economist* (at: www.economist.com/business/displaystory.cfm?story_id=E1_SRRSJVT&CFID=90344009&CFTOKEN=22fffbf-16e76902-4f0a-4359-afb7-1fecdd11a607).

chapter four
identity.digital

The headlong development that has characterized the digital world from its very inception has not been even in all its parts: some issues have been relatively neglected and have not kept up with rapid technical and market changes. Among these are questions relating to digital identity, data security, and consumer privacy. With all the expansion in progress in this domain, and the constant innovation, the risks involved are magnified and thus assume an increasing urgency. Matters such as social participation and interaction in the digital environment are equally important to consider as they ultimately provide the backdrop for developments in this field. This chapter examines the rapidly changing technological and social environment surrounding the individual (later referred to as the "digital individual"), and the blurring boundaries between the public and private spheres of existence. Detailed consideration is then given to the establishment and management of digital identity online.

4.1 The digital individual

4.1.1 From person to personae

The complexity of the interaction between technology, personal consumption and the construction of virtual identity in cyberspace has traditionally been ignored[1], but is now the subject of observation in many quarters. Users of digital technologies today have a wide scope for constructing their identity. The mostly nameless and faceless environments of cyberspace create an ideal background for developing alternate identities or digital personae. Unlike face-to-face interaction, it is much more difficult to categorize people online according to age, gender, race, country of residence, social class, body shape etc. Consequently, users may feel more inclined to interact in what seems to them a more anonymous and forgiving world.

Moreover, the internet makes it fairly easy for individuals to create multiple representations of their identities, mainly due to the lack of a generic system for identification. This fragmentation of identities can be accidental, but also intentional[2]. Creating more than one identity can even be desirable to some, depending on the context and exchanges involved. For instance, a user may wish to be aggressive and egotistical in one context (e.g. in a multiplayer game), but sensitive and sociable for virtual encounters of the romantic kind.

Alternate identities can enable the exploration of a wide variety of feelings, personalities, interests and motivations. The phenomenon of online avatars has served to make these more popular and accepted[3]: an avatar is an icon or representation of a user in a shared virtual reality space[4] (box 4.1). Although avatars were first used in online role-playing games (e.g. Everquest and Lineage) or virtual universes (e.g. Second Life and Active Worlds), their use is increasingly being extended to the non-gaming world, notably to online networking sites and forums. The avatar in this context is a picture or icon

that a user of that community displays to represent his or her virtual self. In this respect, avatars may resemble a person's real or off-line self in varying degrees: wholly, partly or not at all. One of the most interesting examples of how the digital world affects the construction of identity is the phenomenon of gender switching, i.e. when users represent themselves as members of the opposite sex in social interactions online.

There are many reasons why people might take the opportunity to explore multiple identities, including:

- the ability to change character at will–this gives users the possibility of exploring other forms of existence and changing the ways in which they may be perceived by others;
- the opportunity to form relationships that may be perceived to be more difficult in the off-line world – e.g. between people from vastly different backgrounds or people who may be shy or uncomfortable with face-to-face interaction;
- the opportunity for those who are marginalised or persecuted in society to express their views freely without fear of discrimination or reprisal;
- the potential for finding groups and individuals with similar interests – identities online can bring geographically and socially disparate individuals together based on common interests, thereby stimulating dialogue and curbing loneliness;
- the possibility of sexual relations – virtual identity is important to those who seek romantic or sexual relations, particularly for those who lack confidence or have little opportunity to engage in such possibilities in the offline world.[5]

Box 4.1: Avatars and digital descents

Origins of avatar and its present use online

Avatar is a word that is commonly heard but rarely understood. It comes from the Sanskrit word *Avatar*a, which means "the descent of God" or "incarnation." In English, the word originally meant "an embodiment, a bodily manifestation of the Divine." Below is the definition from the Vedas, the oldest and most comprehensive spiritual literature currently known:

> The Avatara, or incarnation of Godhead, descends from the kingdom of God for [creating and maintaining the] material manifestation.
> And the particular form of the Personality of Godhead who so descends is called an incarnation, or Avatara. Such incarnations are situated in the spiritual world, the Kingdom of God. When They descend to the material creation, They assume the name Avatara.
>
> *(Chaitanya-caritamrita* 2.20.263 -264)

The digital world has transformed the original meaning of avatar. Today, avatar most commonly refers to a graphical image of a user, for example in instant messaging applications, or, a graphical personification of a computer or a computer process. Avatars are intended to make the computing or network environment a friendlier place. An avatar can also be the virtual representation of a real participant in an activity in a virtual reality environment. For example, an avatar could represent a participant in a virtual meeting, or a tutor in a distance learning situation. To be effective, a digital avatar will need to have some basic human characteristics, such as speech and language capabilities.

Image source: insurat.com

Source: avatars.com

4.1.2 Blurring boundaries and digital interactions

An individual in today's world spends more and more time using digital means to communicate, be that sending and receiving e-mail, talking on a mobile phone, participating in a social networking site or playing an online game. As such, many aspects of daily life are increasingly mediated by technology, and this has important implications for human interaction and social behaviour.

As mentioned in Chapter 2, social networking sites like Cyworld (originally created in the Republic of Korea) provide good case studies for the changing nature of social interaction in the digital environment. Cyworld's new site, based in the United States, tells its visitors: "create and connect: record your days, keep up with friends and share what makes you special"[6]. The site has been adapted to the cultural context of the United States, but like its original version, site users can create their own avatars ("minimes") and virtual spaces ("minihomes" and "minirooms"). They can also display journal entries, photographs, and sundry virtual items (including lucky charms and miniroom furnishings). Users can reveal as little or as much as they like about themselves on the site, but the main objective is to encourage the sharing of details about personal lives that might not have been as readily shared in the offline world. An embedded "random minihome" function can transport Cyworld users to the minihomes of other users, where they can make comments, sign a guestbook, or buy gifts on a "wish list".

The rise of such social networking sites points to the increasing use of publicly shared experiences to form social bonds. Unlike the offline world, contact with strangers is not avoided, but encouraged and even expected. It is possible, and in some cases acceptable, to exaggerate, hide, alter or undermine the truth about oneself in order to encourage contact or construct more interesting and desirable online impressions or reputations. In some cases, online personalities can be vastly different from off-line personalities, and those who are well-liked and seemingly sociable in virtual spaces may not necessarily be so when engaging in social interactions off-line. Some may even forego interactions with real persons in favour of entirely virtual ones (box 4.2).

The growing use of mobile phones has been blurring the boundaries between the private and public spheres of existence even further. The mobile phone has become such an intimate and important aspect of a user's daily life that it has moved from being a mere technical tool to an indispensable social accompaniment. [7] Its highly personalized and emotive[8] nature has meant that its form and use have begun to represent the very personality and individuality of its user. In other words, it has in some respects become a reflection of a user's identity. Much can be gleaned about the personality of a user by looking at their mobile phone:

a) its model, shape and size;

b) the ringtone in use (e.g. traditional telephone ring, classical music, hip-hop or heavy metal music);

c) the chosen wallpaper (e.g. personal photo, cartoon, abstract or realistic landscape);

d) the messages and digital photos stored in the phone's memory (e.g. content, style, number, origin and so on).

It is little wonder that phone manufacturers and operators are capitalizing on this trend by offering an ever-increasing variety of customized and fashion-conscious handsets and services, thereby shortening the average lifecycle of their phones.

Mobile phones have transformed the way people interact in many respects. Not only can they communicate with each other anytime and anywhere, but they can also avoid contact by screening phone calls, resorting to voice mail, or limiting communication to SMS. Revealing yourself when phoning has become expected—some users might be criticized by friends when their incoming call is listed as "private" or "withheld". In traditional fixed-line phone environments, most calls were dutifully answered when possible, and the identity of the person on the other end was typically unknown, or at least unconfirmed, until the conversation was engaged. Today, many young people text each other before engaging in a voice call. There is a reticence towards voice communications until both parties are available, willing and prepared. Consequently, the spontaneity of voice communications has diminished, resulting in more controlled and predictable exchanges.

Box 4.2: You too can win her digital heart

The virtual girlfriend

For men who are tired of spending the time, trouble and expense of having a real girlfriend, the city of Hong Kong proposes a digital solution for their lonely hearts.

A creation of Hong Kong based Artificial Life, "Virtual Girlfriend" is a 3G mobile game in which users can meet, woo, date, and develop a relationship with virtual partners. The Virtual Girlfriend herself is based on intelligent animated 3-D characters existing only in the virtual world. Virtual girlfriends can be visualized and contacted using a 3G phone at any time. These virtual characters are usually involved in different activities throughout the day: for example, they could be relaxing at home, working in the office, lounging in a bar, dining in a restaurant, or shopping at the mall with a virtual friend.

Players in the game can observe their girlfriends during these various activities and interact with them via the mobile phone. The characters and the game follow a certain daily and weekly schedule which will continuously change and progress over time. The purchase of flowers and diamonds might serve to get increased attention from a character, and might develop the relationship to more advanced levels. In return, a virtual girlfriend might introduce the player to her virtual parents or friends, and unlock other aspects and details of her private life.

It is not all rosy, however. As in the real world, relationships do have their ups and downs. A virtual girlfriend can get angry and ignore a player if she does not get what she expects. And, since virtual flowers and diamonds cost real world money, players have to take care not to fall into the hands of purely money-minded digital characters. But, that as they say, is fate.

For women, the "Virtual Boyfriend" made its debut on 1 February 2005.

Image source: V-girl.com

Source: Artificial Life Inc., at **www.artificial-life.com**

On the other hand, recent fads such as "bluejacking" (communicating with Bluetooth-enabled mobile users in a given area) and "flash mobs" (the spontaneous assembly of people through targeted SMS and internet communications) have given an entirely new meaning to spontaneous communications and associations. Indeed, in the online world, spontaneous instant messages are encouraged between members of the same networking site, or even the same service (e.g. Skype through the "skype me" mode[9]). People are much more likely to contact strangers in the digital world for a query or comment about a website, a book, or a common interest in the digital world than they ever were in the off-line world (through e.g. the postal service or fixed-line phone). In some sense, therefore, everyone has become increasingly accessible. This can be desirable in some cases (e.g. a student can more easily write to her professor with a question) but undesirable in others (e.g. direct access to minors has become easier).

Yet another aspect of the digital environment is its impact on family structure and communications. In the past, a fixed line household telephone served as the gateway to all members of the family, be they parent or child. In the digital world, this has given way to individual gateways to each member of the household (e.g. father, mother, and school-going children). Families may own as many mobiles as they have family members, or even more (for instance, for business and home use). Individuals may typically own up to two or three e-mail addresses each. As such, channels for communication go up manifold, and many distinct exchanges can be carried on simultaneously. Whereas in the past, parents were aware of when their children might be interacting and with whom, today these exchanges can easily take place without the knowledge of other members of the family. In order to prolong participation in their peer group, many children engage in online chats or text messaging in their bedroom (and late into the night): this has been known to cause sleep deprivation[10], high monthly

bills and parental frustration. On the one hand, this gives the benefit of allowing members to create and assert their individuality (e.g. a teenager who has an overbearing parent), but on the other hand, it can lead to disaffection from the family. Of course, the vacuum left by this disaffection may be filled, at least to some degree, by an affiliation with a chosen social network in the digital sphere.

Wireless e-mail and SMS have created another related phenomenon, that of the "permeability" of the separate contexts of social life[11]. People are frequently interacting with others present in their physical space and simultaneously messaging with other "remotely present" persons (by e-mail, SMS or MMS). This form of intrusion, or even potential intrusion, in any given social context has become commonplace. Among youths getting together for a social event, it would be unusual to expect that no one is seen using their mobile phone to interact with others. In fact, not doing so might even lead some to conclude that that person was unpopular. In this sense, much of one's digital reputation, or identity, is based on the quantity of communications received, such as the number of SMS or e-mail, the number of comments on a moblog or website, the number of visitors to a Cyworld minihome. Prospective employers may take into account the number of "hits" on Google that an applicant's name generates. Data available on the internet may also be used to verify elements contained in a curriculum vitae. Thus, it would seem that a sufficient connection between online and offline identity is required for societal purposes, especially in the face of the trend towards alternate and multiple identities.

4.2 Virtually private

The advent of the digital world implies a progressively ambient use of technology and communications. This in turn leads to an increase in the amount, quality and accuracy of data generated and collected. Not only does this increase apply to the ability to collect data, but also the ability to store, analyze and process it.[12] The sheer amount of data is alarming, but so too is its nature, which is ever more detailed and personal. The public and private spheres of existence are experiencing a progressive blurring of the boundary separating them. This creates a new set of concerns that bear serious consideration.

4.2.1 The value of privacy

The Merriam-Webster dictionary defines privacy as follows:

privacy:

- the quality of state of being apart from the company or
- isolation, seclusion or freedom from unauthorized oversight or observation;
- a place of seclusion or retreat *(archaic)*

Over the ages, privacy as a concept was not explored in much detail, and was not a popular subject of consideration. The great classical philosophers seem to have left it alone. But it is unlikely that this was a conscious omission. Perhaps it was thought to be a core aspect of existence, inherent to the very processes of life. The right to privacy has in many circles been viewed as the cornerstone of freedom and liberty.[13] Freedom lies in the ability to better understand one's position in the world and to develop opinions independent of external pressures. Indeed, a good deal of individual thought is a private matter.

It has traditionally been thought that what one thinks, believes and knows is inalienable to oneself, and may only be revealed with the voluntary consent of the thinking person. Slowly and gradually, however, this notion has begun to erode. Today, eavesdropping or monitoring by all sorts of agencies (not only governments) seems to have become regular practice. Large amounts of information can be gathered by a variety of actors, for legitimate or illegitimate purposes. The written works read by a particular community can be known, but so too can those perused by a particular individual. The early days of print media favoured one-way communications and information: by its very nature it ensured that the gap between authors and readers remained intact. The browsing and reading habits of today's digital individual, however, are subject to progressively more detailed observation and

analysis. It can be argued that the current concerns surrounding privacy result from a technological shift in communications, from one-way print media to bi-directional flows of information: as such, it will become increasingly difficult to "reveal without being revealed, and to learn without being learned about"[14].

It might be rightly argued that digital technology has not been developed for the purpose of invading privacy. And in an ideal world, it is possible to conceive that the deliberate or accidental availability of data would not be detrimental to the individual. But today, with the wide and almost universal means of data acquisition, this is less and less the case. And of course, certain applications are being developed with this particular purpose in mind (e.g. profiling). Safeguards may need to be created to disable these applications from carrying out tasks indiscriminately. The universal availability of data, the ease of its accessibility, its durability over time, and the possibility of its early and infinite accumulation present us with an entirely new situation. In this context, the good news is that it is generally been accepted that data pertaining to the individual should only be propagated with the knowledge and consent of the individuals concerned. Many governments and organizations (commercial or otherwise) show an awareness of this aspect by making disclaimers at the time of the acquisition of data. But these efforts, often voluntary, are feeble in the face of the many challenges present in this field. For these reasons, the privacy of personal data, while appearing to some to be a subject of only passing interest, is actually of considerable importance, and moreover, one whose importance will grow with time.

4.2.2 Privacy and digital ubiquity

The vision of digital ubiquity is based on Gordon Moore's long term vision (known as Moore's law) of the increase in the power of microprocessors, which has held true with remarkable consistency, and also seems applicable to other parameters such as storage capacity and bandwidth. All indications are that this trend is likely to continue for some time to come, with advances in nanotechnology, RFID and sensor networks[15] further fuelling developments towards a global "internet of things"[16].

As digital innovation gathers even more speed and as the information environment becomes pervasive and intensely functional (such as in the case of smart homes), tracking and monitoring will become commonplace. As such, this "enriched" environment will differ from the more traditional information technology environment in four main ways[17]:

- Ubiquity: infrastructure and information will be everywhere and constantly on, affecting every aspect of daily life;
- Invisibility: the infrastructure will be cognitively or physically invisible to the user – as such, the user will have no idea when or where they are using a computing or communications device *per se*;
- Sensing: the network, mostly transparent to the subjects, will automatically record every activity, human and otherwise, and conscious input will be less and less necessary (such as through a keyboard);
- Memory amplification: selected activities (including private or personal ones), could be stored, processed, or retrieved.

The factors listed above, notably memory amplification, are likely to suffer further aggravation, due to expected exponential growth in digital storage capacity: thus, there will be little technical, or economic, incentive to delete anything. An information environment such as this can lead to easier and more widespread "eavesdropping" and to problems resulting from data leakage and device integrity (particularly as devices or sensors on the edges are inherently more mobile).

Furthermore, as more and more entities in the economic process (goods, vehicles, factories, equipment) are being enhanced with comprehensive methods of monitoring and information extraction (e.g. RFID), the entire lifecycle of products, beginning with their creation and ending with their complete consumption (or recycling) can be witnessed (and to some extent controlled) in real time. As such, the world "would be filled with all-knowing all-reporting things"[18]. Data collection would cross not only the boundaries of space, but also of time (with data about humans starting from pre-natal diagnostics to daily life in a retirement home). Thus, real-time ubiquitous monitoring will create new opportunities for "border crossings": natural borders, social borders, spatial borders and temporal borders.[19]

Naturally, information privacy is at the core of blurring boundaries and borders in smart and pervasive information environments. In order to ensure that border crossings are reasonable and fair, analysts and thinkers have put forth a number of information practices, notably Alan Westin in his book "Privacy and Freedom". Westin's principles include: openness and transparency, individual participation, collection limits, data quality, limits on usage, appropriateness of limits, and accountability. In multimedia environments, three main characteristics relating to the nature of information have been considered: the destination (or receiver) of the information, its use or purpose, and its level of sensitivity[20]. In a pervasive information system, awareness on the part of users must be added to this list, as invisibility of communications might hide from their view that information relating to them was being collected.

In the end, it will most likely boil down to one thing: intention. But intention can never be guaranteed. Data about an individual or a group of individuals in a digital environment can be used for beneficial as well as nefarious purposes. In this respect, digital technologies share common characteristics with many other technologies such as nuclear technology. Somehow, vigilance will have to be exercised and means found for the elimination of illegitimate uses of private data. This is doubtlessly urgent and important. At stake is human freedom itself which is recognized to be the very foundation of modern civilization. The maintenance of the privacy of designated data can be indispensable for the maintenance of a free society. This is especially true given the universal availability of computing power. A society in which every detail concerning an individual's interests and associations are recorded and easily available will result in a total freeze of movement – the equivalent of a traffic jam. The same holds good for the individual. It is on the basis of confidentiality and some minimum level of privacy that individuals are able to function. As data acquisition and accumulation proceeds apace, the equilibrium between privacy and convenience is threatened.

4.2.3 A delicate balance

The gathering, processing and analysis of information are crucial aspects of today's digital information economy. Without it, cash would be required for every purchase, there would be no licensed drivers, no health system, and no unemployment benefits. There is a balance to be struck, however, between the need to harness the power of information for economic progress, quality of life and convenience, and the need to curb potential abuses relating to its collection and distribution. The balance is a delicate one, but one to which the state and private corporations need to pay heed for the protection of individuals in an environment which has been deemed by many as a potential threat to human dignity.

The individual and the state

Many states have made attempts to manage data pertaining to their citizens, in order to provide streamlined and efficient government services. Moreover, since the number and scope of terrorist attacks continue to rise (e.g. New York in 2001, Madrid in 2004, London in 2005 and Mumbai in 2006), security concerns are increasingly at the forefront of national policy priorities. Biometric data is now being used in many cases for identification purposes, or for entry into a particular country, notably in the United States through its US-VISIT programme (under which foreign visitors are required to provide fingerprints upon entry[21]).

The United States government has been criticised for various measures introduced since 2001 that are seen to violate the protection of privacy, in the name of national security. In late 2005, for instance, an article in the New York Times revealed that in the months following the September 11th attacks, the United States President authorized the National Security Agency (NSA) to spy on citizens without a warrant or court order[22]. Since then, the NSA has been monitoring international phone calls and intercepting international e-mails between residents of the United States and people in certain foreign countries. Two opposing positions regarding the legality of such measures have emerged: the United States Department of Justice claims that the President acted at the "zenith of his powers in authorizing NSA activities", whereas the American Civil Liberties Union believes that the NSA programme "seriously violates the first and fourth amendments and is contrary to the limits imposed by Congress"[23].

The European Union (EU) attempted to harmonize its data protection legislation across its member states through Directive 95/46/EC on the protection of personal data[24] (hereafter referred to as the Data Protection Directive), which defines minimal requirements applicable at the national and European level in this regard, notably the sharing of databases using identifiers and the use of these identifiers by private bodies and citizens. Case law under the directive includes the 2006 annulment of a Council Decision[25] which concluded an agreement between the European Community and the United States on the processing and transfer of passenger data by air carriers to the US Department of Homeland Security, Bureau of Customs and Border Protection[26].

A single multi-purpose state identifier, also known as a single identification number (SIN), is under consideration in a number of countries. In the special administrative region of Hong Kong, an e-citizen card is already in use, with biometric data and preferences (box 4.3). The problem, however, is that despite a progressively borderless digital world, the application of the SIN is not globally harmonized, even within groups of countries that are otherwise

Box 4.3: All about who you are—on a tiny card

Residents in Hong Kong SAR see their identity go digital

It contains your name, address and birthday. It carries a template bearing your photo and fingerprint. It reveals your favourite books and travel records. It keeps track of your tax returns – all on a small card. And this is only the beginning.

The government of Hong Kong SAR launched an ambitious and innovative identity card replacement scheme in August 2003. In the course of the four-year programme, 6.9 million Hong Kong residents over the age of 11 were issued with a "Smart ID card". The objective was to introduce multiple value-added applications onto the identity card.

The card itself is made of polycarbonate and anti-forgery laser-engraving technology is used for printing personal data, and a digital photo. A duplicate of the data with digital thumbprint templates is stored in a chip embedded on the card, and authentication is required every time the data in the chip is retrieved. This prevents unauthorized access. If the chip is tampered with mechanically, electrically or electronically, there is a self-erasing mechanism, which denies an intruder access to the data.

Cardholders have the choice to decide whether to make use of the value-added applications of their Smart IDs. At the same time, the Hong Kong government continues to broaden the range of applications. By the end of 2004, for instance, card-holders were able to use their cards for immigration clearance through self-service control points. This facilitates the immigration control process notably at the border crossing between Hong Kong's SAR and mainland China, which handles nearly 300'000 people and 31'000 vehicles every day. If cardholders are not permanent residents of Hong Kong, their condition of stay and limit of stay are also stored on the chip. By the end of 2006, the Smart ID could also double as a driving license. The e-Cert, a free optional digital certificate issued by Hong Kong Post, allows various online transactions such as e-banking, stock trading and online payments. It is widely acknowledged that e-Cert will boost e-business development in Hong Kong in the immediate future. The Hong Kong SAR government is also hoping to encourage citizens to file tax returns online using the Smart ID-based credentials for identification and authentication.

To cater for the increasing number of Smart ID Cards and digital certificate holders, self-service kiosks have been installed at all Immigration Department offices to enable citizens to check the data on their ID cards. In addition, more than 600 public kiosks and computers in public transport stations, shopping centres, post offices, public libraries, and community centres throughout Hong Kong have already been equipped with smart card readers.

Image Source: sxc.hu

Source: Hong Kong S.A.R. Immigration Department and m**ultos.com**

closely associated, such as the member states of the EU. A recent study points to the increasing use of single identifiers across Europe: in 2001, 60 per cent of Member States had a national SIN and in 2005, that proportion rose to 78 per cent. Two countries have thus far been against the notion of a SIN due to data protection concerns: Germany and Hungary[27]. The study found that a minority of countries (three out of the fourteen studied) have constituted their respective SINs from purely random figures. The other eleven countries use meaningful data such as sex or date of birth. In terms of the data used, there is also a wide variety across countries. Some countries limit the data to those items that are absolutely necessary for reliable identification (such as family name, first name, sex, and date/place of birth). Many others, however, have identified a wider array of data points (over twenty in Bulgaria and Cyprus). In all, some thirty possible attributes were found, ranging from main domicile and marital status to photographs and academic titles (figure 4.1). The study concluded that while the use of SINs is widely prevalent in the EU, there are a number of different systems to constitute them: the number of data attributes, documents comprising the identifying numbers, the legislative and organizational framework set up to regulate the use of the SINs, and the role of the designated supervisory authority.

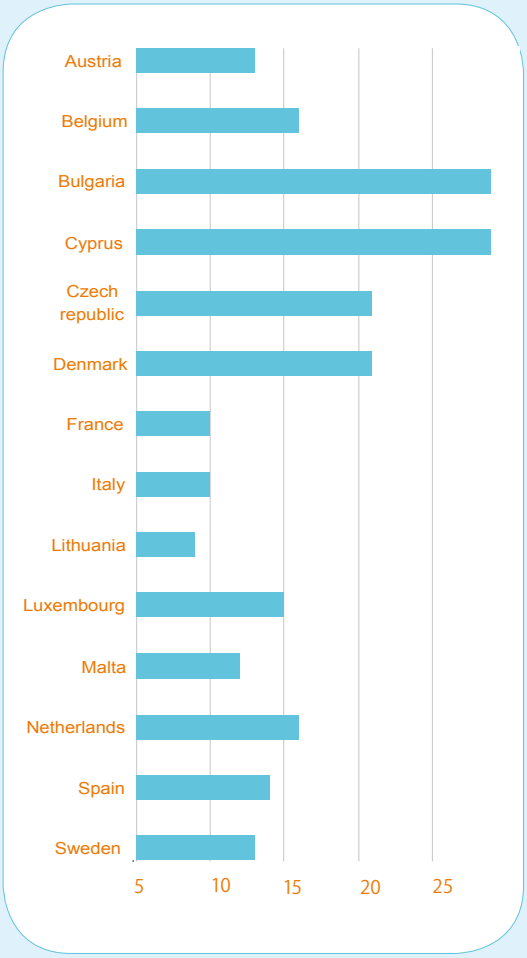
In light of the new technologies available to governments, the need for streamlined government processes and the growing concerns for national security, governments are studying and implementing new ways of using the vast databases of personal information that they have at their disposal, and those collected by companies and data aggregators. As such, some analysts warn that civil liberties advocates should not rely on protracted or inefficient government processes in the use of information and communication technologies (ICTs), and that to the contrary, inefficiency may itself pose a threat to civil liberties[28].

Although governments must work with market mechanisms to ensure security and raise awareness[29], they have a duty not to neglect or minimize their more general social responsibilities (ethical and social) relating to data use and protection[30]. Defining the limits of data collection relating to human individuals and the safeguarding of authorized data are matters of too great an importance to be left solely in the hands of private agencies. It is integral to the role of governments to be deeply conscious of human and privacy rights in the handling of data pertaining to citizens.

The individual and the corporation

Although a number of countries have taken steps to safeguard personal data gathered by their governments, this has not been equally true so far as the private sector is concerned. Legislation

Figure 4.1: A variety of SIN in Europe
Number of data attributes linked to single identification numbers (SIN) in selected member states of the European Union



Source: B. Otjacques, P. Hitzelberger & F. Feltz, "Identity management and data sharing in the European Union", Proceedings of the 39th Hawaii International Conference on System Sciences, 2006

Box 4.4: Trashing data

What happened to eGroups user data after its purchase by Yahoo!

Yahoo! purchased eGroups in the Summer of 2000. At the time, eGroup users were not given permission to access their data unless they provided Yahoo! with a complete profile and agreed to entirely new terms of service. If users declined to provide a complete profile or agree to the new terms, Yahoo! maintained ownership of their data and the archives of their correspondence. In October 2001, a number of listserv owners had all of their archives and data deleted. They were given no explanation at the time, nor were they given any recourse. Their attempts to contact Yahoo! were in vain, and resulted in silence. In 2002, a Washington Post article was published on the subject, which finally gave the reason for the deletion. Apparently, Yahoo! had declared those users to be terrorists in the month following the 9/11 attacks on New York.

Image source: sxc.hu

Source: D. Boyd, MIT Media Lab

regarding access to information may go some way in keeping the public sector and credit agencies in check, but little has been done to make the private sector accountable in a similar fashion. Ubiquitous networks and technologies are creating a socio-economic paradigm, in what has been termed the "ambient economy" or "real-time economy", and in which enterprises monitor their environment in real-time in order to be in a position to react instantly to changes affecting their business.[31]

Despite the recognition of the evolving socio-economic and technical context, there is limited recourse for individuals wishing to challenge the collection of data about their behaviour by private companies, or by those who have suffered damages as a result. If an individual attempts to block cookies from a certain website, for instance, the result may simply be exclusion from the website altogether. In such cases, it would seem that the monitoring of behaviour or user preferences becomes a prerequisite for accessing a particular service. By contrast, in the off-line world, loyalty cards offered by supermarkets or department stores remain optional, where shoppers may exercise discretion.

Moreover, online, the use of data about users can easily change hands, thus shifting contractual obligations. When Google purchased the Usenet archives owned by the company Deja in 2001, they were able to purchase all of the content that Usenet had collected, including statements made public by individuals. Google gave no guarantees about removing those statements from its data repositories. Thus, it would seem that any website or service that collects data on users can sell that data without the permission of the users. The purchaser of the data does not have to abide by the terms of the contract as understood by the users when they first signed up with the original service. A similar problem arose following the sale of eGroups to Yahoo![32] (box 4.4). Criticism over Microsoft's Passport platform also points to the importance of creating services that do not give a single service provider complete control over a user's identity and data (box 4.5).

There remains significant ambiguity about social and corporate responsibility relating to personal data (e.g. shopping habits, location, information accessed and so on). Not surprisingly, many observers are calling for a shift from self-regulatory mechanisms and a mere awareness of ethical principles to concrete and tangible legal measures. If corporate responsibility is to be expanded to include issues such as information privacy—an expansion that is wholly desirable—there remains much work to be done in order to identify mechanisms for its elaboration, application and enforcement.

4.2.4 Current solutions for enhancing privacy

The rise of PETs

Though much has been done since the 1970s for developing legal principles and provisions for the

Box 4.5: Passport to privacy?

Microsoft's Passport platform

Microsoft launched Passport as its "platform service" in 1999, providing an easy single sign-on mechanism for an individual's everyday online tasks, including access to e-mail (hotmail) and other online content.

To merchants and other partners, it promoted the service as a convenient and safe means of determining whether individuals browsing a site were who they claimed to be. Passport operates on a "federation" model, which is meant to allow other authentication vendors to create systems that interoperate with it.

However, in order to use Passport, users are prompted to enter all kinds of information, that are not wholly necessary for the purpose of its Passport service, e.g. full name, e-mail, sex, address, postal code, occupation and income. And since Passport includes a wallet system that speeds shoppers' checkout at designated sites, Microsoft can also maintain encrypted credit card information. Given the need for users to accurately represent themselves at payment sites, this mechanism ensures that users are not able to lie about who they are or where they live (lest a book is sent to a wrong address). The system therefore excludes the possibility of anonymity online and goes against the principle that only a minimum of a user's personal information is to be disclosed. It is also impossible to establish two different identities for two different contexts, as users can only be logged into one passport at a time.

Users initializing Windows XP are actively encouraged to create a passport account. Microsoft maintains most of the personal data, as most of the sites that participate with Passport are owned by Microsoft.

Passport, of course, only works if a user enables cookies allowing the tracking of their surfing behaviour. If cookies are disabled, users receive the all-too-familiar message: "Your browser is currently set to block cookies. Your browser must allow cookies before you can use the Passport Network."

In order to address some of these criticisms and the security failures of Passport, Microsoft has been phasing out Passport to make room for its new identity metasystem, known as "InfoCard".

Image source: flickr.com (ahhyeah)

Sources: Wired News, internetnews.com, D. Boyd (MIT Media Lab), Microsoft

protection of privacy, many argue that legislating for a digital world is essential but that it is as yet insufficient, and especially so in the absence of the necessary technical measures deployed in this area, both at the network and application layers. This has led to the growth of a number of so-called privacy-enhancing technologies (PETs) with the aim of giving users greater control over their personal data. These can be thought of as falling into three categories:[33]

- Proxy: protecting privacy through proxy is the most common approach to PETs. It prevents the receiver of a message from identifying a sender, e.g. it may remove the sender's information from the header of an e-mail before forwarding it. The main disadvantage of this system is that the anonymity is uni-directional, that is to say the perpetrators of harassing or harmful messages can remain anonymous. Furthermore, the solution is onerous, as all communications need to be mediated via a central hub.
- Informed consent: protecting privacy through informed consent includes the popular

Platform for Privacy Preferences (P3P). P3P is an open standard that a given website can use to describe how it uses personal data collected during any session: this is done through a set of multiple choice answers which are made available in a machine-readable format. P3P-enabled browsers can then interpret this description, providing users a way of making decisions about how they use the site by reference to their own set of "privacy preferences". Of course, the use of P3P is dependent on the availability and willingness of sites and service providers to share information about their privacy policies[34]. These privacy policies can also be certified by trusted third parties (e.g. TRUSTe). Although this encourages users to seek out companies with better privacy protection, there may not always be alternate services available, resulting in a lack of choice for users. If the number of such sites is to be reduced, P3P will certainly need the support of legislative measures.

- Untraceability: protecting privacy through the absence of traceability (i.e. through "untraceability") is yet another category of PETs. Not being able to link persons to their representations and expressions of identity online lies at the heart of fundamental rights such as the freedom of expression. The Freenet Project[35] falls into this category. This project, having begun as part of a research project at the University of Edinburgh in 1999, had as its main objectives, *inter alia*: to incorporate anonymity for producers and receivers of information, to create dynamic routing, and to decentralize network functions. More specifically, Freenet eliminates the link between a document's origin and its place of storage. One of the main criticisms of the project is that though it is designed to protect free speech, it has the undesirable consequence of stifling measures to curb the free circulation of material. Thus, Freenet seems to question the very need for protecting intellectual property rights in a digital world.

Cryptography for enhanced security

In addition to the privacy-enhancing systems as described above, improvements in cryptography have been contributing to the growing security of data. Although privacy and security are often related, there is an important difference: security refers primarily to the ability to protect certain information from unauthorized access by third parties, whereas privacy refers to the ability to keep that information private: a system can be secure without necessary being private[36]. Cryptography does not ensure the absolute protection of privacy, but the denial of it to unauthorized parties. As such, it plays an important role in authentication, i.e. checking the identification of those seeking access, but cannot guarantee that privacy is protected.

Cryptography is not a new concept: literally, it means "secret writing". Secret codes (or ciphers) have been in use for centuries, and cryptography has a long tradition in religious writing. Scholars argue that Egyptian Hieroglyphs themselves (used in ancient documents or monuments) are actually early examples of cryptography[37]. Today, information flowing through and stored by the computer is an increasingly rich field for the application of cryptography. In the digital world, most cryptography is based on the use of keys. A popular example is Pretty Good Privacy (PGP)[38], a program which can be downloaded by users to encrypt and decrypt e-mail messages. SSL (Secure Socket Layer) and TSL (Transport Layer Security), communication protocols in daily use for hiding sensitive information (like credit card details online) are also based on cryptography.

Due to its ability to conceal information from those unauthorized to view it, cryptography can be a useful support mechanism for digital identities. It is seen as a core component of a coherent and secure identity management scheme. It may be useful at this stage to outline in brief some of the basic principles behind cryptography, and in particular the most common form of cryptography in use today: public key encryption.

There are two forms of cryptography (figure 4.2): symmetric (or private key cryptography) and asymmetric (public key cryptography). Symmetric encryption is the less complex form of key-based cryptography. It uses the same key to encrypt

and to decrypt messages, and parties are required to ensure that the key remains private. A simple example of a private key is a password, e.g. an alphanumeric code used to open a document. The main disadvantages of symmetric encryption is that it is difficult to ensure that the private key stays private, and anyone who intercepts the key can later have access to all messages encrypted with that key, without the knowledge of the owner. Moreover, this form of encryption can be burdensome and does not scale very effectively (imagine all the passwords and private keys that would need to be in circulation). The second form of encryption is asymmetric. It differs from the symmetric form in that it uses two separate keys: one public and one private. Information encrypted by the public key can be decrypted by a private key. The main disadvantage of this system is that encryption and decryption can be very slow, given the increased complexity of the system.

The basics of public key cryptography were first set out in a paper by W. Diffie and M. Hellman in 1976[39], and are the foundation of PKI or public key infrastructure. In public key encryption, symmetric keys (that are encrypted by a public key) encrypt the data. Public key and symmetric key cryptography are complementary. A public key infrastructure refers to the entire set of processes, technologies and policies that aim to ensure secure online transaction environment. In PKI, the use of keys is complemented by the use of "digital certificates", which separate the signing and lookup of identity by allowing a certification authority (CA) to bind a name to a key through the use of a "digital signature" and then store the resulting certificate in a database[40]. The use of a CA is central to PKI, and introduces an added level of security.

Today, PKI is one of the main online tools for trusted transactions, but also for ensuring that new identity mechanisms such as biometric passports are secure[41]. But it does suffer from a number of shortcomings. For instance, it does not address the problem of linking a digital identity with a network, an e-mail, an account or a role. Moreover, its digital certifications do not provide sufficient information for authorization, e.g. access permissions for whom and in what context. Though it is one of the most popular forms of security online, it is not universally deployed and does not offer a uniform security and identity platform.

Life beyond PETs

The main reason that the use of PETs for the provision of privacy has been limited in the digital world is that the market for privacy is still relatively small. Besides, most consumers find that the available systems are too complex or burdensome to apply properly. Others lack information and awareness relating to the possibility of privacy violations. Furthermore, there is a "significant disconnect between action and negative effect, but connection between action and positive effect"[42]. When access to information is required, gratification is instantaneous (e.g. if you accept cookies). On the other hand, the tracking and compiling of information about a user can take several months or more, and so it does not affect a user consciously in the short term. In this respect, tools for enhancing privacy should be made part and parcel of the digital world, and not just a rag-tag assortment of software left to the user to use or not use. Indeed, a consistent and coherent digital identity management framework should contain the necessary mechanisms for protecting user privacy. One of the main developments in this area is the emergence of federated identity, discussed in section 4.3 below.

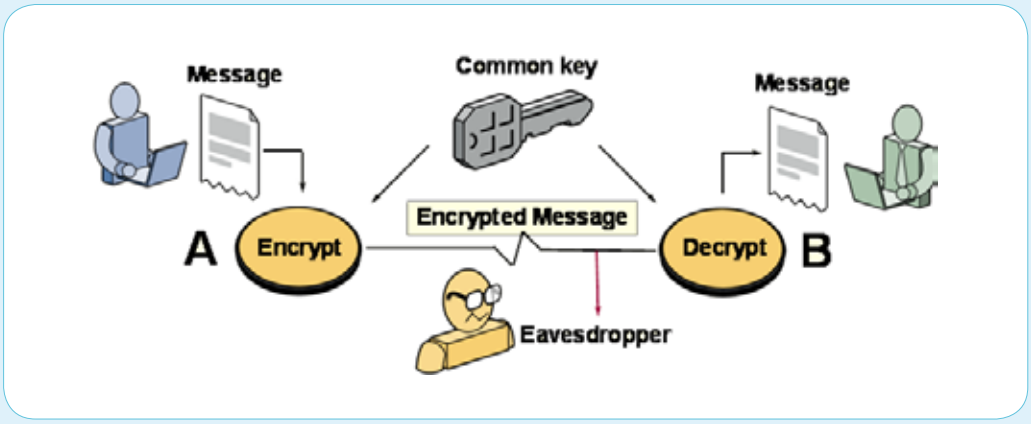
4.3 Managing identity in a digital world

From the foregoing considerations, it emerges that the notion of identity is complex. It incorporates not only philosophical considerations but also legal and practical ones. Identity is what makes individuals the same today as they were yesterday (sameness), but it is also what makes them different from one another (uniqueness). Underlying identity is the distinction between the private and the public spheres of human existence, and as such identity and privacy are forcibly linked[43]. In practical terms, identity can include parameters such as a social security number, a date of birth, a job title, a bank account or a credit card number. And some of these parameters are used both online and offline.

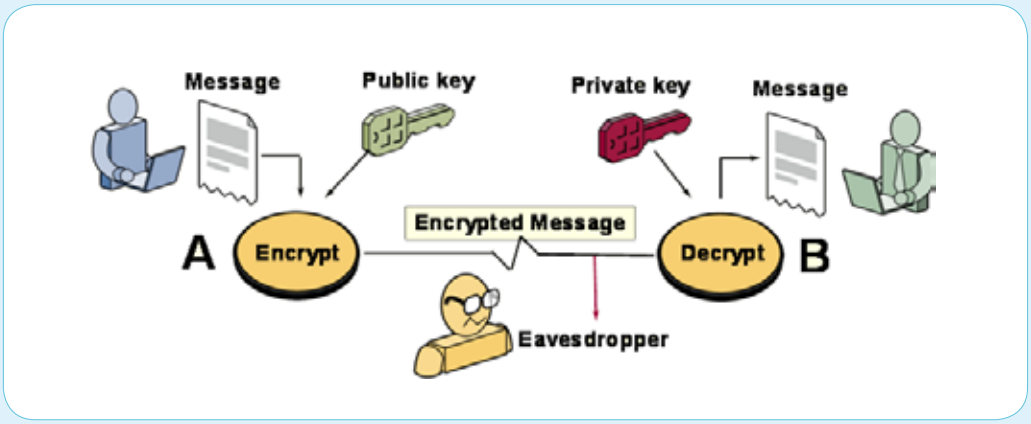
As the boundary between the private and the public in the digital age becomes increasingly blurred, the creation and maintenance of secure identities online has emerged as an important priority for businesses

Figure 4.2: Have you got the keys or have I?
Symmetric versus asymmetric key cryptography

Private Key Cryptography (Symmetric)



Public Key Cryptography (Asymmetric)



Source: Verisign

and consumers alike. Governments, too, are looking for ways to effectively streamline their procedures, offer e-government services, and reduce criminal activity. The confirmation (or in technical terms, authentication) of identity in the online world is much more difficult than it is in the everyday "real world", and comes with its own set of challenges. As such, there is a progressively important role to be played by digital systems that can simply and accurately identify, to the extent required, persons, machines or even things[44], while minimizing the risk of access by unauthorized third parties. This goes beyond assuring the security of networks or of transactions (e.g. through PKI or SSL), to developing a coherent system for managing identity online.

The next sections examine further the rationale behind digital identity management, and outline its key principles. After considering the relevant vulnerabilities of the digital age, they explore design principles for maximizing trust and predictability online.

4.2.1 The changing nature of identity

In the Merriam-Webster dictionary, identity is defined as follows:

identity:

1. Sameness:
   - sameness of essential or generic character in different instances
   - sameness in all that constitutes the objective reality of a thing
   - the condition of being the same with something described or asserted
2. Individuality:
   - the distinguishing character or personality of an individual
   - the relation established by psychological identification

The reference to sameness in this definition points to the continuity and permanence of the identity of the human self. The notions of uniqueness and individuality contained therein are what differentiates one human being from another, and are the basis of self-awareness, social interaction and decision-making.

Though these fundamental concepts have remained the same over time, changes in economic and social structures have affected the determination and perception of identity. In the past (pre-modern times), human identity was defined by geography, community, and family relationships. If an individual was born into a well-known and rich family in London, that is typically the environment in which he or she would remain. If an individual began life in a poor remote community in India, they would typically not be able to change their life pattern or economic status over time. One's geophysical space and one's place in society were inextricably linked, the possibility of freedom of movement being severely limited. With modern times there arrived a greater choice for participation in different social circles, and the possibility of social and economic mobility.

In today's (post-modern) world, the individual has even more choices, covering even more aspects of life, and is at the centre of an increasing number of social networks (that are often quite distinct)[45]. Sociologists have been arguing for some time now that human relationships are increasingly short-term and fleeting. The widespread and constant availability of information and communications in the surrounding environment have made constant change and unpredictability the rule. Change in the perception of identity is a direct consequence of this phenomenon.

Today, most people carry some form of identification on them at all times, but this practice is relatively recent in human history. In the past, the declaration of an individual's name, sometimes accompanied by the name of their city or village, was sufficient to prove their identity. This is no longer the case. Further, the notion of identity today can refer not only to humans, but also to animals, machines, and other objects or resources. A machine may have an identity which would allow it to access certain information at certain times, or be employed by some individuals, to the exclusion of specified others. This possibility complicates an already complex issue.

4.3.2 Vulnerabilities and rationale

The consumer perspective

The internet was developed without a coherent mechanism for determining to whom and to what a user might be connecting. Like the network itself, which was founded on ad-hoc principles of information dissemination, online identities, too, exist in the form of a "patchwork of one-offs"[46]. Although most sites require some form of identification or registration, many of these are fairly basic (e.g. requiring a simple password and username) and do not communicate any form of centralized registration system on other sites. Even e-commerce or payment sites, which typically have at least one identity mechanism in common

Box 4.6: Stolen selves

The growing problem of identity theft

A personal identity is an asset that everybody owns but most people neglect. However, if one loses it, one does risk losing everything.

People whose identities have been stolen can spend months or even years – and large sums of money – cleaning up the mess that thieves have made of a good name and credit record. In the meantime, victims of identity theft may lose job opportunities, be refused loans for education, housing, or cars, and even get arrested for crimes they did not commit. Humiliation, anger, and frustration are among the feelings victims experience as they navigate the process of rescuing their identity.

Identity theft, while not new, has quickly gained the attention of consumers, businesses, and legislators around the world. As internet use continues to grow rapidly, thieves have found it more direct channel for identity theft, posing a considerable threat to consumers and to the expansion of electronic commerce. Once thieves gain access to sensitive identity information, they can change profile information and preferences, and make or change transactions (e.g. move sums of money). New reports of identity theft or misuse seem to appear every week, and from every corner of the globe.

A September 2003 survey by the United States' Federal Trade Commission (FTC) estimated that 10 million US citizens have been victims of one kind of identity fraud or another. The survey found that:

- Only 15% of victims find out about the theft due to a proactive action taken by a business;
- The average time spent by victims resolving the problem is about 600 hours;
- 73% of respondents indicated the crime involved the thief acquiring a credit card;
- The emotional impact is similar to that of victims of violent crime.

The FTC has carried out a series of campaigns to educate the public on the importance of self-identity and how to prevent it from being abused. FTC is also urging citizens to report to the authorities immediately after discovering that their identities have been stolen.

In the United Kingdom, personal data is protected by the country's Data Protection Act which covers all personal data that an organisation may hold, including names, birthday and anniversary dates, addresses and telephone numbers. The Home Office has now set up a website explaining the danger of identity fraud and provides details on how UK residents can prevent or report cases of identity fraud.

Image source: University of Exeter

Sources: U.S. Federal Trade Commission website, "Fighting Back Against Identity Theft" at **www.ftc.gov**; United Kingdom Home Office Identity Fraud Steering Committee at **www.identitytheft.org.uk**

(i.e. credit card payments systems or systems like Paypal), offer no less of a patchwork. Users may still use different passwords for different sites. For instance, a user may enter the same credit card number to pay for travel on easyjet.com as to buy a book on Amazon.com, but with different usernames and passwords in each case. Users are often obliged to form or select usernames and passwords that are mnemonically difficult to remember; their username of choice being already in use. This has led to an every-increasing burden of usernames and passwords for the user to carry, each associated with different websites. This is in addition to banking (PIN) numbers and such that are already used in the offline world. Many users feel obliged to resort to unsafe practices, like using the same password for different services. This may cause security breaches, and leave them vulnerable to the

machinations of identity thieves ever increasing in number and inventiveness (box 4.6). Thus, the lack of coordination in identification systems is a source of growing inconvenience to users and needs to be addressed rapidly.

Today, consumer privacy has become an equally important concern. A dramatic recent example has been the well-publicized boycott of Benetton following the announcement of their plans to integrate radio-frequency identification tags (RFID) in some products. Privacy violations are taking place without the knowledge of consumers, and in some cases, consumers are left with little choice if they are to adopt new services. From an ethical perspective, an environment in which citizens are obliged to disclose more and more personal data, simply in exchange for convenience, or for lower prices, must be discouraged and eventually eliminated. For example, on the internet today, most are obliged (usually by default) to accept cookies that track online behaviour—a phenomenon that just a few years ago was considered to be a serious invasion of privacy. Many sites are now effectively unusable to those who do not wish to be tracked. Although privacy is a concept that is under constant evaluation and definition, it must always remain an important consideration. The issue of privacy is magnified today because citizens' actions and interactions are perceived and recorded in greater and growing detail.

Identity management systems can empower users to regulate their activities online, and serve to instil trust in information networks that are seen to be increasingly vulnerable to misuse and attack. A clear and transparent approach to identity management will mean that users can interact with each other in a more meaningful and confident manner, i.e. to benefit from online opportunities without the fear of being monitored or intercepted. User-centric identity management will enable users to create their own impressions and representations in the digital world, rather than have these created for them through mechanisms that lie outside their control. Often, representations of identity are formed through historical data interpreted out of context which may thus result in a negative repercussion on the reputation of an identity. Without the ability to control identity (and personal information) in multiple and often disparate online contexts, the only option left for some users may indeed be absolute anonymity.[47] This may not necessarily be desirable for certain services and may affect the possibility of participating fully in a digital life.

The business perspective

For businesses, identity management can confer a number of benefits. It can, for instance, reduce the complexity of multiple users managing, entering and using their premises. For instance, physical or electronic e-mail aliases can continue to exist even after an employee's departure, due to time constraints and systems not initially designed to deal with identity management (e.g. the inability to delete identity parameters like e-mail addresses securely without compromising overall system integrity). With the availability of digital identity systems, businesses might better manage the growing array of web-based applications through a single sign-on mechanism. This would also facilitate the management of changing roles (and permissions) of users in the organization, be they employees, machines or resources (e.g. computer systems, parking garages or board rooms). More importantly, a good identity management system can protect an enterprise from unauthorized access to corporate information. Finally, for ICT service providers, digital identity management can help promote new value-added services (such as location-based services) that may otherwise be a hard-sell for consumers concerned about invasions of privacy.

Important limitations

As mentioned earlier, today's systems are insufficiently equipped to deal with the rising number of interactions occurring in the digital space. Although it is currently possible to identify machines (e.g. servers) in most cases, it is not as easy to accurately identify human parties in a virtual transaction. The inconvenience of having to register multiple accounts and passwords has already been mentioned. There are also many different types of login or registration systems in existence, and their functionality varies greatly: some allow the deletion of access permissions entirely, and others do not allow passwords to be easily reset. Moreover, current

login systems are fairly primitive and typically rely on browser technologies. Identities cannot be effectively transferred from one account or context to another, even if a user would wish to create such a "meta-identity". And in spite of the continuing availability of information, identities may expire after a length of time. This may not be considered serious in some instances (perusal of online newspapers), but in other cases, the consequences may be grave (such as the deletion of user accounts after a fixed period of time, e.g. Hotmail).

Yet another source of concern is that the current network infrastructure suffers from security problems, due to persistent difficulties, with viruses, worms, and spyware. Serious information leaks have been known to occur, compromising entire data systems (box 4.7). Security and trust in critical network infrastructure is an indispensable requirement, and must be addressed in parallel with data protection initiatives. Thus far, an approach favoured by governments and industry has been to secure the affected network only after a security violation or leak has occurred. This amounts to locking the stable doors after the horses have fled. A more astute policy would require security to be built into technical design, thus preferring prevention over cure.

Human identity receives protection from many sources – constitutional and other legislation, international conventions and protocols and so on. Freedom of speech and self-expression, freedom of movement, freedom of association are all examples of efforts to protect identity. Lawrence Lessig cites four different means by which behaviour can be controlled: the law, the market, the architecture and social norms[48]. In essence, his contention is that in the online world, these forces are not operating effectively. Due to the complex architecture of the internet, social norms are often ignored, while the market capitalizes on the many facilities that the internet affords. At the same time, the legal community is not fully recognizing that the digital space may require an alternative legal approach. It is true that the legal system may well deal with issues relating to acceptable usage and architecture (as in the case of Napster), but its approach thus

Box 4.7: Digital information leaks
The Lexis-Nexis fiasco

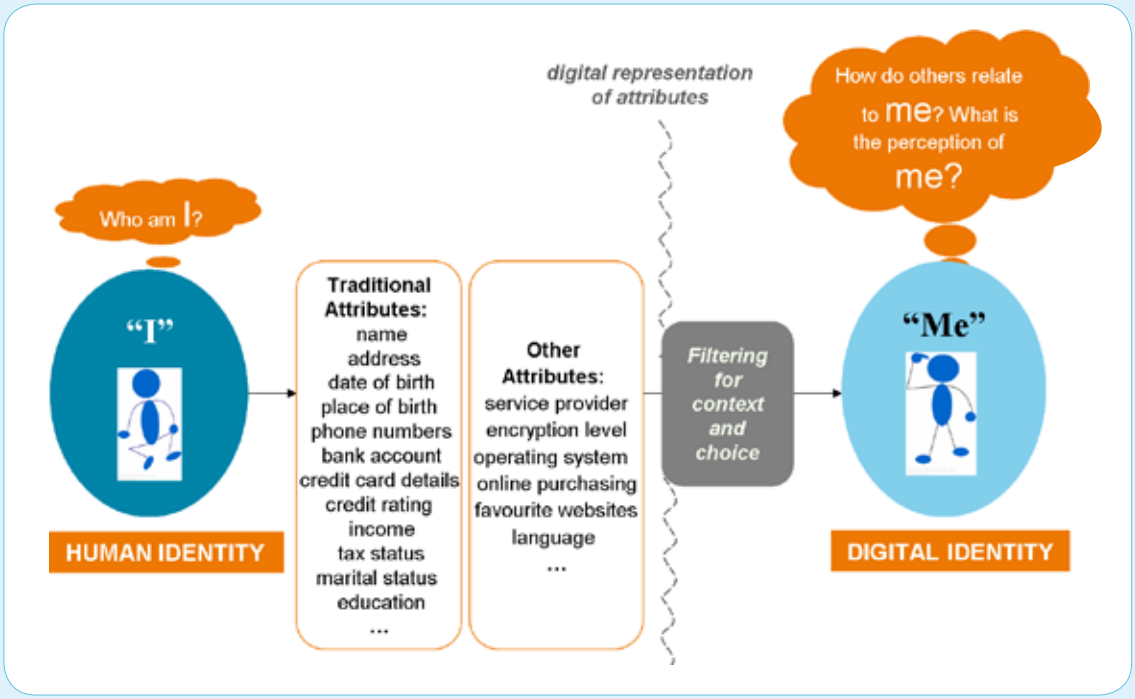
In 2005, LexisNexis, a provider of information and services solutions, revealed that an intrusion into their databases had compromised the personal information of about 310'000 users. This was not the first digital information leak to be reported in the United States – in 2003 a security flaw at the florist's website 'ftd.com' left individual's personal information open for harvesting – it exposed the names, addresses, phone numbers and billing records of customers. Elsewhere, the personal and confidential information on 185'000 current and former patients of the San Jose Medical Group was lost, and the details of more than 1.4 million credit cards were obtained from transactions made by customers of DSW Shoe Warehouse.

It seems that information leaks have become a real risk in today's digital age. More and more organisations are converting large amounts of information to digital formats. This may increase an organisation's productivity, but it also increases the risk of exposure to leaks and unauthorized access. In tandem, the growth of technological channels over which information can move – for example instant messaging systems and e-mail – means that the ability of an organisation to control its data is reduced. The vast scale of the LexisNexis leak forced the United States Congress to respond aggressively: Senator Dianne Feinstein introduced a bill that would require that consumers to be notified of certain types of security breaches. Given the increasing tendency towards the storage, use and exchange of information in digital format, coupled with the ubiquity of distribution media, it is likely that regulators and policy-makers will seek to enhance accountability and transparency among corporations that collect personal information on a more regular basis.

Image Source: flickr.com (jenica26)

Source: news.com, "LexisNexis flap draws outcry from Congress", April 2005 and "FTD.com hole leaks personal information", Feb 2003; Business Management, "Plugging information leaks", 2006

Figure 4.3: From "I" to "Me"
From human identity to digital identity



Source: ITU

far has focused almost entirely on protecting corporate interests and copyright. In other words, the legal system has not focused sufficiently on individual interests and the underlying architecture corresponding to them. Lessig also points to the key role of technology designers in giving users more control over their existence in the digital world and in promoting self-regulation. Legal structures and market forces alone are not equipped to address the issue of digital management, and certainly not at the requisite pace.

For this reason, there have been calls from many quarters for technology designers to begin focusing on the creation of a single and predictable digital identity management system, with due support from the law and the market.

4.3.3 Designing for trust and predictability

This section outlines the main definitions and principles underlying digital identity management. It focuses on the need for predictable online environments, and summarizes some of the current thinking in this area.

Definitions and key concepts

Digital identity refers to the online representation of identity. More specifically, it refers to the set of claims (in their digital form) made about a user or another digital subject.

In this context, a "digital subject" can refer to a person, a group, a software programme or another entity. Typically, a subject might make a series of claims when trying to access a particular resource (e.g. information, goods, or monetary value). The Oxford English Dictionary defines "claim" as "a statement that something is the case". In the context of identity management, one can take this definition further as follows: a claim is "an assertion of the truth of something, typically one which is disputed or in doubt"[49]. The extension of the original definition to that which is "in doubt" refers to the characteristics of a distributed world like the internet. As networks

become increasingly open to participation by many different actors or subjects, these claims need be evaluated and verified by those who need to rely on them.

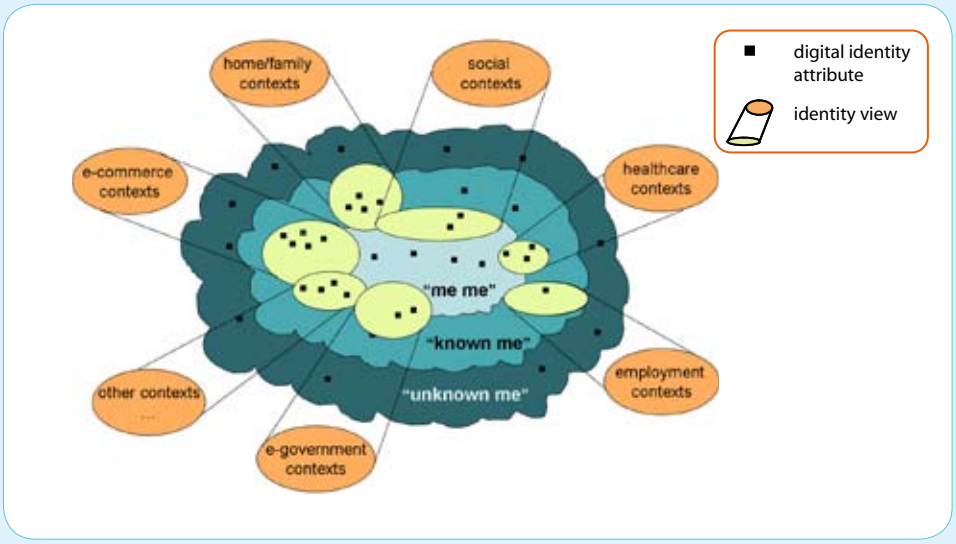
Digital claims can be made up of sets of data, also known as attributes or identifiers. Attributes can include a name, a date of birth, a bank balance, but also past purchasing behaviour, medical or employment records. Attributes can also include preferences, such as currency used, preferred language or seating for travel. Some information is static (such as a date of birth) and other information is dynamic (such as employer's name or dietary preferences). Attributes also ensure that the distinction between the public and private spheres of individual lives remains intact. As figure 4.3 illustrates, the core of human identity is accessible only by the individual self, wherein lies the values of freedom, self-awareness and self-reflection (i.e. the "i" of identity[50]). The series of attributes that are accessible by external parties (i.e. the "me" of identity) through information and communication networks must not compromise these essential values. The "me" that is known to the outside world is a representation of characteristics that are necessary to conduct daily life within a societal and/or corporate structure. There can be many different representations of the "me" depending on the nature of the interaction. In the information age, these representations are collectively known as "digital identity".

In order to establish trust between parties in the digital world, a subset of digital identity attributes needs to be communicated. Digital identities exist in specific contexts and the contextual relationship between them is crucial to managing transactions and interactions. The context will determine which subset of attributes is required, or which "partial identity" will establish enough trust for the transaction to go forward. Alternatively, individuals may also wish to decide which subset to use in a particular context. As such, the "me" that is perceived by the outside world is either known or unknown depending on context (figure 4.4).

Let us consider the case of Alice who is using partial identities to manage her interactions with many different parties, including her boyfriend Bob, her health care provider, her travel agency and various government services (figure 4.5). With her health care provider, she may share her name, address, blood group and health status. With her employer, she might share her insurance information, her name and address, and her employment records, but not her health status. As it is still early days with

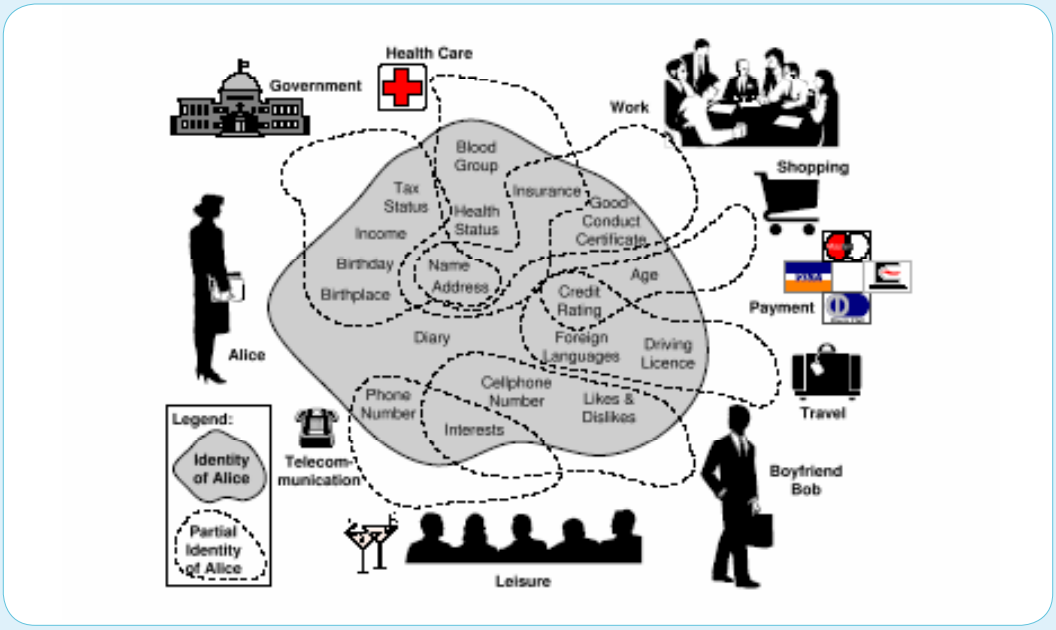
Figure 4.4: Contextual identities

The known me and the unknown me in a digital context



Source: ITU, adapted from J. de Clercq & J. Rouault, "An introduction to identity management", Hewlett Packard, Dev Resources, June 2004

Figure 4.5. Identity as a subset of attributes
The many partial identities of Alice



Source: S. Clauβ & M. Köhntopp, "Identity Management and its support for multilateral security", Computer Networks 37 (2001), 205-219

her boyfriend Bob, she may share her mobile phone number, but not her fixed line number, which she might share with other friends.

In order to use these partial identities to conduct the various aspects of her daily life, Alice needs to justify her access to various resources. As such, she must present "credentials" to prove that she has the necessary identity attributes for a specific task in a specific context. These credentials establish trust with the different parties. Once Alice communicates her credentials to a "security authority" (which might also be a third-party "certification authority" or CA), the authority "authenticates" the credentials, through mechanisms such as a username or a password. Authentication methods can be simple or complex, depending on the level of risk associated with the particular resource (e.g. they may or may not use mechanisms such as PKI). For instance, a simple password might be sufficient to access a news article online, but more stringent authentication mechanisms may be called for in the case of financial transfers, e.g. name, address, credit card number, credit rating, security codes etc. Once credentials are authenticated, a security authority would forward them to a separate policy decision point (PDP), which would use a pre-determined security policy to assess the entitlements and permissions associated with the subject's identity and the particular resource in question.

Most of the notions relating to identity already exist in the physical world. A driver's license, for example, contains the necessary credentials to perform specific tasks, whether it is for driving a car or towing a trailer. Such a license can also provide the required attributes for buying alcohol. The process of buying alcohol is a good example of how identity is managed in the physical world—in this case by "Alex":[51]

1. Let us say that Alex wishes to buy vodka coolers for a college party, i.e. to perform an action on a "resource", and to do so, presents his driver's license (credential) to the clerk at a liquor store (security authority);

2. The clerk carefully examines Alex's driver's license to see if it looks real (validation);

3. The clerk then looks at the picture (biometric device) on the license and compares it to Alex's physical appearance. She asks Alex to take

his glasses and hat off to make him look as he appears in the picture;

4 The clerk satisfies herself that the picture in Alex's license resembles him (authentication);

5 If the clerk deems the license to be authentic, she verifies (verification) Alex's age (attribute);

6 The clerk then verifies whether Alex's age meets the minimum age requirements to purchase alcohol according to the national legislation (security policy);

7 The clerk finally allows a happy Alex to purchase the vodka coolers with some loose change (authorisation).

The privacy concerns in this scenario refer to the protection of attributes and preferences associated with Alex's identity. He is only required to produce proof of age to purchase the alcohol. He is not required to disclose data such as the name of his college or the address of his employer. Moreover, as Alex paid in cash, neither his name, age nor license number were recorded. As such, Alex's early predilection for vodka will not be automatically communicated to his biology professor or to his parents. The privacy of his actions in this case is assured because the data in question is: a) minimal: only a driver's license was presented, b) temporary: the license was only examined briefly by the store clerk, and c) un-linkable: it cannot be linked with Alex's other attributes (parents' name and address or professor's contact details). These same considerations should apply to the online world, and indeed many proposed digital identity management schemes have focused on principles such as "un-linkability" and data minimisation.

Design principles: from anonymity to pseudonymity

The process of digital identity management consists of three main phases:[52].

- **Verification** refers to the mechanisms which establish or create an identity, and which can later be used to make claims. These mechanisms can be very simple, such as choosing a username which is not yet in use (e.g. a username for a web-based e-mail account) or stringent, such as a photo or a personal visit.
- **Authentication** is the process of establishing trust in a claimed identity. As discussed above, authentication serves to prove that a transacting party is authentic (that they are who they say they are). Authentication for an individual user can be either: something they own (e.g. a token or RFID tag), something they know (e.g. a password), or something they possess inalienably (e.g. iris recognition or fingerprints). Authentication can be very minimal in some cases (e.g. requiring only the authentication of a user's age category), and in others it may be more stringent.
- Finally, **revocation** is the process of rescinding an identity an individual has been granted. This process should ensure that the revocation is properly recorded and that the identity in question is no longer in use (e.g. when an employee leaves a company, for instance, or in the case of death). This revocation process should also ensure that the identity can not be stolen.

Digital identity management includes a number of different technologies that administer verification, authentication and revocation (such as electronic signatures, password management and synchronisation, PKI, directory services, to name a few). It is important to note, however, that this is a wide subject, encompassing not only technological elements, but also broad design principles and context-driven security policy. In particular, a satisfactory identity management system must accommodate the full range of options stretching from anonymity to full "identifiability". In some cases, disclosure of identity may not be required for parties to transact, e.g. in the case of browsing web pages or buying goods through an electronic money scheme. In other cases, a proof of identity issued by a trusted third party may be needed, e.g. in the case of purchase of high-value goods like property. In yet other situations, varying levels of accountability and authentication may be required, depending on the sensitivity of the transaction. One of the measures that has been identified as essential in this regard is the use of pseudonyms (also known as "nyms"). These make possible the use of partial identities, and can thus cover the entire range from anonymity to identifiability. Pseudonyms allow users to take on different

identities depending on the specific context and parties involved. The use of a pseudonym is effective only when it cannot be linked with its holder (i.e. holder anonymity) or with other pseudonyms a holder may have. Nonetheless, when necessary, the holder of the pseudonym can be revealed and as such, he/she is liable and accountable for actions taken under that pseudonym.

Discussions regarding the principles upon which digital identity management systems should be predicated are ongoing both nationally and internationally. Not only are security experts evaluating the need for a coherent identity scheme that would stimulate online interactions, while protecting data and alleviating privacy concerns, but so, too are, lawyers, corporate strategists, and economists. Governments are taking a greater interest in this area, particularly in an effort to thwart illicit interactions and identity theft. The European Commission's approach to this question was first expounded in its PRIME (Privacy and Identity Management for Europe) project. The objective of the project is to give "individuals sovereignty over their personal data", and to "enable individuals to negotiate with service providers the disclosure of personal data and conditions defined by their preferences and privacy policy"[53]. This project calls into play some fundamental principles: user support, openness, consent, accuracy and completeness, data minimisation, notification, security, and access to law enforcement (box 4.8).

Forward with federation

As previously mentioned, identity management systems online have thus far been predominantly deployed by a single entity for a fixed user community, or represent walled garden systems, in which a number of service providers are grouped together for the purposes of secure exchanges and transactions (e.g. business-to-business commerce). Spurred by the resultant fragmentation of online identity, one of the newest trends in digital identity management is the federated system. A federated identity system is one in which no single entity operates the system, and one which creates an environment in which users can log on through a central identity provider and use the state of being authenticated to access resources across numerous domains. The main aim of federated identity systems is to facilitate the management of attributes for different applications and different contexts, i.e. partial identities (discussed above). An open federated model means that network identity and user information is available in various locations, and as such there is no single point of failure and users can be identified by different and disparate systems. For a federated identity system to work, there are three main requirements:

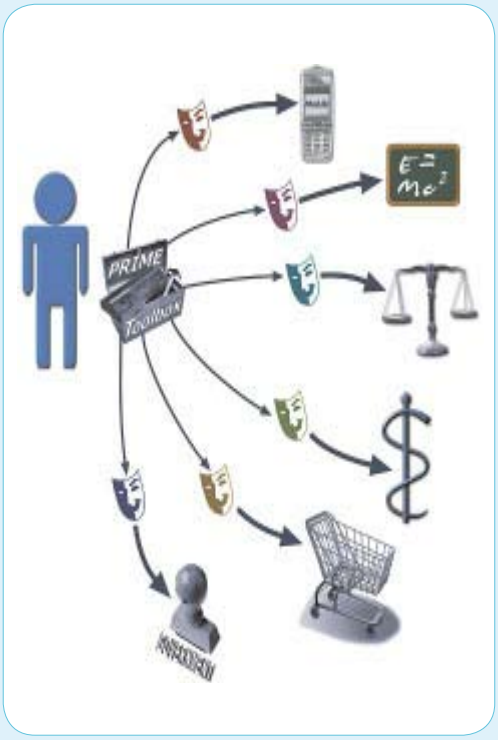
- standard formats for representing identity information;
- standard, secure and privacy-enabled protocols for the exchange of information between application components;
- the possibility of setting up trust relationships between entities that might share identity information[54].

The fact that a person can use a bank card at many different ATMs (automatic teller machines) around the world is due to the federated nature of that identity system. It allows travellers to retrieve cash at many cash points by simply entering a plastic card and a numeric password (personal identification number or PIN). This system works because banks have agreed to use common standards for authentication, and have secure and trusted systems in place to transfer information. Another good example of a federated identity system is the use of a national passport when travelling. In the online world, federated systems similarly aim to share the identities of users across multiple (often disparate) trusted domains[55]. In enabling effective access control and the secure transmission of personal data across domains, the occurrence and impact of identity fraud are minimized. For users, the key advantage is that the consolidation of identities improves the online experience, making it both simpler and more secure.

There are two main players in a federated identity scheme: a service provider and an identity provider (Box 4.9). These may also be part of the same organization. In a typical system, a user would have to register with an identity provider, usually face-to-face[56]. Individuals can then add additional attributes to their identities, as well as introduce the corresponding policies for the release of these attributes. When a user interacts with a service

Box 4.8: Designing for identity in Europe

European Commission PRIME Project's digital identity management system design principles



Although the European Union and its Member States have enacted legal frameworks to facilitate the exchange of personal data, a fast-changing digital world is widening the gap between rules and regulations on the one hand, and practical realities of online interactions, on the other. The PRIME (Privacy and Identity Management for Europe) project, sponsored by the European Commission and the Swiss Government, aims to restore the dignity of an individual's private sphere in an increasingly online world. As such, it looks to technologies to provide a comprehensive approach to managing privacy and identity.

Its main principles are elaborated as follows:

- Design must start from maximum privacy
- Explicit privacy governs system usage
- Privacy rules must be enforced, not just stated
- Privacy enforcement must be trustworthy
- Users need easy and intuitive abstractions of privacy
- Privacy needs an integrated approach
- Privacy must be integrated with applications.

In addition, the PRIME White paper cites a number of important design principles:

- User support during the complete lifetime of the personal data – an integrated view must be given to help users make their choices (thus carefully designed and validated Human-Computer Interface is required)
- Openness with respect to privacy policies and practices, by means of readily available information to individuals by service provider in consider and understandable way
- Consent, based on conscious decision of individual (except where inappropriate)
- Accuracy, completeness and validity of the personal data users and maintained by service providers for explicitly stated legitimate purposes
- Data minimization–Service providers should aim to use the minimal set of personal data required to perform a particular service. Anonymous access should be offered wherever possible with pseudonym access, involving identifiers distinct from and not related to the user's real name
- Notification of the existence, use and disclosure of a user's personal data should be given to all. They should then have the right and ability to assert their privacy rights, such as access to own data and the right of correction of their personal data if necessary
- Security measures appropriate to the sensitivity of the personal information under protection
- Access to law enforcement agencies should be guaranteed on the basis of proper legal safeguards.

Image source: PRIME

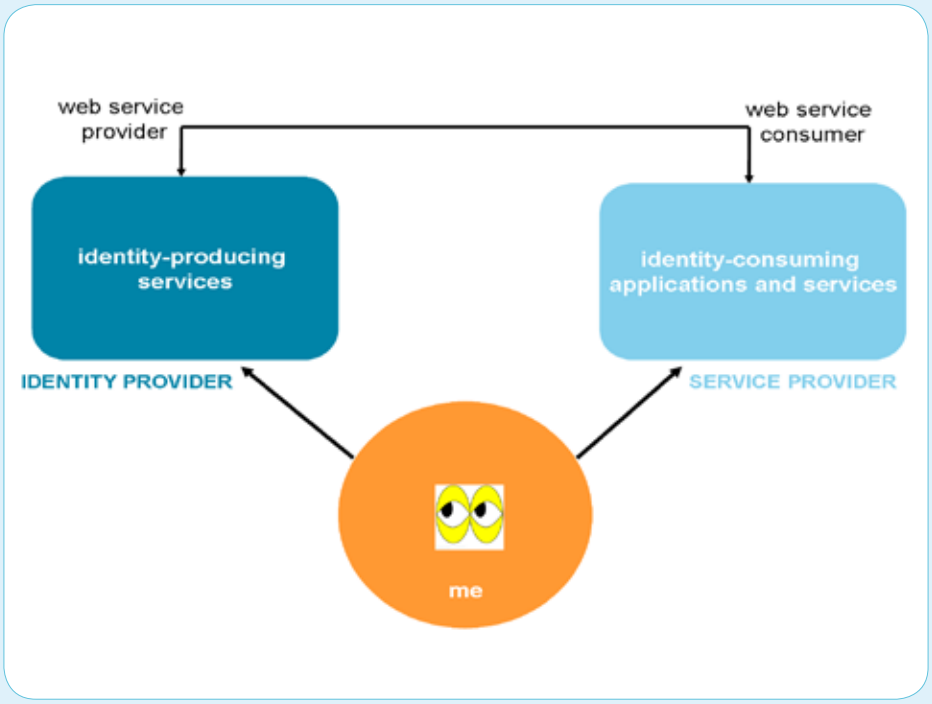
Source: PRIME, European Commission

provider, the identity provider is responsible for sending that service provider the relevant user attributes in accordance with the release policies stored in its database. As such, a federated system has four main elements: a single sign-on, the mapping of identifiers, the sharing of attribute profiles, and user management (box 4.10).

Federated systems go a step beyond simple single sign-on (SSO) systems. Where SSO relied on setting up a central server to be accessed by each application, the notion of federation implies that local applications maintain their own data repositories that can respond to queries from both local and remote applications. If local applications encounter non-local users, they can query other federated repositories to authenticate and authorize them, according to their respective privacy and security policies.

Nonetheless, federated systems currently suffer from a number of shortcomings. First of all, registering identity through a face-to-face process may not always be possible, and in some cases can represent an important bottleneck. Second, the relative weakness and strength of identifiers are not taken into account. Third, although there have been a number of efforts to establish federated identity standards, the landscape for federation remains fragmented. The main players are Liberty Alliance[57] and the Organization for the Advancement of Structured Information Standards (OASIS), with the most established standard to date being OASIS's SAML or Security Assertion Markup Language. SAML is based on XML (Extensible Markup Language). Version 1.0 was standardized in November 2002 and it is expected that Version 2.0 (which was approved in March 2005) will go some way in bringing together the various federated identity management standards in use. However, interoperability has not yet been fully addressed between these standards, as well as between different versions of the same standard. Clearly, to ensure a truly consistent and global identity framework across domains and platforms, much more is needed.

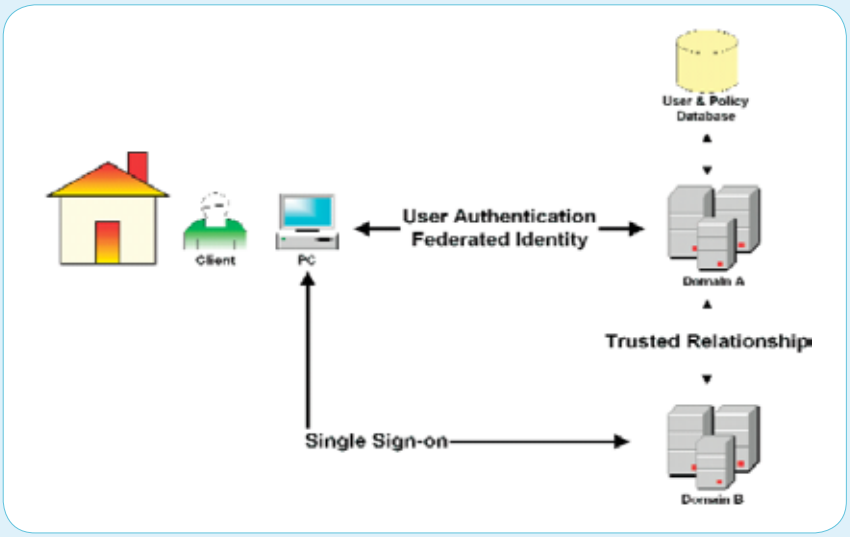
Figure 4.6: Identity production and consumption in a federated system
Main players in a federated identity scheme



Source: Adapted from Sun Microsystems and Liberty Alliance

Box 4.9: What's in a federation?

Main concepts underlying federated identity



There are four main concepts underlying federated identity:

1. Single sign-on means that authentication information of a user is communicated across multiple domains. After a user logs in to any one particular domain, that information can be passed on to other trusted domains, without the need for re-authentication.
2. Identifier mapping provides the linkage of different user identifiers for the same user in multiple domains. For example, a user can be "alicedoe" in one domain but "adoe" in another. Both names would then be linked by identifier mapping in a federated system. The user can be accepted in different applications even though the identifiers may be different. This enables the use of pseudonyms and partial identities.
3. Attribute profile sharing means that information about users can be accessed by different domains. Basic information can be retrieved by trusted applications, according to the agreed privacy and security policies.
4. User management refers to the creation, modification, provision and deletion of federated identity.

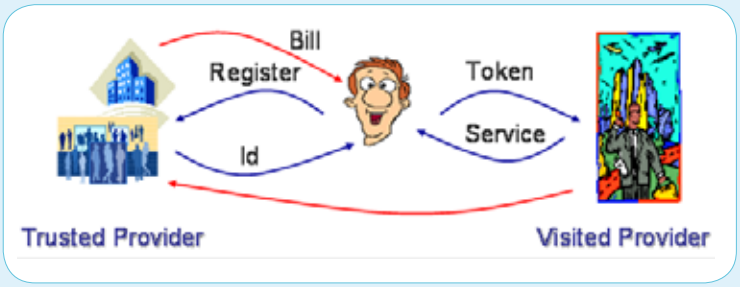
Source: R. Tam, "Federated Identity: A Fairytale or Reality", The ISSA Journal, July 2005

An important step in this direction is the European research project Daidalos ("Designing advanced network Interfaces for the delivery and administration of location independent, optimised personal services"), which has as its main objective the promotion of an end-to-end service in a heterogeneous network environment. The Daidalos project explores how identity can be used across layers: from the core network to web services at the edges–in mobile, fixed or broadcast environments (box 4.11). As such, it builds on existing standards, such as SAML and Liberty Alliance, but aims to create a single solution which can be used regardless of platform. A European project launched in 2003 by Deutsche Telekom and partners like NEC and Lucent, Daidalos has a 50 million Euro budget, and involves 37 partners. More recently, it submitted a proposal to the International Telecommunication Union (ITU) that would incorporate the results of the project in global standardization activities[58]. Discussions are currently ongoing within the ITU-T's standard-setting study groups as to how best to move forward on this important issue.

Box 4.10: Extending identity in a wireless post-3G environment

European Daidalos project gives users "handles" for control

Daidalos is a European Union IST 6th Framework Research Project in the Beyond 3G Area running from November 2003 to December 2008. It has 37 Partners and is led by Deutsche Telekom AG. Its goal is to integrate mobile and broadcast communications to deliver ubiquitous end-to-end services across heterogeneous technologies.



In particular, the project is intended to:

- Give customers a diverse range of personalized services – seamlessly and pervasively supported by the underlying technology ;
- Establish mobility via an open, scalable and seamless integration of complementary heterogeneous network technologies including broadcast, ad-hoc, moving and sensor networks ;
- Empower network and service operators to develop new business activities and provide profitable services in an integrated mobile world.

One of the project's five key Concepts binding various project elements together is the Virtual Identity (VID). Specific aspects of the Daidalos VID concept include:

- Providing a global identity for network, transport, accessing services, content and beyond;
- Represent and link a set of users' contractual rights and duties in terms of authentication, authorization, QoS, etc;
- Allowing users to define context and preferences, thereby simplifying management of these attributes;
- Decoupling the roles of providers of identity, billing and services.

The Daidalos VID concept allows users to build virtual identities that they can associate with specific profiles and activities. The communications system will not be able to identify the person associated with each identity unless lawful disclosure is required, since each identity will be supported by independent communication features, from the lower layers to the higher communication identifiers. Although linkage of activities is still possible across the multiple activities made under the scope of a virtual identity, the same user can carry out completely unlinkable sets of communication activities by using separate virtual identities.

Virtual Identities are built around identifiers that users obtain from trusted providers, which can be used across different levels of access and across providers ranging from network access providers over service providers to content providers. Users may conceal their identities from visited providers and conceal their service usage from their trusted provider.

The Daidalos project aims to complete its Framework and Architecture for Virtual Identities in March 2007. Based on this, prototypes will be developed in 2007 and integrated in 2008.

Source: European Commission Project Daidalos, A. Sarma (NEC)

4.3.4 The road ahead

Though the importance of digital identity mechanisms is finally being recognized, much work remains to be done. Information regarding individual identities is becoming an increasingly valuable commodity, and as a consequence, its protection and management has become a pressing matter.

In this regard, global standardisation efforts and open source initiatives are crucial. No common set of technical standards has thus far emerged, and consequently a wide range of authentication methods remain in use. Moreover, legal and policy considerations require further harmonization at the global level. There is also a need to develop a business case for digital identity management through concerted public-private sector dialogue. This is not only to stimulate development but also to ensure the widest possible take-up among both consumers and businesses.

A number of questions remain to be addressed, but it seems at this time that the notion of federation offers the best model upon which to base identity frameworks in the digital age. In order to ensure the global impact of such a system, dialogue at the international level seems indispensable.

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chapter five
living the digital world

The telecommunications industry began as a digital-only world. The dots and dashes of the electronic telegraph that "made the world one", in Arthur C. Clarke's oft-cited phrase[1], were not only digital in nature; they were also generated by the "digits" of an army of telegraph operators around the world. Between the invention of the telephone, in 1876, and the development of the first digital switch, exactly 100 years later[2], the telecommunications industry took an analogue detour. But rapid innovation over the last few decades indicates that the digital world is firmly back on track.

5.1 Challenges to the digital world

5.1.1 Getting there

So what are the challenges to the digital world? The first, and most obvious challenge, is to complete the process of network digitisation.

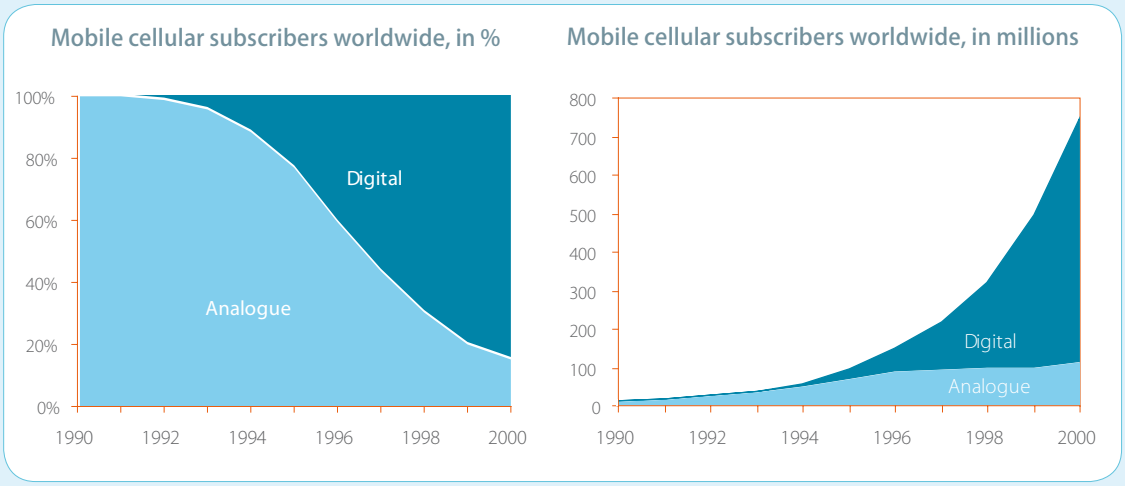
- The process of digitisation in the fixed-line telecommunications industry, which began in 1976, is now more or less complete, at least in the inter-urban and international network, as the last analogue exchanges are phased out.[3]
- In the mobile communications industry, digital systems have slowly taken over, starting with the first GSM network in Finland in 1991 (figure 5.1). Many analogue networks have now been closed down altogether.
- The internet has always been, in essence, a digital network but the use of dial-up modems in the access network is still based on analogue technology. internet subscribers are slowly migrating from narrowband to broadband (figure 5.2) on both fixed and mobile networks.

Even the broadcasting industry is slowly shifting towards digital technologies, in both transmission and reception, as broadcasters prepare for the digital switchover, planned for completion by 2015 in many parts of the world.[4] Although the transition from the analogue to the digital world is far from complete, the direction of change is clear and irreversible.

The transition to entirely digital networks is also associated with the transition to fully IP-based networks, in which Internet Protocol (IP) forms the *lingua franca* for all data exchange. To use a linguistic comparison, digitisation means that the whole world is using the same script (ones and zeros) and migration to IP means that the whole world is speaking the same language. The analogue "Tower of Babel"[5] is slowly being dismantled.

The fact that different types of devices (e.g. computers, mobile handsets, MP3 players etc) are able to "speak" to each other in the same language should make interchange of data much easier. It also makes it possible to use single devices for multiple services. Thus, the desktop computer can become the hub of a home-entertainment centre, the mobile handset can be used as a video, and an audio playback device or television set provides a link to the global internet.

Figure 5.1: Digital replacing analogue
Analogue and digital cellular mobile phones, 1990-2000, worldwide



Source: ITU Information Society Statistics Database

5.1.2 Ease of use

As devices become more complex and offer an ever-widening array of functions, there is a risk of a corresponding loss in terms of "ease of use". Certain important parts of the user base are particularly sensitive to ease of use, especially older users or users with only limited digital literacy. Often, single purpose devices outperform multi-purpose devices in the marketplace and many of the more advanced functions available on a particular device go unused by the majority of users. Thus, a continuing challenge for operators and service providers will be to ensure that, while seeking to exploit the apparently limitless opportunities of the digital world, they do not lose sight of the need to keep things simple.

There is a learning process involved in any new technology. The pioneering users of broadband, for instance, often struggled to get their "plug'n play" systems to work, and even today, setting up a domestic wireless network is far from straightforward. Ease of use may also be compromised, for instance, in trying to make systems more secure and free from spam, spyware and viruses. And if the digital world is to grow beyond the educated digerati, it will be necessary to focus attention on ensuring that a maximum number of people can use technology with a minimum amount of training.

5.1.3 Regulatory consistency

A third challenge to the digital world, at least for policy-makers and regulators, lies in ensuring regulatory consistency. Fast-paced technological change means that regulatory policy must adapt rapidly, but regulators must also remain conscious of the original rationale for regulation. For example:

- Traditional definitions applied to tele-communications, computing and broadcasting were often service-specific (e.g. telephone calls were delivered over the public switched telephone network) or device-specific (e.g. television broadcasts were received on TV sets). These strict definitions no longer hold true. For instance, telephone calls can also be delivered over the internet or over a cable TV network, while television can also be received on a mobile phone or a computer. Thus, there is a need to aim for technological neutrality when making definitions or issuing licences, to the extent possible.
- When applying competition policy to the ICT sector, it is first necessary to define the addressable market, and to understand the level of substitutability between services and network. This is becoming harder to do due to convergence and increased complexity. For instance, a few years ago, it may have

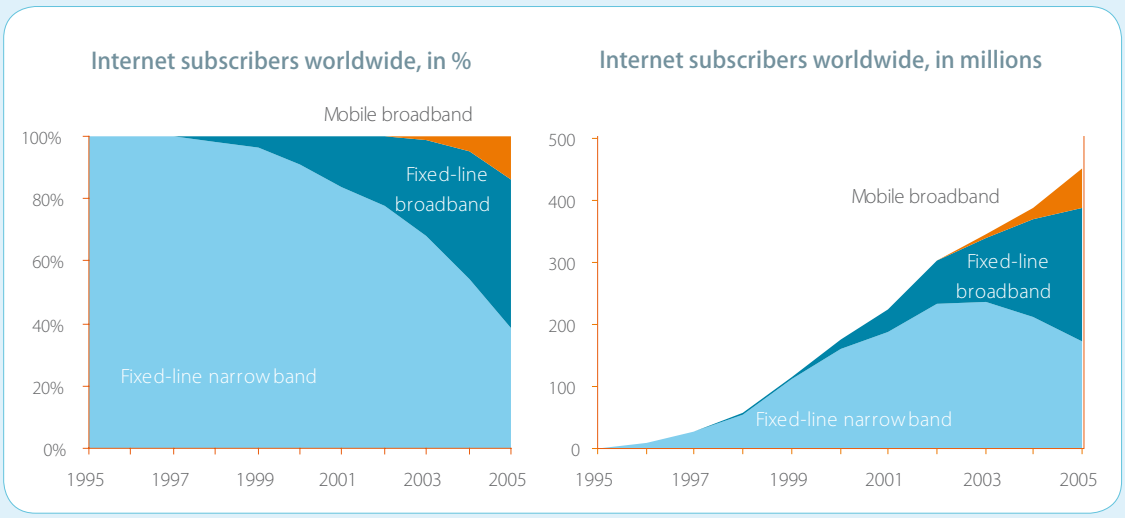
been sufficient to define the cellular mobile market as a single market for the purposes of measuring significant market power (SMP). Now, however, in measuring SMP, it is often important to differentiate, for instance, between call origination and call termination markets, and also to take into account the level of substitutability between cellular mobile and other advanced wireless services, such as WLAN or WiMAX.

- Timing is a critical regulatory issue, particularly in deciding when an infant industry is becoming a mature one, or when a former monopoly market has become a competitive one. These decisions relate to when regulation should be imposed and when forbearance should be exercised.
- Licensing is also a complex issue. The example of the wireless communication market, which has shifted from scarcity-driven policies (e.g. auctioning licences) to abundance-driven policies (e.g. license-exempt spectrum), illustrates this point quite nicely: many countries have been left in a situation in which companies operating in license-exempt spectrum (e.g. WiMAX) are now offering services which are almost fully substitutable for those that are offered by companies operating in parts of the spectrum for which huge prices have been paid at auction, and for which licences stretch many years into the future.

5.1.4 The security and privacy balance

A fourth challenge for living the digital world is how to strike the right balance between security and privacy. In reality, the optimal balance is likely to vary between different countries and between individuals. In an ideal world, the two concepts ought not to be in opposition in that good security reinforces privacy and *vice versa*. But, in practice, what might be beneficial for national or corporate security is not necessarily so for privacy and data protection.

Figure 5.2: Broadband replacing narrowband
Internet subscribers, by type of connection, 1995-2005



Note: The figures for "fixed-line narrowband" also include some business users on leased lines, but this is only a fractional proportion of the total. The vast majority of subscriptions in this category are dial-up internet users. "Narrowband mobile" internet subscribers are not shown because data on subscriber numbers is not widely available (few mobile service provider require users to take out a separate subscription to access the internet).

Source: ITU Information Society Statistics Database

The world changed on 11 September 2001, after the bombing of the World Trade Centre in New York. Governments around the world became much more concerned with their ability to monitor the electronic lives of their citizens, residents and visitors. The amount of personal information generated in electronic form (phone calls, phone records, e-mails, SMS and so on) has grown exponentially, and this is making effective surveillance harder. Nevertheless, using modern data mining tools, it is possible to combine information from many different sources to build up a detailed picture of the movements and habits of an individual person.

This practice of "profiling" can be used to identify potential terrorists. But it can also be used, as a powerful commercial tool, for developing targeted marketing. It is possible, for instance, to combine location-based information (e.g. from mobile phone use) with information about the use of credit cards for purchases, to gain an idea of when and where to send targeted messages to a potential customer. Any time we use an electronic device, or give out our phone number or e-mail address to a friend, we are surrendering a little bit of our own privacy. If we have confidence in the way that information is captured, stored and used, and by whom, then giving up security in return for added protection, or for more relevant advertising, is a trade-off we are willing to make. But once our trust in electronic networks is impaired, then all aspects of our lives are at risk. In particular, as shown in chapter four, our digital identity may be more vulnerable than we think.

5.1.5 Content without frontiers

A fifth challenge is to determine, at a global level, what kind of "frontiers" we may wish to maintain in the digital world that would mirror, or reinforce, those of the physical world. Each society has its own "red line" over what is considered acceptable behaviour and what is not. Some of those red lines are absolute, in all societies, like the abhorrence of child pornography, genocide or murder. But many of those red lines are relative or country-specific: for instance, over questions like whether it is acceptable to gamble online, to criticise a member of a royal family or ruling elite, what differentiates a terrorist from a freedom-fighter, when "free speech" becomes "hate speech" and so on.

Convergence, in the digital world, is bringing together two quite different regulatory cultures on a collision course: on the one hand, the "content-regulated" culture of the broadcasting sector, and on the other hand the "carrier regulated" culture of telecommunications. When we add to this the "regulation is treated as interference" culture of the internet, it is a potentially explosive mix.

In the early days of the internet, it was trendy to say that cyberspace was a world without borders and that notions of national sovereignty were outdated and did not apply to the internet. In practice, frontiers are deeply embedded in our *zeitgeist*. Far from disappearing, borders in cyberworld have tended to become reinforced over time. In the early days, for instance, the geographical domain name of an e-mail address or a website was the only guide available for understanding the location of a user, and in the case of generic top-level domains (like *.com* or *.edu*) this was not a reliable guide. Now, more sophisticated techniques, based for instance on the geographic allocation of IP addresses or the location of e-commerce services, can be used to locate a user.

The ability to localise a user has encouraged rather than deterred the use of the internet as a medium for commerce. For the broadcasting and entertainment industry, in particular, with its complex system of national and regional rights and release dates, the ability to offer services (like music or video on demand) to certain parts of the world while excluding others, and to offer differential pricing, has encouraged rights holders to put their material online for the first time.[6] However, there are already many semi-legal websites that stream live television channels from around the world onto the internet as well as many less-legal sites that offer copyrighted material for download on demand. Equally, it is now possible to "place-shift" as well as time-shift television viewing–for instance by taking a video stream received at home and viewing it elsewhere in the world via the internet.[7] Nevertheless, the concept of "television without frontiers"[8] remains an elusive one at the global level, and there are many that are content for it to remain that way.

5.1.3 Create, access, utilise and share

A final challenge for living the digital world is to extend the benefits that it might bring to all the world's inhabitants. In the words of the *Geneva Declaration of Principles* of the World Summit on the Information Society (WSIS), the aim is to build an Information Society where "everyone can create, access, utilise and share information and knowledge".[9] WSIS has raised the bar of public expectations by arguing that not only should everyone have the ability to access and utilise information and knowledge, but also to create and share it. This marks a shift from an essentially one-way information society—which used the medium of television and radio as a form of mass communication—to an interactive information society, in which consumers become content creators in their own right.

Even in developed countries, we are still a long way from achieving this goal of full interactivity. Access networks, such as those based around DSL technologies, are typically asymmetric with a greater capacity to download than to upload. But as we shift from DSL towards fibre to the home, we are returning to the symmetric network structure that characterised the first telegraph and telephone networks. In developing countries, network asymmetry is less of an issue because there are still large territories and populations that have only limited service and in which any capability greater than the 19.2 kbit/s available on a 2G mobile connection would be a distant dream. The telegraph may have "made the world one" from the perspective of spreading information to all regions of the world, simultaneously; but the internet and other more modern ICTs are not yet sufficiently widespread to "make the world one", in that not everyone is able to create, access, utilise and share information.

5.2 A day in the digital world

The duration of a typical day in most cultures has remained unchanged since about 2000 BC, when the Sumerians put in place the sexagesimal (base sixty) system we use today, making each day twenty-four hours in length.[10] For the average Sumerian, a typical day might have involved building and maintaining basic shelter, hunting for food and making basic tools. A twenty-four hour period for today's human may not be that different: home improvement and gardening, cooking or finding a restaurant, downloading software tools. But, the advent of digital technologies has greatly changed the way in which we communicate and carry out mundane tasks. Digitization has certainly helped us in accomplishing tasks quickly and more efficiently, but the digital phenomenon goes much further than that.

Digital technology is fast becoming indispensable. In the future, it may be entirely integrated into daily life, to the point that it may no longer seem appropriate to refer to 'digital technology' as a detached and discrete entity. As such, it might "disappear" into the very fabric of life, much like electricity, which is simply taken for granted. In the future, sensors embedded in clothing or under skin, for instance, might be able to communicate important medical information to healthcare professionals. In the home, devices could take on multiple roles, allowing users to move seamlessly from one environment to another (e.g. from home to work) while staying connected to the same network. With all these possibilities, digital technology goes a long way in addressing humankind's long-standing struggle against space and time.

In order to gain a glimpse of what a truly digital life might be like, and for a bit of fun, boxes 5.1 and 5.2 explore what a typical 'digital day' might mean, at home and at play, at some unspecified time in the future.

5.3 Digital dreams

This report has looked at how the physical world of atoms is increasingly overlapping and colliding with the cyberworld of bits and bytes. It has looked at how human lives are being changed, and new habits are being formed, through advances in digital technologies.

Box 5.1: Digital days, digital daze

24 digital hours@home

Sensing the increasing intensity of the sunlight, Kim's curtains open, and the bedroom radio switches itself on. He awakes and taps the screen next to his bed, activating his house assistant—K-152, a humanoid robot. In his morning daze, Kim selects his breakfast from the images on the screen, and goes for a shower. In the kitchen, K-152 opens the refrigerator and puts the breakfast packet into the microwave oven. The RFID tag on the wrapping tells the oven how long to heat the contents. K-152 has been "learning" to make the coffee that Kim prefers. After a series of failed attempts, it is gradually mastering it. It is also learning to "cook" by downloading recipes online, which contain instructions for robots to make hot meals, based on the ingredients available in the refrigerator.

While showering, Kim watches the news projected onto the shower wall. While brushing his teeth, Kim stands on the scale and places his ring finger in a health check-up device. From the initial scan, Kim feels fit and healthy, but the scale disagrees and his weight is displayed in accusing red numbers on the mirror: 5kg overweight. He jumps off the scale quickly, but at the back of his mind he is aware that he has pre-programmed the scale to inform the refrigerator. It's a decision that he took jointly with his girlfriend who is also on a diet. As a result, chocolate bars and candy will not be replenished until Kim's weight reduces. He will have to find a grocery store in the street, and that's becoming increasingly difficult as most people do their grocery shopping online.

Kim enters the kitchen and his breakfast is already on the table, steaming hot. K-152 greets him in Mandarin, as programmed. By downloading interactive audio files from the internet, K-152 can practice conversations in several languages with Kim every morning. After some basic phrases, Kim sips the coffee and almost spits it out. There is no sugar in it. Apparently, K-152 has also been informed about the extra 5kg. While Kim tries to enjoy the rest of his breakfast, his dog Fabo runs into the kitchen. It wags its tail and begs for food but Kim ignores it, knowing that the dog food dispenser can take care of that. Nevertheless, Fabo is very entertaining and Kim quickly shoots a video clip of him, to upload later to *Vids4me*. His videos are already attracting a large number of downloads.

At 9:00am, Kim heads to his study to start work, but first he uses his mobile device to check on Maiko and Ade, his virtual world friends, who are spending all their money at the virtual mall. Suddenly, Kim receives an alarm call from the house monitoring system. With two clicks on his keypad, the site of the alarm call is revealed: downstairs, Fabo has spilt his breakfast. K-152 does not have the functionality to sweep up small objects like dog food, so Kim sends the vacuum cleaner to clean up the mess, and orders the food dispenser to give another portion to Fabo.

Over his lunch of celery sticks and low-fat tofu, Kim signs in to *YourPlace* on the web in order to update his personal profile and to upload some short video clips for his close friends to view. He is something of an amateur film-maker and often modifies clips of existing films to make them funny or thought-provoking. Kim often submits them to the video website *Vids4me*, and the videos have received consistently high ratings from viewers. If only he could convert his film-making hobby into a new career …

Source: ITU

Image source: sxc.hu (mai05)

In the early days of the internet, it was possible to order goods and services (e.g. books, flight tickets) for delivery off-line. Later it became possible to order those same goods and services for delivery online (e.g. downloading the full text of a book or purchasing an e-ticket for a flight). Now, it is possible even to consume those goods and services online. An online persona might buy a short- e-book to put on a digital bookshelf in their digital home to share with guests, or use an e-ticket to gain access to a subscription-controlled part of the digital world. These digital goods can even be paid for by "work" done in the digital world, for instance, by viewing advertising, or trading other digital goods. For the moment, the real economic value of the market for digital goods is quite tiny, but it is growing faster than any real world economy. These three stages of transition of the e-commerce market—from

Box 5.2: Digital days, digital daze

24 digital hours@play

Sam Yi usually works until 5pm, when she begins to receive picture messages from her friends, discussing where to eat and socialise in the evening. Sam Yi and their friends always opt for the restaurant that offers the most attractive special offers and menu for that day as well (discount vouchers can be downloaded to their mobile devices). Kim, her best friend, always has good ideas and the two of them usually go to the restaurant of his choice. Sam Yi leaves her apartment and heads for the subway. By changing her status from "At Home" to "Away" on her mobile device, the central server in Sam Yi's house turns off the lights and locks the windows and doors. It also begins monitoring the house so it can send reports to Sam mobile device if anything should happen during her absence.

Entering the subway network, Sam Yi points her RFID-enabled mobile phone "wallet" to the gate, which automatically opens and debits her account. Using the train's Wi-Fi internet access, she visits her regular MyWorld haunt—her Myroom inside her own Myhome. Sam Yi enjoys the anonymity of the cyberspace environment, and has used this opportunity to create a unique persona that is more outgoing and daring than she is in real life, and which offers more excitement. Her new persona, a young actor, has made lots of virtual friends, and Sam Yi's close MyWorld friends or 'buddies' often drop by her virtual home at this time of the afternoon. Sam Yi has a special relationship with these buddies and receives alerts when they update their 'Myhompies' – a combination of a photo gallery, message board, guest book, and personal bulletin board.

Sam Yi is not especially proficient as a computer user but this does not stop her from being able to buy items for her virtual space. Sam Yi uses "walnuts"—a digital currency—to spend on paintings to furnish her digital home, and music tracks to entertain her guests. Her virtual persona has a rather limited wardrobe, and Sam Yi resolves to spend some Walnuts on clothes for him for the new season. Getting off the train, Sam Yi walks past City Hall where she witnesses a large protest against the new higher fare structure for road pricing that has recently been introduced—some tolls have more than doubled in price overnight, causing a lot of resentment. She records the moment using her mobile phone's camera, and uses the phone's browser to upload the video to XYZ.video, a 'citizen journalism' news website.

She sees a teenage boy leaning against a wall, listening to internet radio and chatting on a mobile instant messenger program. People have gradually begun to talk less in public, switching instead to other modes of communication such as multimedia messages. Before getting to the restaurant, Sam Yi places a bet on the *Mobilottery*, a state-run online gambling website. Sam Yi is not expecting much, but she certainly hopes to get rich one day, and in the meantime the "walnuts" she receives as an incentive to play the lottery help her to finance the lavish lifestyle of her digital persona.

Source: ITU

Image source: sxc.hu (mai05)

off-line delivery, to online delivery to purely digital goods—have taken shape in less than a decade. They are mirrored by an equally rapid evolution in other online activities—such as voice over IP, video on demand, music downloads, social networking and so on. These changes are being driven, on the one hand, by the increased availability of bandwidth and mobility and, on the other hand, by changing user habits and preferences.

Ultimately, the digital world is a user-driven one in which consumers who are not happy with a particular service provider or website can easily switch to another. It is a footloose world, with a very low cost of switching for users and a relatively low cost of entry for service providers. It is a world in which traditional barriers to communication, like geography and social class, disintegrate. What is more, users can now actively participate in creating their own services and content. In the physical world, the height of most people's ambition is to find proper employment, develop a hobby, purchase a home of one's own, decorate it to reflect a chosen lifestyle, and fill it with their friends and family. We can now do all this in the digital world, too. So, perhaps, digital dreams are not so different, after all.

Endnotes for Chapter five

1 See Clarke, Arthur C. (1992) "How the world was one: Beyond the global village", Bantam Books, NY.

2 Although there are always arguments about who comes first, AT&T's 4ESS exchange, first installed in Chicago in 1976, is generally accepted as the world's first digital switch. See the "History of network switching" (at www.att.com/history/nethistory/switching.html).

3 Although the inter-urban exchange network is now more or less fully-digital around the world, the access network remains largely analogue. For instance, most telephone handsets are analogue, as are most of the world's fax terminals and dial-up modems. But handsets are slowly being replaced by digital models and fax terminals and modems are in abeyance, as e-mail and broadband take their place, respectively.

4 The ITU Regional Radio Conference for Region 1 (Europe and Africa) plus Iran concluded in June 2006 with agreement on a harmonized series of dates for the switchover to digital broadcasting, rather than analogue. See "Digital broadcasting set to transform the world's communication landscape by 2015", ITU press release (available at www.itu.int/newsroom/press_releases/2006/11.html).

5 In the biblical book of *Genesis*, chapter 11, the story of the Tower of Babel is used to illustrate the creation of many different races and languages scattered across the world.

6 As an example, in September 2006, UEFA has launched a view-on-demand service offering a number of different packages of material from European Champion's League football matches, including packaged highlights and pay-per-view live matches (see www.uefa.com). This has been done in conjunction with the broadcast rights holders in each separate member country.

7 Place-shifting is available, for instance, by using a Slingbox (see www.slingmedia.com). Another example is the "Venice Project", planned by the co-founders of *Kazaa* and *Skype* (Niklas Zennstrom and Janus Friis), which is expected to apply peer-to-peer filesharing technology to video content (see http://featured.gigaom.com/2006/10/05/five-questions-with-skype-co-founder-janus-friis/).

8 "Television without frontiers" is the title of an EU Directive adopted in 1989. It has now been updated in the proposed new EU Audiovisual Media Services Directive.

9 See WSIS Outcome Documents (at www.itu.int/wsis/documents/doc_multi.asp?lang=en&id=2316|0). This particular phrase appears in para 1 of the *Geneva Declaration of Principles,* adopted on 12 December 2003.

10 The Sexagesimal System based on the number 60: 60 seconds in a minute, 60 minutes in an hour, 24 hours in a day—all divisible by six (see http://en.wikipedia.org/wiki/Time).

Annex:

Information society statistics

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