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Chapter 7

Emerging Technology Applications

Many emerging ICT applications have major economic and social potential. Applications of ubiquitous networks (including RFID), location-based services, natural disaster prevention and warning technologies, the participative Web and the convergence of nano-, bio- and information technology are all growing and developing. Commercial applications and social acceptance and use will determine their long-term impacts.

Introduction

This chapter deals with selected emerging information technology (IT) applications and discusses their historical background, economic opportunities, social acceptance and benefits. The interaction between technological opportunities, commercial development and social acceptance and use determines which technologies become widespread and have positive economic impacts. The chapter illustrates some of the many developments and opportunities in information and communications technology (ICT):

- **Ubiquitous networks** connect persons and objects anywhere at any time to provide real-time tracking, storing and processing of information. Applications of enabling technologies such as RFID (radio frequency identification) and sensor technologies are increasingly affordable, investment is rising and specific applications are being deployed as applications move into commercial use.
- **Location-based services (LBS)** use a variety of position-determining technologies to follow the location of objects and users. Besides the two most common applications – navigation and asset tracking – other uses include emergency and rescue, nearby information services and people tracking, the last of which raises privacy and security concerns.
- **Natural disaster prevention and warning technologies** are becoming more important at different phases of disaster management. While technologies are often specific to one type of disaster, satellite remote sensing technology is used to detect nearly all types, often combined with a geographical information system (GIS) for analysing and processing the data which are then transmitted via different ICTs.
- **Participative Web** is the active participation of Internet users in creating content, customising the Internet and developing applications for a broad variety of fields. Blogs are one of the most popular examples of the participative Web. Their impacts include development of new business models, enhanced efficiency and new communication possibilities and ways to influence traditional media.
- The **convergence of nano-, bio- and information technology** provides major opportunities and challenges, driven by ongoing innovations in all three enabling technologies. Convergence in applications such as healthcare and robotics is leading OECD countries increasingly to assess its potential and impacts.

These technology applications are very different but they have common points and are interlinked. On the *technological side*, the convergence of nano-, bio- and information technology paves the way for further development of ubiquitous networks, for example via ambient sensor devices. Applications of ubiquitous networks, location-based services and natural disaster prevention and warning technologies are based on tracking and can, for example, rely on global positioning systems (GPS). The participative Web encourages Internet users to develop open source applications that can be used in other emerging technology applications (*e.g.* GIS systems for disaster prevention). On *the economic side*, data on market estimates vary; the market is often not clearly defined, but overall, estimates are positive and promising, and practical commercial development is the necessary link between technological potential and economic and social impacts. On the *social side* almost all applications face the challenge of social acceptance. Only if their utility is clearly understood can new and promising applications be introduced, commercialised and contribute to economic and social development.

Ubiquitous networks

The "ubiquitous network" is a network environment in which persons and objects are always connected. It is characterised by an all-inclusive use of networks and networked devices (ITU, 2005; OECD, 2002a). The term "ubiquitous" in the IT context was coined in 1988 to describe a new era in which computers are (invisibly) embedded into the everyday world and in which scale and location are of crucial importance (Weiser, 1991). Both Japan and Korea have policies to develop ubiquitous networks (Box 7.1).

Box 7.1. **U-Korea and u-Japan: Korea's and Japan's policies towards a ubiquitous network**

In order to promote the development and propagation of ubiquitous networks, Korea and Japan have put in place the "IT839 strategy" and the "u-Japan" strategy respectively. Both aim at the realisation of a "ubiquitous network society" (see also Box 8.1).

Korea's "IT839 strategy" defines specific measures and links eight IT services to three infrastructures and nine products. Short-, medium and long-term goals have been set for each service, infrastructure and product. Services include for example WiBro, RFID and Internet telephony services. Long-term goals include 9 million WiBro and 4 million Internet telephony users as well as a 5% share in the world RFID market. The eight services are supposed to encourage investment in the three infrastructures: broadband convergence network, ubiquitous sensor network and next-generation Internet protocol (IPv6). Among the nine products are mobile handsets and equipment, telematics and intelligent service products. To promote the "839" measures, government initiatives include model projects, provision of funds and support for technological development.

The u-Japan strategy applies ICT to resolve diverse social and economic problems and to address negative aspects of ICT. These targets will be promoted by: *i)* the development of infrastructure (*e.g.* consistency among wired, wireless networks, broadcasting systems and transport networks); *ii)* advanced usage of ICT, to achieve a society in which 80% of the population can appreciate the role of ICT in resolving issues; and *iii)* the development of the usage environment, which deals with the challenge of anticipating negative effects and devising solutions. Clear goals are defined and a schedule was prepared for measures to achieve these goals up to 2010.

Source: Korea, Ministry of Information and Communication; Japan, Ministry of Internal Affairs and Communications; Murakami (2005).

As ubiquitous networks are available anywhere and anytime, they can provide real-time tracking, storing and processing of information, and as devices get smaller these networks becomes almost invisible. One application is the use of contactless tags in supply chain management to track goods and their condition at any stage of the chain (usually known as RFID for Radio Frequency IDentification).

The structure of the ubiquitous network ICT industry has four layers (MIC, 2004): the network, the terminal, the platform and the solution. The network layer includes infrastructure and technologies such as DSL, cable Internet and the transport network. The terminal layer comprises mobile phones, PCs, sensors, electronic tags, etc. The platform layer deals with such issues as billing/payment, authentication and copyright. The solution layer comprises applications such as tracking, disaster monitoring, electronic data exchange and telemedicine.

Examples of enabling technologies that will drive the development of ubiquitous networks include radio frequency identification (RFID), sensor technologies, smart technologies and nanotechnology (ITU, 2005). RFID is an increasingly common example of the deployment of ubiquitous networks, and its economic and social impacts provide insight into some of the challenges confronting these technologies.

RFID

RFID technology is being deployed to monitor manufacturing assembly, track goods of all kinds, enable financial transactions, pay tolls and fuel, and allow secure building access and other applications (see OECD, 2004a, for an earlier overview). RFID uses radio frequency-based communications for contact or contactless identification of entities (products, animals or humans), places, times or transactions. RFID can be combined with sensors and actuators, with localisation functions enabled by Global Positioning System (GPS) technology or mobile telephony, and is increasingly (inter)connected through radio technology to produce innovative applications. RFID offers promise as the first iteration of intelligent sensor networks, and the interlinking of RFID and various increasingly capable, smaller and cheaper devices constitutes the technological basis for an environment in which everyday objects can communicate. By extension, RFID is considered a building block for networks of distributed sensors.

Overview

RFID consists of the following key elements: RFID tags (transponders, typically miniaturised semiconductors); RFID readers (transceivers), which transmit data via electromagnetic radio waves using air interface and data protocols; and a data collection, distribution, and management system that is able to identify or scan information with speed and accuracy.

RFID tags consist of tiny electronic circuits with limited on-board memory attached to small antennas that can transmit a unique serial number to "reader" devices. The tags are attached to physical objects, people or animals, which can then be tracked. Readers located within limited distances communicate with the tags, receive data from the tags, and send the data for processing to an IT system consisting of databases, middleware and application software. When a tag comes into proximity with a specified RFID reader, data on the tag can be read. The data may be used to identify the tagged object or to provide information about it. According to the needs of the application, readers transmit data such as information on identification and location or product price, colour, date of purchase and expiration date.

There are many different types of RFID systems and they vary in their mode of operation and performance. For example, a completely "passive" RFID tag has no internal power supply. Instead, it harvests power for its operation from the electromagnetic field of the reader. This makes the tag much cheaper, but the reader has to drive the communication. With "active" RFID systems, instead, the tag contains a small battery which enables it to communicate with

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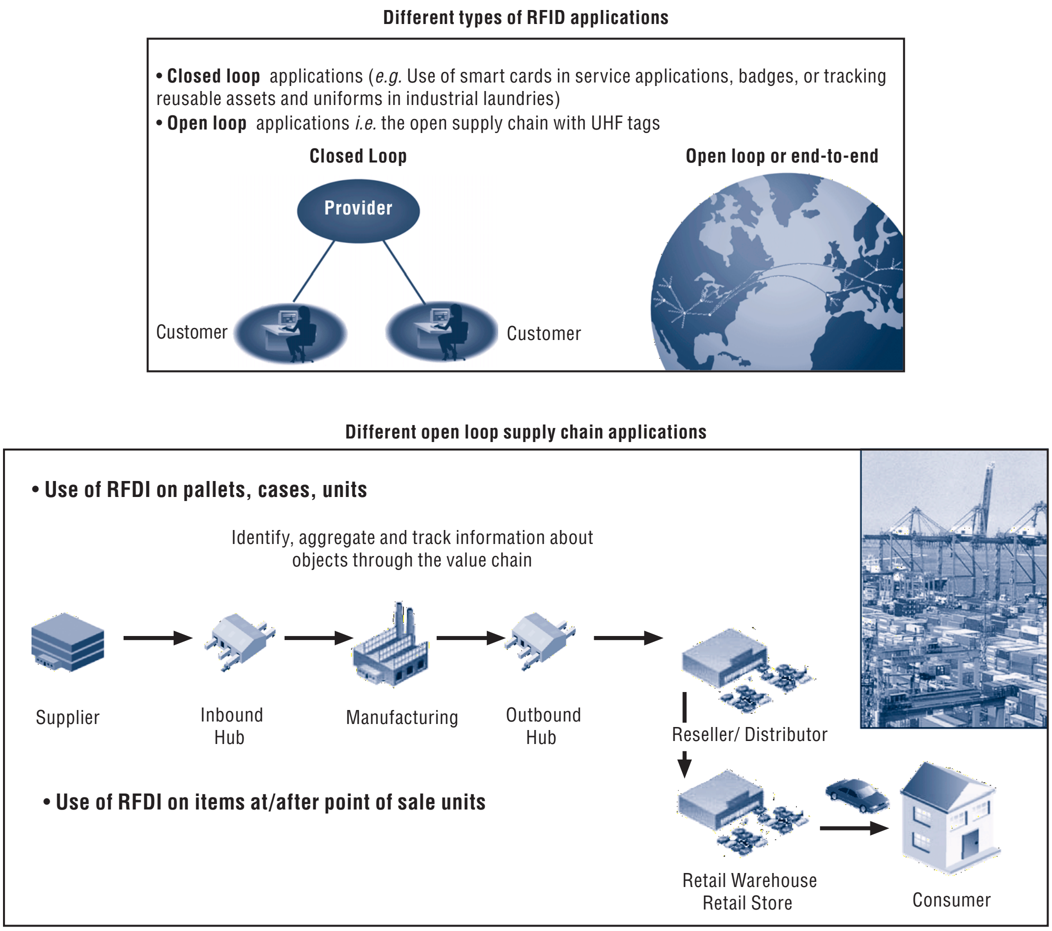
the reader. "Active" tags have a longer range, depending on the size of their antenna, strength of battery and the portion of radio spectrum used. Active tags also typically have more memory than passive tags.

There are significant differences between open loop applications, *e.g.* the open supply chain with ultra-high frequency (UHF) Electronic Product Code™ (EPC) tags, and closed loop applications, such as contactless payment cards used in a closed payment system or inventory applications such as tracking reusable assets (Figure 7.1). In the open supply chain, a distinction needs to be made between use of RFID at pallet level and use of RFID at item level for retail goods. In the supply chain, pallet-level tagging offers clear economic benefits. RFID can make the whole supply chain more productive, and it is predicted to shift the dynamics of competition from the enterprise level to the supply chain level. However, pilots for item-level tagging of individual goods in retail environments suggests that economic benefits are likely only in specific cases and only with time, widespread adoption, and a virtuous circle of innovation in supporting technologies.

Figure 7.1. **Overview of different RFID applications**



Source: OECD.

Contactless smart cards, such as payment cards, identity cards, passports, transport cards and loyalty cards, are essentially a sophisticated form of RFID technology, with embedded processing power[1] and ancillary security features.

Economic potential and applications

RFID is increasingly used by firms involved in manufacturing and production, logistics, retail and health care and by some government agencies. The technology enables users to efficiently collect, store, analyse and distribute information on tracked objects. Benefits include fewer human and machine resources dedicated to simple data entry, better inventory control, more efficient just-in-time production, and increased transparency and accountability in supply chains.

The development of standards, technological advances and end-user mandates has spurred the use of RFID in retail and consumer goods applications. RFID is poised for growth worldwide, as businesses and governments implement RFID applications to facilitate global commerce and spur innovation and competitiveness. RFID promises greater reliability and efficiency than the bar code system in areas such as supply chain management, transport, defence, health care and security and access control. It is increasingly used in commercial supply chains through aggregate level tagging (*e.g.* tagging of cases and pallets) and is projected to produce long-term measurable productivity gains in supply chains and economies as a whole.

High costs in the early stages of adoption will give way to cost reductions and growing adoption, leading to benefits and further adoption. Based on current assessments, demand will grow from tens of billions of tags in 2006 to hundreds of billions by 2009. Analysts have identified three distinct phases of RFID deployment: initial pilot tests and experimentation (2003-05); a supply chain infrastructure phase mainly using aggregate-level tagging (2005-09); and widespread item-level tagging (2009-13). An improving cost structure and smaller component size have recently made RFID accessible and practical for wide-ranging tracking and tracing applications across the economy, especially in the industrial, transport, security, consumer goods and services sectors. However, owing to cost barriers, performance issues and lack of accepted standards, the impact on supply chain management is just beginning to be felt.

Drivers of RFID applications

RFID tags are expected to generate productivity benefits in "open loop" supply chain management and asset allocation, through automation of receiving, expediting, replenishment, handling, quality control, tracking of lots for recall or expiration, and other supply chain tasks. They can also enable better asset allocation with increased fill rates, lower inventory, reduced theft and better management of products. They are also increasingly considered for specialised "closed loop" applications. These include in-process inventory tracking, goods location or tracking, warehousing, repair and maintenance, mobile payments, theft detection, luggage tracking and location or identification of people. RFID will also affect other facets of business processes, including sales and marketing. General benefits include:

- ***Speed and accuracy:*** RFID has greater potential for speed and accuracy than barcodes because applications may require less human intervention.
- ***Visibility:*** Supply chain participants can benefit from the ability of RFID tags to hold more information about an item than existing barcode technology.

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- ***Information enrichment:*** Some RFID tags are writeable, and as they go through various stages of the product life cycle, information can be added to the tag.

Studies have found that RFID can lower supply-chain costs by 3-5% and increase revenue by 2-7%. The EPC™ provides for the delivery of a unique serial number at the individual item, pallet or box level. A unique ID number offers the potential for reducing counterfeiting, and could, for some applications, significantly reduce infringement of intellectual property rights by tracking and identifying genuine articles (pharmaceuticals, fashion goods) and comparing them with counterfeit products. It could also enable animal pedigree tracking.

Mandates by large retailers and governmental agencies, such as Wal-Mart and the US Department of Defense, requiring their top suppliers to use RFID tags, have spurred the adoption of this technology. Mandates of key customers were cited by many manufacturers as their primary reason for deployment of RFID in 2005.[2]

Legislation and procurement, particularly relative to product traceability, person tracking and national security, catalyse RFID adoption in certain industries and for certain application areas. These include recycling obligations, requirements to provide country-of-origin labelling, pharmaceuticals tracking, food ingredient traceability, and techniques to prevent counterfeiting and cross-border controls.

Emerging issues

Realising the potential of RFID requires addressing interrelated economic, technological, standards, interoperability, privacy and security issues which have potentially wide-ranging social, economic, as well as national security implications. RFID touches on several regulatory and/or policy issues, including international trade, intellectual property rights, standards, spectrum, security and privacy.

Business and technological challenges

At this early stage, cost is a significant impediment to adoption of RFID. There is also the related issue of who bears the cost and who reaps the benefits. Suppliers claim they are forced to pay for an investment that saves retailers money. Successful implementation of RFID also requires process changes and companies' ability to redirect personnel from tasks such as scanning, searching and verifying products to higher-value tasks. Another main stumbling block is the edge-of-network or RFID middleware, which links RFID hardware to an enterprise's various IT systems. Tracking many RFID-enabled objects will require efficient data management, very rapid access and high-capacity storage, methods of dealing with inaccurate data, and ensuring data integrity and data transfer across different systems.

Technological issues must also be managed. Although radio waves can pass through most articles, the combination of materials, operating frequencies, associated power and the environment can be problematic. Interference from other RFID or wireless devices (mobiles, personal digital assistants [PDAs], etc.) is a main issue. In addition, RFID hardware must be tuned to specific radio wave frequencies, but these are not consistent worldwide or even in Europe. Yet another challenge is security through encryption, since the inclusion of cryptographic features increases cost and may reduce speed.

Standards and interoperability

Standards work is under way in both standards developing organisations and industry consortia, such as the International Organization for Standards (ISO) and EPCGlobal. Challenges include harmonising frequency allocation for RFID operations and adopting worldwide interoperable communication protocols. ISO has set standards for "closed loop" RFID, including standards for animal identification and for the air-interface (contactless) protocol for RFID tags used in payment systems, smart cards and in-vicinity cards. It also has established standards for testing the conformance of RFID tags and readers to a standard and for testing performance.

Fewer standards have been finalised for "open loop" supply chains, with tags designed for use throughout the whole supply chain. ISO is developing standards for tracking 40-foot shipping containers, pallets, transport units, cases and unique items. The EPCGlobal consortium has produced a taxonomy of tag classes, standard radio frequency signalling protocols between tags and readers, and formats for the storage of identity and data in tags. EPCGlobal has ratified a UHF Class 1 Generation 2 RFID standard for the air-interface protocol of second-generation EPC technologies, which has yet to be ratified by ISO. In addition, common standards have to be worked out with China, which has stated that it will adopt standards that are compatible with EPCGlobal and ISO standards but will use its own intellectual property to build a royalty-free standard.

Security and privacy

As RFID migrates to item-level tagging and as governments adopt it for various personal identification schemes, it is crucial to address privacy and security issues related to certain types of RFID systems and applications: a solution might combine self-regulatory mechanisms, policy guidelines and technological solutions with education and awareness programmes.

Privacy is an important issue for RFID implementation, as an individual's personal details could be compromised if the application is not sufficiently secured.

Trade unions in some countries have complained that RFID tracking technology may violate employee privacy. There is also opposition from consumer groups who worry about the "big brother" aspect of the technology.[3] If privacy-related issues are not carefully addressed, including through education, consumer and citizen backlash could limit the long-term benefits and development of RFID.

Location-based services

Location-based services (LBS) follow the geographic location of objects or users to provide enhanced, specific and usually personalised services. These relatively new services facilitate safety and rescue in emergency situations, they represent new business opportunities for various participants at different positions of the value chain (such as geographical data providers, application developers and content providers) and for a wide field of applications, but they also present privacy and security challenges. Following a short history, this section presents the value chain of the LBS sector and its wide range of applications. It then discusses market size and market drivers in order to estimate the economic impacts of LBS. Before dealing with emerging issues, social impacts are analysed.

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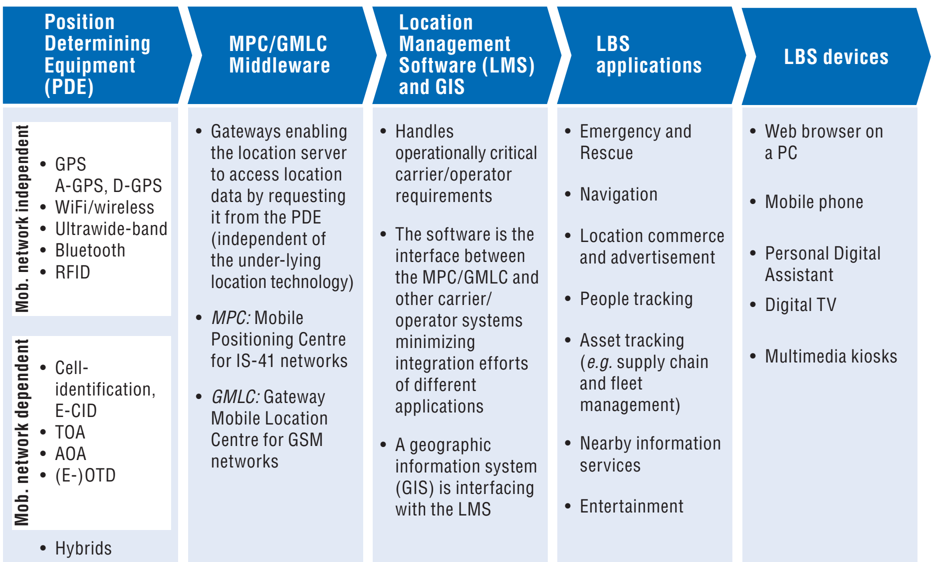
LBS were first used in 1978 when the US Department of Defense launched the GPS, a satellite infrastructure for military purposes comprising 24 satellites (Pfeiffer, 2003). In the 1980s, the United States made the positioning data generated by the system freely available worldwide (Schiller and Voisard, 2004). This was the starting point for the development of commercial applications. Fleet management and car tracking applications began to be developed in the early 1980s, but widespread interest in LBS only emerged in the late 1990s when there was a new market interest in data services. In 2001, the US Federal Communications Commission (FCC) required tracking subscribers' location for emergency service response to E911 calls (Dao *et al.*, 2002). In Europe since mid-2003, operators must be able to make caller information available for all calls to the emergency number E112 where it is implemented (Commission of the European Communities, 2003). Overall, whereas LBS were first only used by companies that could afford to invest in special software and devices, they are now widely accessible via devices connected to the Internet and cellular wireless devices. Companies such as Google, Yahoo! and MSN have reduced their prices significantly or offer LBS at no cost. They also provide developers with access to interfaces for Internet-based maps and therefore the possibility to develop LBS further (Malykhina and Lecca, 2005). Consumer applications are at the end of the LBS value chain.

Figure 7.2 represents LBS technologies and services. At the beginning of the value chain, position-determining equipment (PDE) identifies the location of devices. The equipment used to locate devices can be grouped into equipment that is dependent on or that is independent of the cellular wireless network. Table 7.1 provides an overview of the main PDEs with their advantages and drawbacks. Besides cost and investment issues, LBS applications have three fundamental characteristics: *i)* accuracy of measurement; *ii)* the application environment (*i.e.* if the technology can be used both indoors and outdoors), and *iii)* range of coverage.

Figure 7.2. **The value chain of location-based services**



Note: For acronyms see Table 7.1. IS-41 is a standard for identifying and authenticating users, and routing calls on mobile phone networks.
Source: OECD based on D'Roza and Bilchev (2003), ESBI Computing (2006), Giaglis *et al.* (2003), Spinney (2003), TruePosition (2006).

Table 7.1. **Overview of the main position-determining equipment**

Technology and methodology	Accuracy	Application environment (AE) Coverage range (CR)	Advantages	Problems
GPS, A-GPS, D-GPS Network of 24 satellites A-GPS and D-GPS: Enhanced measurement using information from terrestrial infrastructure A-GPS: increases the sensitivity of GPS receivers. D-GPS: increases the accuracy of the measurement	GPS: ca. 3-15m A-GPS: up to 1-10 m	AE: GPS and D-GPS: outdoor A-GPS: outdoor/indoor CR: long (cross-national)	High outdoor precision Long coverage range (nearly global)	Line of sight required Problems in big cities ("urban canyons") Cost of the integration of components in mobile devices New or upgraded handsets needed
Wi-Fi WLAN infrastructure similar to cellular systems where the terminal communicates with the base station over an air interface at a certain frequency band	1-20 m	AE: indoor/outdoor CR: rather short (more than 100m but depending on the network quality)	High accuracy Low implementation costs Development of free public wireless networks Advantage compared to Blue-tooth: higher band-width capability	Possibility of signal interference Limited geographical range
Ultrawideband (UWB) Technology using short energy bursts at extremely low power over a large frequency spectrum	Up to several cm	AE: indoor/out-door CR: short (about up to 70m)	Very high accuracy	Until now not as developed as other position determining equipments (such as Wi-FI) Two competing standards. The IEEE UWB task group failed to develop a common standard in January 2006
Bluetooth Radio frequency specification for short-range, point-to-multipoint data transfer	Very high, up to milli-meters	AE: indoor CR: Short range (10cm to 1m; can be extended up to 100m)	Low-power requirements and low costs compared to Wi-Fi	Very short range Not possible to maintain multiple Bluetooth connections simultaneously for mobile phones
Radio frequency Identification (RFID) Wireless systems for non-contact reading of RF-enabled tags. Effective in environments where other identification mechanisms (such as barcode labels) may not be sufficient	High (few cm to one metre)	AE: indoor/outdoor CR: Short	Works in environment where other identification technologies are not effective (*e.g.* barcodes) Accuracy can be very high	Costs for tags currently too high for the mass market but falling rapidly
Cell identification (Cell-ID) Detects the approximate position of a device by identification of the cell the device is using. Most basic form of cellular detection	Rather low, but depends on the cell size	AE: indoor/outdoor CR: long	Already in use Relatively widespread infrastructure	Low accuracy Differences in cell size affect the accuracy
Time of arrival (TOA) TOA measures the time it takes a signal from a mobile device to reach three different cell sites which are equipped with location measurement units (LMUs) (triangulation)	10-100 m	AE: indoor/outdoor CR: long	Fairly accurate method	Significant investments for network operators due to the equipment of all cells with location measurement units which must be synchronized (maybe included with 3G)
(Enhanced) observed time difference ((E)-OTD) Similar to TOA. Method also based on triangulation but the measurement is realised by the mobile device	50-125 m	AE: indoor/outdoor CR: long	Only a limited number of cells have to be equipped with LMUs. No handheld modifications necessary	Significant investment for the end user as mobile devices must be suited for calculations
Angle of Arrival (AOA) AOA identifies the location of a mobile device using antenna arrays based on the angle at which signals transmitted from the device arrive at one or more base stations (BS)	Can get < 100 m	AE: indoor/outdoor CR: long	No modifications of mobile phones necessary	Requires special receivers at the base stations

Source: OECD based on Dao *et al.* (2002), D'Roza and Bilchev (2003), Djuknic and Richton (2000), Giaglis *et al.* (2003), Madhava and Tse (2005), Pfeiffer (2003), Rao and Minakakis (2003).

The raw location data obtained by the PDE is insufficient for most uses. It is only useful when combined with information that includes personal profiles, geographical data (*e.g.* in map form), directions to a location and nearby information (*e.g.* restaurants, hotels). To combine these data, a middleware depending on the network system (see Figure 7.2) enables the location server to access location data by requesting it from the PDE. The location server has two main functions: it acts as the interface between the middleware and other carrier or operator systems to minimise the effort to integrate different LBS applications and it interfaces with the GIS. The GIS server provides geographic and location information, including maps, street networks or information on consumers and locations. It then provides location-based information tailored to specific needs. The value chain described above is for networked services. The value chain may be less complex for some applications, *e.g.* car or boat navigation systems which receive positioning data from a satellite and then consult stored information such as driving directions.

LBS applications can be classified in seven main fields (Figure 7.2).

- *Emergency and rescue* LBS contribute to early warning systems by providing location-based weather and geological information. For example, for rescue services they provide information on the location of people by tracking calls from their mobile devices, especially to E911 in the United States or E112 in Europe.
- *Navigation services* are one of the most popular location-based applications and include navigation itself, information about traffic conditions, driving directions as well as safety driving. Car navigation systems are increasingly popular and often come as standard equipment in cars.
- *Location commerce and advertising* has promising commercial applications and good measurability but is potentially intrusive. It includes location-sensitive billing, transaction services (*e.g.* ticket reservation) and location advertisement services. Location-based advertisements to cellular wireless users have a significant advantage over other forms of advertisements as they can be personalised because of knowledge of customers' location and history of use. Mobile banners, SMS alerts and proximity-triggered advertisements are examples of location advertisement services (Giaglis *et al.*, 2003). As these advertisement services can raise privacy concerns it is generally acknowledged that consumers should opt for the service (see below on privacy concerns).
- *People tracking* monitors the location of specific groups such as children, elderly people, employees or friends and raises even more sensitive privacy and trust issues but also has an important security aspect.
- Besides people, location-based services also *track goods and assets*. Two important sub-application areas are supply chain management (SCM) and fleet tracking. The ability to locate assets at certain stages of the supply chain generates important gains in efficiency and thus cost reductions. The same applies for fleet tracking, which is mainly used by logistics companies. Tracking of stolen cars is also an application of asset tracking.
- *Nearby information services* group all LBS that provide mobile yellow pages, travel and tourist services such as accommodation information and information on landmarks, etc.
- Finally, LBS are also used for *entertainment* purposes, such as location-based games or dating services. All the above-mentioned applications are displayed on a LBS device such as a mobile phone or a PDA.

Economic impacts

It is very difficult to estimate market size and projected growth, and data may vary as there is no widely accepted or official definition. According to some industry analysts, the LBS market amounted to about USD 1 billion in 2005 (Juniper Research, 2005; ABI Research, 2005). ABI Research predicts a market size of USD 4 billion in 2009 and USD 8 billion in 2010, while Juniper Research estimates that the market will be over USD 8.5 billion by 2010. Market growth is slower than expected some years ago. According to Red Herring (2005), in 1998 analysts' estimates for the LBS market in Europe in 2005 ranged from USD 13 billion to USD 30 billion. Current estimates set the European LBS market at around USD 333 million in 2005. Taking all estimates into account and focusing on more recent ones (after the initial enthusiasm that accompanies most promising technologies), all sources suggest a significant increase in LBS, albeit from low levels.

A closer look at drivers and inhibitors of LBS can help project future development. As mentioned, the US FCC requirement for emergency services was an early driver. In 2006, broadband, through 3G wireless and Wi-Fi networks, delivers a diversified range of mobile or nomadic services. Public Wi-Fi networks are proliferating and starting to provide LBS. Furthermore, mobile phones are converging with PDAs. Network operators are still considering how to develop profitable business models. However, there are some inhibitors to the growth of LBS. Lack of LBS standards and low dependability – low content and communications quality as well as software reliability – mean that users cannot fully rely on the service. Security and privacy concerns, discussed below, are also factors in the rate of uptake. When such issues are resolved, as they have been for some LBS services, LBS will increase significantly.

A further factor influencing the success of LBS is the choice of business model, which depends on the application and the targeted customers. According to Rao and Minakakis (2003), subscription-based services and pay-per-view business models can be used for the consumer (mass) market mainly for nearby information and navigation application. For nearby information, a possible business model is free access to a service that is fully financed by advertisement. For niche consumer markets, another business model, revenue sharing (the user is charged for the service and the mobile operator gets part of the revenue) can be used. This is well-suited to people tracking, navigation and nearby information services. Finally, several business models for corporate customers concern asset tracking. They include consulting services and full-service solutions (*e.g.* infrastructure, network and application services).

Social impacts

As mentioned, security and particularly privacy concerns are important challenges for the further development of LBS. For people-tracking applications, for instance, security concerns include unauthorised access to the data of the person tracked. There is also the question of the possibility of circumventing privacy and security measures and tracking people without their knowledge. As to the issue of privacy, there is a fundamental question for people tracking (friend finder, child tracking): do users want other people to know where they are at any time? The same applies to users receiving location-based advertisements when using free LBS applications. Do they want companies to know where they are and be able to reconstruct their route during the day? To protect privacy, it is crucial to have the explicit consent of users and give them the possibility of turning off location finding (Giaglis *et al.*, 2003; Pfeiffer, 2003).

Customers' trust with respect to providing location information to third parties (*e.g.* advertisers) is crucial for service providers. Broad and flexible framework guidelines have been established by the OECD in the areas of privacy and information security which provide guidance and foundations for meeting privacy and security concerns associated with LBS (OECD, 1980, 2002b). One regulatory example is the EU Directive on Privacy and Electronic Communications (2002) which states that the "use of mobile phone location (for purposes other than routing calls) must have the consent of the user or be anonymised" (Soppera and Burbridge, 2005). Voluntary rules and codes of conduct can also be useful, but they do not provide legal redress if the code of conduct is not incorporated in legal regulations.

Once a user has decided to opt in or the service is put in place, privacy and security concerns during service provision can be significantly mitigated by effective technological security that protects the identification process. A hardware token can be used to identify people or assets and a software token can be used to identify applications or processes. Identifier systems consist of three parts, each of which requires specific design solutions: the physical device storing the identifier, the communication channel and the back-end system. On the device level, a trusted platform, which contains a module that is separate from the CPU, stores the secret information. Its drawback is that it can be used in PDAs, for example, but not in most embedded systems. For such systems the solution might be to change the identifier continuously, although this requires high management capability or encryption.

For security of the communication channel, three approaches can help: *blocking* which prevents "surreptitious scanning"; *access control* by simple passwords, encrypted identifiers to authorised readers, or a mutual authentication mechanism; and *encryption*. For the back-end system, two approaches have been suggested: In one, a trusted intermediary can be employed and act as anonymiser for communication between the end user and the application, and privacy can be enhanced if the intermediary blurs the location information. Encryption-based models can also be used. Pseudonym schemes, the second approach, allow the linkage between different pseudonyms and other data. Pseudonyms can be generated by the devices which are then communicated to the reader. Through the pseudonyms, limited secret information can be delegated to a reader for "a limited number of read operations". The advantage is that if an application is compromised, the user loses only the delegated parts. Furthermore, the pseudonym scheme makes it possible to link different pseudonyms (*e.g.* a pseudonym used in interaction with a doctor with a pseudonym used in a pharmacy (Soppera and Burbridge, 2005).

Emerging issues

Standardisation is another crucial factor for widespread adoption of LBS. Paradoxically, LBS depend on current localisation but users generally need them when they are in another environment (*e.g.* for asset tracking) which raises in particular the interoperability issue (Giaglis *et al.*, 2003). This issue has to be addressed across the whole value chain (see Figure 7.2). Several international bodies are dealing with standards and interoperability: the Location Working Group (formerly the Location Interoperability Forum) of the industry forum Open Mobile Alliance (OMA) is working on the development of specifications to ensure interoperability (OMA, 2006). Another example is the Open Geospatial Consortium (OGC, the former Open GIS Consortium), an international industry consortium of companies, government agencies and universities developing OpenGIS specifications that support interoperable solutions. OpenGIS specifications define a set of core interfaces for implementing interoperable LBS applications (OGC, 2004). Despite these interoperability standards, major companies (currently Google and

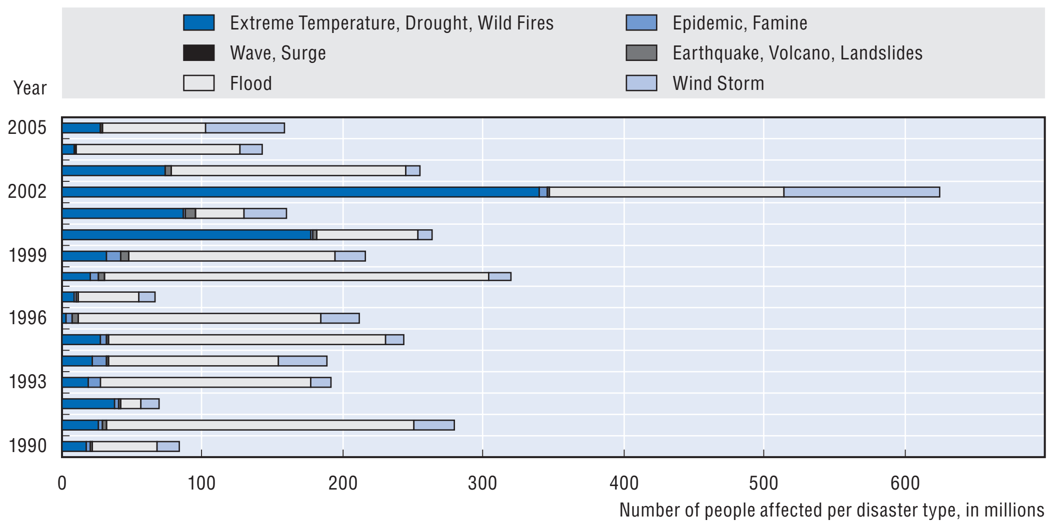
Microsoft) are also developing standards, making further developments difficult to predict (Bell, 2006). Service portability and roaming issues also have to be addressed to guarantee that LBS are affordable for users (Giaglis *et al.*, 2003).

Natural disaster prevention and warning technologies

The impact of disasters

The term "disaster" refers to a "sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, economic or environmental losses that exceed the community's or society's ability to cope using its own resources".[4] Natural disasters involve climatic disasters (such as windstorms, flood, drought, wildfires and extreme temperature), lithosphere disasters (such as volcanic eruptions, earthquakes and landslides) and other disasters (famine and epidemics) that are due to the complex interaction of many factors. The number of disasters[5] worldwide has exceeded 300 a year since 1998. In 2000 and 2002 there were over 500. Floods play a dominant role in both the number of disasters and the number of people affected (Figure 7.3). The number of occurrences of a type of disaster is not necessarily correlated with the number of people affected. For example, there are large numbers of earthquakes a year, but relatively few people are affected.

Figure 7.3. **Number of people affected[1] per disaster type per year**



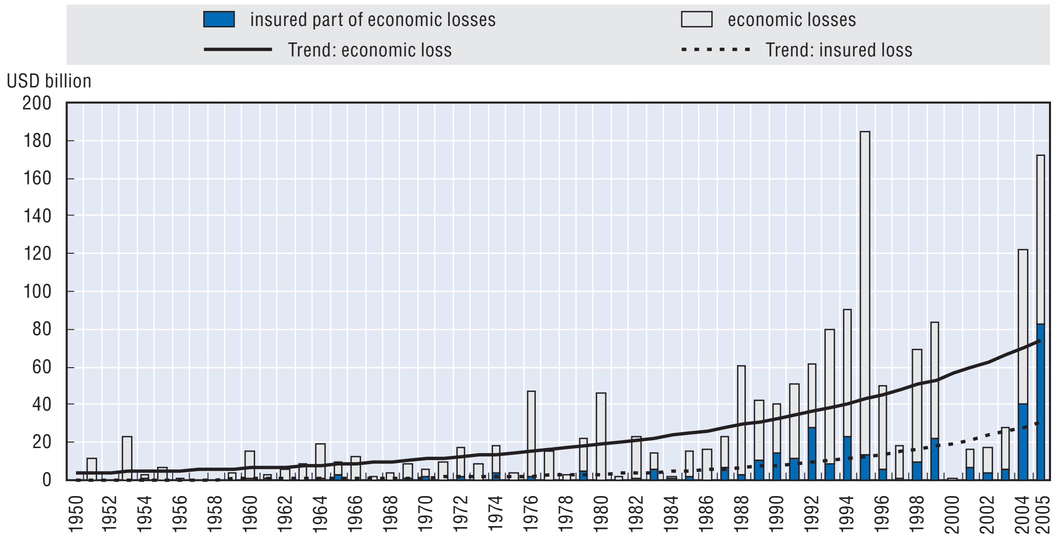
1. The category "total affected" covers people "that have been injured, affected and left homeless after a disaster". The term "affected" refers to "people requiring immediate assistance during a period of emergency, *i.e.* requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance".

Source: EM-DAT: The OFDA/CRED International Disaster Database, *www.em-dat.net*; Université Catholique de Louvain, Brussels.

StatLink: http://dx.doi.org/10.1787/574518225844

As Figure 7.4 shows, disasters entail important economic losses. The data, adjusted to present values, are collected by an insurance company and are mainly based on official reports and claims paid. Consequently, the numbers are conservative and may underestimate effective economic losses in particular cases. Nonetheless, the figure illustrates the importance of economic losses. In 2005, catastrophe economic losses amounted to more than USD 170 billion. There is a clear upward trend for both economic and insured losses.

Figure 7.4. **Economic and insured losses due to disasters: absolute values and long-term trends (2005 values)**



Source: OECD based on Munich Re (2006), "Topics Geo: Annual Review: Natural Catastrophes 2005".

StatLink: http://dx.doi.org/10.1787/472346304415

Technologies for disaster prevention and warning

Natural disasters cannot be avoided, but efficient disaster management can reduce the number of people affected and the economic losses. Disaster management has three main phases: prevention, warning and preparedness, and relief management. The following paragraphs concentrate on information technologies used in the first two phases.

Satellite remote sensing technology is used for nearly all types of natural disaster but different types of satellites are used for different types of disaster. *Earth observation satellites* provide extensive, real-time coverage of wide areas of the world in order to observe the state of the Earth and its processes. They provide synoptic views of large-scale phenomena and dispose of rapid measurement capabilities. Applications include forecasting hurricane and cyclone tracks. *Geo-stationary satellites* remain in place over a defined point, *i.e.* the satellite rotates around the Earth at the same speed as the Earth rotates around its axis. They are positioned at about 36 000 km and can provide continuous, frequent observations over large areas. They are particularly suitable for meteorological applications (see Box 7.2). *Polar orbiting satellites* have a much lower orbit and can provide images at much higher resolution. They have an inclination of 90° and pass over or nearly over the North Pole and the South Pole. Owing to their high resolution imagery, they are suitable for disaster monitoring even if the temporal frequency is rather low. *Communication satellites* play a crucial role in the diffusion of disaster warnings and the co-ordination of preparations for disaster mitigation. They are especially essential for data collection and for distress alert (CEOS, 2005; NOAA, 2005; Rao, 2000; Sylves and Wood, 2003).

Despite recent developments in satellite remote sensing technology, challenges and obstacles remain. Satellite systems and the linked computer systems are complex and expensive; this may impede the use of their data for disaster management (OECD, 2003). Furthermore, there are institutional and technical challenges. On the institutional side,

Box 7.2. **Tsunami early warning systems**

Geostationary satellites are used in the data transmission and communication phase of tsunami early warning systems. These systems have two important phases: the prediction and detection phase and the data transmission and communication phase.

For the first of these phases, tsunami early warning systems use different kinds of data, including seismographic and oceanographic data and data generated by the Deep Ocean Assessment and Reporting (DART) programme. Whereas regional early warning systems rely mainly on seismographic data, the international Tsunami Warning System (TSWS) in the Pacific also uses tide gauges and the DART system, which currently consists of six buoys. Both tide gauges and the DART system measure changes in the ocean's depth. Among the advantages of the DART system are its ability to measure deep ocean tsunami energy directly and the fact that it is less vulnerable to earthquake damage. It relies on an anchored pressure recorder on the seafloor that measures changes in water depth. The recorder uses an acoustic modem to transmit data to a surface buoy (González *et al.*, 1998).

Transmission of data from the buoy to tsunami early warning centres takes place via the Geostationary Operational Environmental Satellite (GOES). In the early warning centres, the data are combined with the seismographic and oceanographic data. Once the data are processed and show the need to issue a tsunami warning, it is crucial to have a reliable and effective communication system to warn the population. This system should include a clear communication framework and a reliable communication infrastructure. In Aceh, Indonesia, for example, the warning could be transmitted via loudspeakers of mosques (Alverson, 2005).

In addition to the TSWS a tsunami warning system for the Indian Ocean is currently being deployed which, like the TSWS, will rely on buoys, regional seismographs and satellite communication. In addition, technologies currently under development might be integrated. They include satellite-based radar interferometry which maps the deformation of the ground as well as new computer models and two-way communicating ocean buoys (BMF, 2005; Coren, 2005).

better and more extensive co-operation among space agencies and between these agencies and the private sector is needed to ensure adequate and fast response (CEOS, 2005). Additionally, satellite-generated data has to be embedded in appropriate and user-friendly tools to ensure that the data are used effectively for disaster management. Speed of delivery and spatial resolution could be improved (OECD, 2005). For the future, CEOS (Committee on Earth Observation Satellites) expects new capabilities such as greater compatibility of satellite-derived data with the GIS and better precipitation measurements for flood warnings.

Once satellite data are generated, they must be processed and combined with other spatial data and relevant information to be useful for disaster management. A GIS, which is a computer system, assumes the role of interrelating, analysing, processing and displaying geographically referenced data. Its advantage is that it can convert digital information that may not be in map form into a recognisable and useful form (USGS, 2005). For example, digital satellite imagery can be analysed and converted to a user-friendly map form. In addition to commercial GIS software applications, open source GIS software applications are increasing available, especially for Web services. Owing to the active GIS market and lower costs, GIS software, hardware and data have been improving continuously and may lead to broader use of GIS software by the public and private sector (USGS, 2005).

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Transmission of disaster warning

After the data is processed, fast and effective communication is crucial. Different technologies are currently used to alert the population, ranging from loudspeakers, radio communication, sirens, beepers and television to mobile phones, the Internet and a combination of technologies. Currently, radio, TV and mobile communication are mainly used. The Dutch government, for example, is testing a mobile phone SMS danger alert system relying on the GSM (Global System for Mobile Communications) standard for mobile phones to identify users of mobile phones in a particular area (Clothier, 2005). When a disaster occurs, a message is sent out to all mobile phone users in the area. In another example of the use of mobile phones for hazard alerts, the Japanese city of Yokosuka delivers information, including map and location information, to mobile phones via the Internet. New projects include the use of broadband for disaster warning. Korea is developing a means of disaster warning via Terrestrial Digital Multimedia Broadcasting (T-DMB) (see Box 7.3).

Box 7.3. **Korea Disaster Warning System with Terrestrial Digital Multimedia Broadcasting**

T-DMB is a technology for broadcasting digital content to mobile devices such as mobile phones, PDAs and moving vehicles. The digital content includes video and audio services as well as data services such as weather forecasts or news. Mobile TV in cars and buses was successfully tested in the metropolitan area of Seoul and commercial services were launched in the second half of 2005.

When disasters occur, T-DMB broadcasting stations convert disaster warning information into DMB format data which are transmitted to automatically activated T-DMB receiver devices. The receiver devices display information on the screen and check disaster warning information periodically. The advantages of T-DMB include spectrum efficiency (national coverage with single frequency network), easy installation and wide coverage.

Source: ETRI (2005), Korean Ministry of Information and Communication.

When different public agencies and emergency services want to combine disaster warning systems, they often face the problem of incompatible communication systems owing to the use of different networks, frequency bands or radio technologies. This can seriously impede the transmission of disaster warning, with severe consequences. To solve the problem there are four main approaches: use of the same systems, of gateway devices, of software-defined radio (SDR) or of an interoperability system[6] that relies on IP networks.

SDR developments allow multi-mode terminals to support a wide range of radio standards seamlessly (ITU, 2005). A single device can thus provide different services which were previously only available through different products. The interoperability system relying on IP networks ideally integrates different push-to-talk radio systems with other communication systems like voice, data (used in GIS for example) as well as images and video devices (Cisco, 2005a). The integration is done by converting voice communication on radio and other devices into data traffic over networks (Markhoff, 2005). Each radio channel is mapped to an IP address, for example. This approach is independent from the underlying technologies and can be used on a geographically broad area (Cisco, 2005b).

All of these approaches make communication between different public agencies and emergency services easier and faster. Technology can contribute to better communication between agencies but it cannot replace a framework that determines the co-ordination of different agencies and services in case of natural hazards. The effectiveness of new technology applications will increase if clear, preferably global, policies for disaster preparedness and warning are implemented to determine which agencies are responsible for which task and at which time. Learning from recent disaster management experience (hurricanes, tsunami) will also help improve future management.

Emerging issues

On the technological side, disaster prevention and warning technologies will improve with advances in information, bio- and nanotechnology and their convergence. As computing processing power increases, costs will decline and larger amounts of data generated by different disaster prevention and warning technologies can be processed, visualised and included in the decision-making process. Moreover, new devices will be developed, and nanotechnology applications will likely make these devices lighter and more powerful.

Effective future disaster warning systems have to cope with two important characteristics of disasters: their increasingly international dimension and the multitude of types of disaster. International co-operation needs to be strengthened to maximise knowledge transfer and take full advantage of observation and monitoring instruments. In addition, disaster warning systems should be able to detect different disaster types. The Indian Ocean tsunami warning system, for example, is currently only conceived for tsunami warnings. This entails large investments for a single type of disaster, yet it may be many years until the next tsunami. The development of a tsunami system for the Indian Ocean should be part of a global ocean disaster warning system that also detects other disaster types, storm surges for example, by upgrading the Global Sea Level Observation System (GLOSS) which observes long-term sea level and ocean circulation (Alversen, 2005). Creating global systems, however, entails challenges. Besides the cost of a system that is always available, there are issues such as co-ordination of the activities of different countries and security considerations. Scientists from different fields would have to work together and commit to a common project. Furthermore, national warning centres need to be integrated and the system adapted to their needs and conditions, as disaster warnings are transmitted at a regional and local level.

It is also essential to train local emergency agencies to communicate disaster warnings and to educate the public on how to use information on natural hazards and how to respond to disaster warnings through the media, schools, hospitals and local public authorities (OECD, 2003). Only if the whole process of disaster prevention and warning, from the detection of natural hazards to communication of warnings and appropriate behaviour by the public, is effective can disasters be mitigated or avoided. Disaster prevention and warning is only as strong as the weakest link in the warning chain.

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Participative Web

The Internet is entering an era of increased participation and greater interaction among Internet users. Various developments confirm this evolution, notably Web 2.0 and virtual communities, with Internet users becoming more active in developing and distributing Internet content.[7] Web 2.0 is increasingly seen as a comprehensive platform for Web service applications. Software is no longer delivered as a product but as a service, such as knowledge networks (*e.g.* Wikipedia) or content-sharing sites which use the Internet as a delivery platform. The underlying technology, which consists of lightweight programming models, is an important driver. Another important characteristic is the increasing number of contributions from individuals (O'Reilly, 2005). The term "virtual community" refers to a group of individuals sharing a common interest via online services. These include email, podcasts, blogs, forums and chat rooms. As Internet access has increased, the concept has become more and more popular. These practices reflect the changing attitude of Internet users. Instead of passive consumption, users participate actively in developing open source software, creating content and customising the Internet. This new behaviour pattern, which applies both to individuals and to companies, is known as participative Web.

Participative Web comprises various services and applications (see Table 7.2 for illustrative examples). Among these services, blogs are the most cited textual applications and are very popular among users who create digital content (see Table 7.3 for a ranking of the most visited UK sites in February 2006). However, Hoem (2004) highlights that textual applications were only the starting point of a cascade of activities: participation via textual

Table 7.2. **Examples of participative Web services and applications with varying levels of user involvement**

Application	Definition	Examples
Online forum	Web service that enables post- and reply-based discussions	Online discussion forums and bulletin boards such as the UNDP Vietnam Discussion Forum
Chat/Instant messaging	Service that provides Internet users a venue for real-time communication	Chat platforms such as IRC and instant messaging services such as MSN and AIM
Feed reader or aggregator	An application that collects and aggregates syndicated content (usually via RSS, Atom) into a consolidated view	Feedreader, NewzCrawler or Web-based aggregator such as BlogLines
File-sharing service	Platform allowing content sharing between users	Video-sharing sites such as YouTube and various P2P applications
Tagging service	Service that tags information on the Web	Bookmarking services, photo management services such as Flickr
Social networking site	Web service that enables users to create profiles, connect with friends and join and interact with various communities	MySpace, Facebook, Friendster
Blog	Type of Web page usually displaying date-stamped entries in reverse chronological order	Daily Kos, BoingBoing
Podcast	Audio segment on Web sites for downloadingindividually or via subscription	Podcasts made by individuals and by corporations, PodcastAlley
Knowledge network	Network of Internet users where users add value to the network by exchanging knowledge	Open source software collaboration, Wikis (Web sites that allow users to add content such as Wikipedia), professional knowledge networks such as InnoCentive
Bundling service	Services that provide a set of some of the applications listed above	Cyworld, TagWorld, LunarStorm

applications, then images, recently also podcasts and finally moving images. OhmyNews, a Korean Internet news service with more than 30 000 citizen journalists, and Wikipedia, a free online encyclopaedia, are examples of textual applications that depend significantly on the participation of Internet users. Image-sharing sites such as Flickr or Fotolog also rely on active participation by users. As an audio application, user-created podcasts are increasingly popular. A further step will be moving images as a combination of visual and audio applications. Footage from individuals at the scene of a natural disaster is already used.

Table 7.3. **Blogs and personal websites, net communities and chat monthly, UK rankings, February 2006**

Rank by number of "visits"

Rank	Blogs and personal Web sites	Market share %	Net communities and chat	Market share %
1	MSN Spaces	36.0	MSN Spaces	8.6
2	BlogLines	31.6	MySpace	8.5
3	MySpace - Blog	4.7	Bebo	6.7
4	LiveJournal.com	3.9	Piczo	5.5
5	LiveJournal Community Center	1.8	Faceparty	5.0
6	Blogger	1.8	Friends Reunited UK	3.7
7	Xanga	1.4	MSN Messenger	2.2
8	CarrieLynne's World	1.4	MSN Groups	2.2
9	Yahoo! 360	1.2	hi5	2.1
10	LiveJournal's Photo Hosting Service	0.7	Yahoo! Groups	1.9

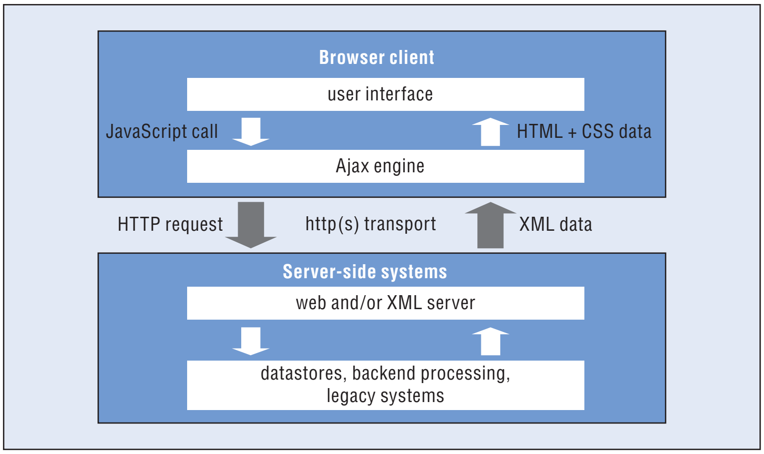
Source: OECD based on Hitwise. Ranks by "Visits", 2006.

Several factors have contributed to greater use of these applications and greater involvement of Internet users. First, the number of broadband subscriptions throughout the OECD area increased in the first half of 2005 from 119 million to 137 million (see OECD Key ICT Indicators and Chapter 5), as prices have declined. The availability of (partly free) easy-to-use software allows users to create content inexpensively (Herring *et al.*, 2004). Participative Web is also supported by Web development techniques like Ajax and XML (Extensible Markup Language) file formats, mainly RSS. Both Ajax and RSS play an important role.

Ajax (Asynchronous JavaScript and XML) is a Web development technique for interactive Web applications which encompasses different technologies. Ajax incorporates XHTML (eXtensible HyperText Markup Language) and CSS (Cascading Style Sheets) for standards-based presentation, the Document Object Model for interaction, XML and XSLT (Extensible Stylesheet Language Transformations) for data interchange and manipulation, XMLHttpRequest (Extensible Markup Language Http [HyperText Transfer Protocol] Request) to retrieve data asynchronously from the Web server as well as JavaScript (Garrett, 2005). The main advantage of this technique is that "Web pages are dynamically updated without a full page refresh interrupting the information flow" and allows creating "richer, more dynamic Web application user interfaces" (McCarthy, 2005). This can be achieved by an Ajax engine which is interposed between the user and the server (Figure 7.5). New Web applications like Google Groups, Google Maps and Flickr (a photo-sharing Web site) are based on Ajax.

The abbreviation RSS can refer to three different terms: Rich Site Summary, Really Simple Syndication or RDF (Resource Description Framework) Site Summary. RSS is an XML (Extensible Markup Language) file format for content syndication. RSS files, also called feeds, transmit structured data which typically include headlines, dates, authors, content summaries and links to the full versions (Bowman, 2003; Gill, 2005). Users can subscribe to a feed and transform the transmitted data into information via a RSS reader. The latter usually aggregates data of a number of feeds and displays a list of new entries with short descriptions and a link to the full text version.

Figure 7.5. **Ajax Web application model**



Source: OECD, based on Garrett (2005).

The first RSS versions (RSS 0.9 and RSS 0.91) were developed by Netscape in 1999 with a view to publishing news headlines or content summaries on Web site portals (Gill, 2005). As Netscape lost interest, UserLand created another RSS 0.91 version for blogging software in June 2000 which was incompatible with Netscape's versions. Finally in 2002, RSS 1.0 was created and again was not compatible with prior versions. In 2002, RSS 2.0 was developed. This version has so far remained unchanged, which significantly facilitates the work of feed reader developers.

RSS files are important both for content creators and readers. On the one hand, content creators are able to easily syndicate content for RSS readers. Often, RSS tools are already integrated in publishing software. On the other hand, readers are able to personalise Web services: they do not have to check Web pages regularly for new entries but are kept informed by their RSS readers. While use of RSS is widespread among content creators, RSS readers, especially for news, are currently only used by early adopters (Business Week Online, 2005a).

A Web page that supports RSS usually has a small RSS or XML icon on the site. News Web pages, blog Web sites, and podcasts that make use of RSS to enable subscriptions have made these icons popular. RSS will increase in popularity when RSS readers are included in Internet browsers.

Blogs

Blogs are currently the most cited application in the present early phase of the development of the participative Web. In the following paragraphs, blogs are defined and classified, and the underlying software and economic and social impacts are discussed.

Although blogs are very popular, there is no consensus on a precise definition of what constitutes a blog. Some definitions only cover online journals (*e.g.* Bowman and Willis, 2003), while others state that the Web page must be updated frequently without specifying the exact meaning of "frequently". The PEW Internet and American Life Project Study on Teen Content Creators and Consumers (Lenhart, 2005) and Gill (2004) define a blog as a type of Web page usually displaying date-stamped entries in reverse chronological order.

The types, purposes and contents of blogs vary widely. Blood (2002) distinguishes three types: filters, journals and notebooks. In filters, the blogger (author of a blog post) comments on external content (Herring *et al.*, 2004) such as world news. Journals, in contrast, reflect the reader's daily life: posts are relatively short and the content is internal to the blogger. Notebooks differ from journals in that posts are longer. They sometimes deal with external content and sometimes with internal content like a longer personal story.

Blogs have four main purposes: one is delivering and/or sharing information. Examples are news blogs, "alternative sources of news and public opinion", and knowledge blogs (k-logs) in organisations and for educational purposes (Herring *et al.*, 2004). Another is reader attraction, a purpose common to nearly all blogs but particularly to news blogs and some personal blogs. Self-expression and self-empowerment is a third purpose and is mainly reflected in personal journals where bloggers note their thoughts and views. The fourth is social network building and social interaction. Many blogs link to other blogs and create social interaction with other bloggers. Compared to emails, blogs facilitate more dynamic interaction and easily include a large group of readers and bloggers. Moreover, compared to chat rooms, any number of individuals can be included. Stating an opinion is also probably easier than in short chat messages.

On the technological level, several tools support the creation and maintenance of blogs. Content management systems (CMS) allow bloggers to create their own weblogs. One important characteristic of CMS is the separation of content from presentation (Machrone, 2005). Content is archived on a database and formatting is only done once the page is built (in contrast to ordinary Web pages). CMS, in the context of blogs often called blogging software, are partly free of charge. Movable Type, WordPress and Nucleus CMS are popular software. Blog-hosting services make it even easier to create a blog by providing online editing and easy-to-use setting up features. The most popular are Blogger, LiveJournal, TypePad and Xanga (InformationWeek, 2005). Technological developments like TrackBack also improve communication among blogs. For example, TrackBack allows automatic notification of references by other blogs.

There are several ways to measure the importance and influence of blogs. Country surveys analyse the blogging behaviour of individuals. Blog search engines and related companies are trying to estimate the total number of blogs worldwide. For example, a survey on US content creators and consumers by the Pew Internet and American Life Project provides demographical data on the popularity of blogs among different age groups. Whereas 27% of adult users declared they had read blogs, 38% of those aged 12 to 17 had done so. While 7% of adult users said they had created their own blogs, 19% of those aged 12 to 17 had done so (Lenhart, 2005). The survey also revealed that teens who blog are generally technically more knowledgeable than their non-blogging counterparts.

According to Herring *et al.* (2004), the first blog with the current format was created in 1996. Jorn Barger, an early American blogger, first used the term weblog in 1997. The

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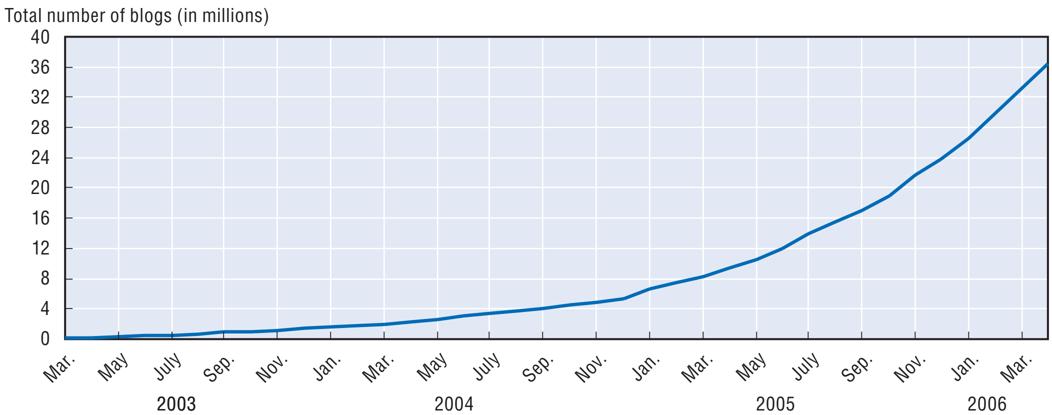
earliest blogging software was issued in 1999. Since then, blogging has increased steadily. By 2002, there were an estimated 500 000 blogs (Gill, 2004). Recent estimates vary between 18 million and 37 million worldwide. The wide variance is due to differences in measurement methods. Blog search engines, for example, track the number of links to blogs and their perceived relevance (*i.e.* they count the number of blogs they effectively identify). Other companies conduct surveys and use blog samples.

Figures 7.6 and 7.7 are based on data generated by a blog search engine. The strength of the data is the fact that blogs are indexed and therefore effectively exist. This means, however, that blogs not indexed by the search engine are not covered; this is especially true for Korea.[8] Figure 7.6 plots the number of blogs from March 2003 to April 2006. During this period, the number of tracked blogs nearly doubled every five months. This rapid development is driven by easy-to-use software and a social network effect, which incites more and more Internet users to create their own blog in order to participate and to express themselves.

Figure 7.6. **The total number of blogs March 2003-April 2006**

Millions



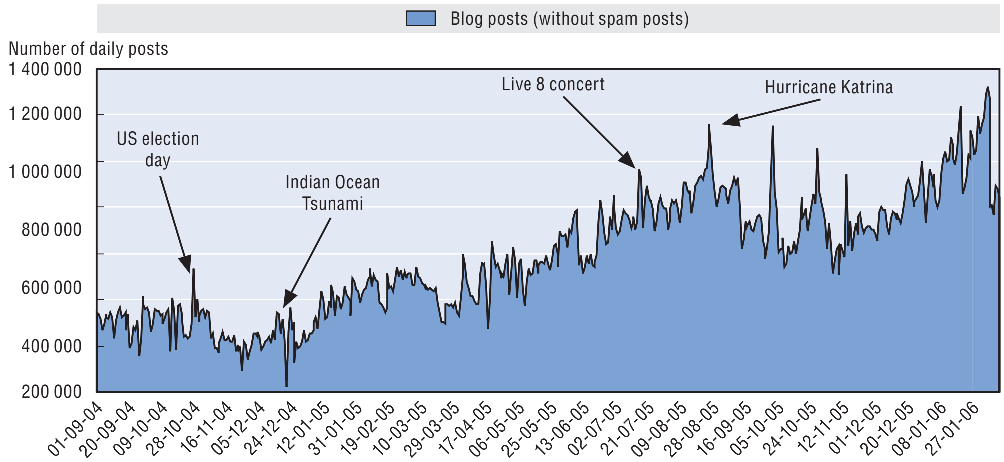
Source: OECD based on Sifry (2005).

StatLink: http://dx.doi.org/10.1787/008771056318

Another way to represent increased participation in blogs is the daily posting volume, *i.e.* the number of individual entries a day. Figure 7.7 plots these for the period September 2004 to January 2006. Its advantage over Figure 7.6 is that it measures bloggers' actual daily activity. The figure illustrates two important points: first, daily posts increased significantly over the last year to over 1 million posts per day; and second, post peaks depend on incidents.

A breakdown reveals that the blogging phenomenon varies significantly between languages. Figure 7.8 plots the language distribution of blogs tracked by a search engine machine and Figure 7.9 represents the use of the Internet per language. Nearly 75% of all blogs are written in English, Japanese or Korean. As mentioned, the data underestimate the number of Korean blogs so that the effective percentage should be higher than 75%. While it is not surprising that English blogs represent 34% given that 32% of Internet users are English-speaking, the number of Japanese and Korean blogs is disproportional to the general use of the Internet (see Chapter 4 for Chinese blogs). There may be several reasons why blogs are so popular among those who speak Japanese or Korean. On the technological side, high diffusion of broadband and hand-held portable Internet access devices such as mobile phones ensure high connectivity to the Internet and enable users to post comments anytime and anywhere. In addition, Japan and Korea are usually early adopters for new information technologies and new services. Furthermore, Korean blog-hosting services often offer a bundle of connected services. Cyworld, for example, with 15 million Korean members (one-third of the country's population) in September 2005, provides a free blog service coupled with other services such as picture sharing and tagging (Business Week Online, 2005b).

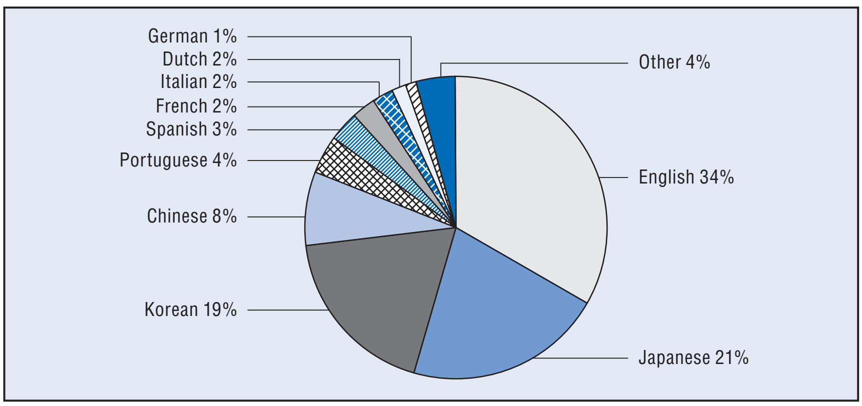
Figure 7.7. **Posts per day September 2004-January 2006**



Source: OECD based on Technorati.

StatLink: http://dx.doi.org/10.1787/303300744306

Figure 7.8. **Language distribution of blogs indexed by Technorati**



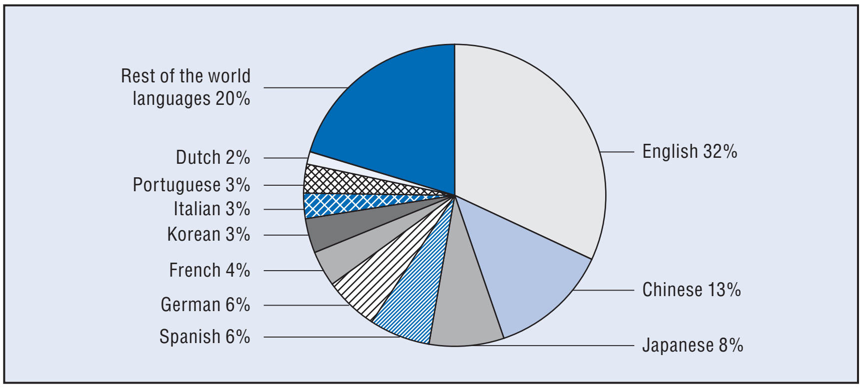
Source: OECD based on Technorati.

StatLink: http://dx.doi.org/10.1787/408783364828

Economic impacts

The development of the blogosphere has economic dimensions: new business models allow bloggers or networks of blogs to make blogging profitable. Companies use blogs in various ways to place classic advertisements for single products or the company's name and are beginning to use new models for advertising purposes. Bloggers currently have two

Figure 7.9. **Internet users per language, November 2005**



Source: Internet World Stats.

StatLink: http://dx.doi.org/10.1787/887201187674

main ways to earn money when blogging: selling their content to a blog or blog network or generating revenue by advertisements on their blog. Content can be sold to news blogs like Korean OhmyNews or to professional blog publishing services like Gawker Media or Weblogs Inc. Weblogs Inc. is a professional network of blogs; bloggers are paid on a freelance basis depending, among other things, on the frequency of updating, and lose their copyright when they sell content. Weblogs Inc. generates revenue by selling advertising space in the form of network advertisements (Google ads, Tribal Fusion) and direct advertisements (Madden, 2005). Although revenues are not formally disclosed, a posting by the founder of Weblog Inc. noted that advertisement revenue amounted to USD 1 000 a day from Google AdSense alone. AOL bought the company in October 2005 for USD 25 million (Reuters UK, 2005). It is more difficult for individual blogs to finance their blogging activity in this way given that the money paid by advertisers generally depends on the size of the readership. Several business services like FM Publishing or BlackIncMedia are offering to provide outsourced business and technical support services.

For companies, blogs offer a variety of advertisement possibilities. As mentioned above, advertisements can be placed on individual blogs with a large readership or on blog networks either directly or via online advertisement services. Furthermore, companies can include blogs on their Web pages to promote a dialogue on the company or a product. However, this marketing tool is questionable, as it is difficult to avoid credibility problems. Blogs dealing with a general topic but sponsored by a company are probably more credible as the content does not deal with a single product or service and as the blogger responsible usually has a private blog and a good reputation. A blog sponsored by the French fashion brand Celio (*http://vousleshommes.blogs.com*) deals with general advice for men. Sponsoring is clearly visible on the site. Employees' blogs are another way for companies to avoid the credibility problem. This is particularly true for blogs that criticise the company, although there have been reports of dismissals for critical blogs. Robert Scoble's Scobleizer blog criticises Microsoft, his employer, and he has a credible image in the blogosphere (Allison, 2005).

Companies also use blogs as an internal communication tool. Compared to other communication tools, blogs have several advantages: they allow rapid communication, do not depend on schedules and largely organise knowledge exchange horizontally. Different R&D teams can for example communicate more easily through blogs than through the traditional hierarchical structure. IBM employees have set up an internal blogging service as well as corporate blogging guidelines. The service is used by more than 9 000 registered users and hosts over 3 000 blogs (Snell, 2005). Beside adequate guidelines, the provision of high-quality information is another challenge. According to Neus (2001), incentives should be provided for high-quality information such as accountability for contributions, personal profile pages, a thematic focus as well as membership criteria.

Social impacts

Blogs are often equated with platforms for exchange of cooking recipes or online journals with very limited readership. However, blogs have important social impacts. One is a contribution to the democratisation of the media through participatory journalism (Bowman and Willis, 2003). Through blogs, individuals and groups can participate in the creation, annotation and selection of news and commentary. Unlike traditional journalists, bloggers are not bound by editorial policy, delays or page constraints and are free to publish what they wish (Hourihan, 2002). Compared to traditional homepages, for which the arguments mentioned above apply as well, blogs make publishing much easier. Thanks to weblogging software, Internet users can create their own Web page with little technological knowledge at nearly no cost. Furthermore, information probably passes faster through the Internet given that many blogs are linked together and that many blogs have subscribers via RSS.

The content distributed by blogs usually differs from the content of traditional mainstream media. Whereas traditional media are organised hierarchically and are generally profit-oriented, the blogosphere is more like an interactive network. Workflow is not dictated and content is not filtered before it is published. This could pose a threat as inaccurate or unethical content can be diffused easily. Blogs use a bottom-up approach whereas traditional journalism follows a top-down approach (Bowman and Willis, 2003). Accordingly, values are different: integrity and profitability are typical values of traditional media whereas collaboration and egalitarianism are values of participative journalism.

Blogs have increasingly shown their influence as a new form of journalism. According to Gill (2005), bloggers have undertaken the role of grassroots reporters and fact-checkers and created a kind of collective databank that influences content in traditional media. Furthermore, some blog sites have a large number of readers and writers and therefore have influence. BoingBoing, one of the most popular blogs , has 1.7 million readers a day, 80% of which read the blog via RSS. Korea's OhmyNews has an estimated half a million readers daily (Lu Stout, 2005). More than 30 000 citizen reporters write articles for OhmyNews.

So far, however, only a few blogging Web pages have a wide readership. Many blogs of the journal type have few readers and are unlikely to influence traditional media significantly. Moreover, the survey of the Pew Internet and American Life Project 2005 shows that 62% of US teens between 12 and 17 years stayed in their personal teen network when reading blogs. Thus, blogs may find it difficult to take a leading media role even though some blogs have the power to affect the news agenda and reach a wide readership. Recent Pew data (December 2005) show that for high US Internet users, who are typically in younger age groups, online news is their major news source and that 20% of under-35 active broadband users have contributed to blog content (Horrigan, 2006). Furthermore, blogs can provide news very fast and are able to give attention to topics that are not treated by the traditional media. For this purpose, blogs do not necessarily need a big readership. It is sufficient to be well linked to other Web sites.

Blogs also have an important social role as a way for political parties to provide information on the party and candidates but also to raise money. During the 2004 US presidential elections, both John Kerry and George W. Bush had blogs on their Web sites. Kerry created his blog in 2003 and encountered some problems as registration was not required for posting comments (Gill, 2004). Political parties need to use blogs with care to avoid the presence of negative images on their Web pages. Besides special blogs for elections, US parties' Web sites have some eye-catching blogs. The Republican National Committee runs a blog with 25 thematic RSS files for RSS readers. The Democratic Party runs a blog with RSS files for different RSS versions as well as an RSS file for podcasts. According to Gill (2004), blogs on parties' Web sites will probably not have enough influence to motivate people to become politically active. However, they are a rapid and inexpensive way to keep the public informed and to appeal for its engagement.

Emerging issues

As the number of blogs rises, the spam phenomenon, which was originally associated only with email, is entering the blogosphere. "Splogs", a combination of blog and spam, are *weblogsites* with faked articles which the author uses only for promoting affiliated Web sites. Content is randomly composed using catchwords that appear on a search engine. For an Internet user searching for example for a lock and key service, a splog would try to maximise the number of words related to this service and thus get the reader to click on links to advertisements. In October 2005, the blog-hosting service "Blogger" received an avalanche of 13 000 spam blogs created on a single weekend (Noguchi, 2005). In order to increase their popularity on search engines, splogs link to many other Web sites. Google and Yahoo! are trying to improve their search mechanisms. Technorati sorts out identified splogs when counting the total number of blogs. Spam in blogs is a form of spam, that is usually random comments having nothing to do with the blog's topic and tries to advertise or to get the reader to click on a link (Noguchi, 2005).

Blog spam functions differently from spam email. Users do not automatically receive it on their computer; they must click on the splog or blog with comment spam. Furthermore, such spam does not currently represent a security problem as it does not transmit viruses. It provokes confusion on search engines and loss of time, but costs should be lower than costs of e-mail spam. However, serious problems may arise from faked or manipulated information aimed at influencing bloggers, as shown by a UK survey which indicated that 77% of UK consumers would use information from blogs for their purchase decision (New Media Age, 2005).

The convergence of nano-, bio-, and information technology

The end of the 20th century was marked by crucial innovations in information technology, biotechnology and nanotechnology. Information technology "prepared the ground for the computer, cell phones and the Internet" and has developed to handle very large databases, computations and data transmission at very high speeds (Nordmann, 2005; Roco and Bainbridge, 2003). Some of these developments are the source of many of the advances discussed in preceding sections. Biotechnological developments have paved the way for targeted and personalised drugs and diagnostic testing as well as innovations in agriculture and food. For its part, nanotechnology is becoming part of other technologies and contributing to the development of new materials, electronics, pharmaceuticals, chemicals, aerospace and tools. It is expected to represent a market of USD 1 trillion by 2015 (OECD, 2004a).

All of these technologies enable R&D, innovation and economic growth, and exploiting the huge potential of their convergence is a major challenge. Nanotechnology involves the creation of tiny structures and contributes to the miniaturisation of many other structures and processes. It can therefore be of value to every technology that can gain from miniaturisation and molecular-level applications. Information technology provides the modelling and computing power for complex processes and problems. Biotechnology detects structures as well as the chemical-physical processes in living systems (Nordmann, 2005). Convergence of these technologies is already having significant impacts and they are likely to increase. Large-scale computing played an important role in mapping the human genome and led to rapid completion of this project. The application of bioinformatics in drug discovery and development is expected to reduce some R&D costs by approximately 30%, so that more resources can be allocated to promising fields (BCC Research, 2005).

The discussion of the convergence of nano-, bio-, and information technology begins with an overview of studies and reports. It then presents some applications and describes in more detail two applications, microarrays and neuroprosthetics, before dealing with social impacts.

Overview of converging technologies

Most reports dealing with converging technologies study an individual technology. The term converging technologies (CT) was first used in this context during two workshops held by the US Department of Commerce and the US National Science Foundation, and in the follow-up report, *Converging Technologies for Improving Human Performance* (Roco and Bainbridge, 2003). CT was defined as "the synergistic combination of nanotechnology, biotechnology, information technology and cognitive sciences (NBIC)".[9] The report states that significant convergence could lead to "a tremendous improvement in human abilities, societal outcomes, the nation's productivity, and the quality of life". Benefits include new organisational structures and management principles thanks to efficiency gains in communication, advances in robotics, machines that adapt to changing situations and wearable sensors that enhance awareness of potential hazards and the individual's state of health. More futuristic ones include the ability to control the human genome or establish broadband interfaces between human brains and machines. That report was criticised as being highly positivistic, futuristic and blurring the frontier of reality and science fiction (NSF/DoC, 2002; Royal Society, Royal Academy of Engineering 2004), and as largely avoiding "discussions of ethical, legal or social issues related to NBIC" (Coenen *et al.*, 2004). However, it initiated a range of activities and reports regarded as the starting point of CT research.

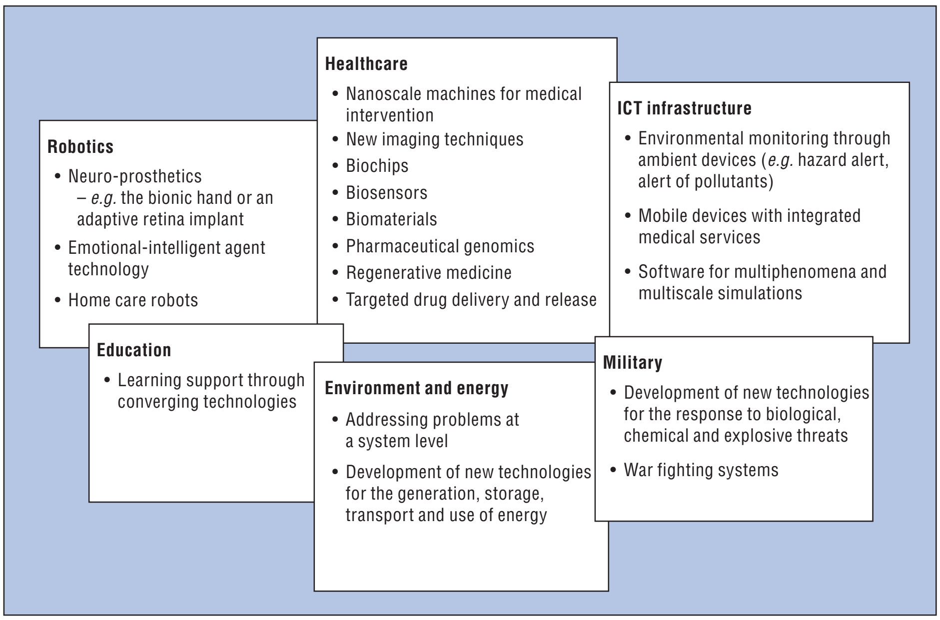
In 2003 the EU set up a high level expert group on "Foresighting the New Technology Wave" to deal with questions raised in that report and contribute to implementation of the Lisbon Agenda.[10] In 2004, this group published "Converging Technologies – Shaping the Future of European Societies" (Nordmann, 2005), the starting point in the EU for debating challenges relating to CT (Coenen, 2004). The European approach is called CTEKS (Converging Technologies for the European Knowledge Society) and besides nano-, bio- and information technologies, it includes social sciences and humanities as well as other enabling technologies and knowledge systems. The European report speaks to the importance of societal needs, which must be considered in order to enhance the European economy and to preserve cultural diversity. It is critical towards brain implants or interfaces between brains and machines (Coenen, 2004).

Economic impacts were seen to depend on technological potential, international markets and social attitudes. Scenario analysis to 2020 identified overall positive impacts in health, education and ICT infrastructure; CTEKS is also expected to have a powerful impact on environment and energy. Whereas CT research in general was "likely to be perceived as beneficial" except for applications that could invade privacy, it was expected to be more strongly contested in environment and energy areas. It was thought that checks and balances should "shape a process of convergence which is malleable and adaptable by its very nature" to ensure that CTEKS applications are targeted and avoid after-the-fact regulation. The report makes 16 recommendations for European policy including inclusion of CTEKS in the Sixth and Seventh Framework Programmes (FP6 and FP7). The first CT project under the nanotechnology priority was expected to start in 2006. Furthermore, CT has been included as a pilot activity in the NEST (new and emerging science and technology) section of FP6, and will probably be taken up in FP7 (Commission of the European Communities, 2005).

Applications

Figure 7.10 shows the main fields of application of converging technologies, and other fields are being continually added. In health for example, CT can increase healthcare efficiency by replacing labour-intensive diagnostics by "biochip" technologies. One application, microarrays, is presented in more detail below, as is the sub-field of neuroprosthetics in the field of robotics, which has seen significant technological progress.

Figure 7.10. **Fields of applications of converging technologies**



Source: OECD based on Nordmann (2005), Roco and Bainbridge (2003).

Microarrays

Microarrays, also called "biochips" or "labs on a chip", are usually composed of a solid support which can be glass, plastic or a silicon component and biological material. As the name "labs on a chip" suggests, they function as tiny laboratories that are able to store biological material (even the entire human genome (Harbert, 2005) and conduct tens of thousands of biochemical reactions simultaneously. There are different types of microarrays. According to Dill and McShea (2005), the most common are DNA microarrays on which snippets of DNA are stored or synthesised. There are also peptide or protein microarrays, as well as other types such as glycobiology and organic chemistry-based combinatorial microarrays. Table 7.4 gives an overview and brief descriptions of the most frequent applications. Gene expression analyses, for example, are used to gain insight into genetic causes of diseases. They are mainly used in cancer research but also for research on cardiovascular disease, immune and inflammatory diseases and central nervous system disorders (Agilent, 2004). Variants of diseases can be detected by confirmation of gene sequences that are present in the sample. Genotyping can, for instance, be used in pharmacogenomics to analyse which variations in the genotype correlate with which response variations to drugs. Another application consists in using aptamers as potential drug candidates owing to their ability to bind to a specific molecule. An application reported to have major potential is the use of DNA chips for diagnostics and personalised medicine (Dill and McShea, 2005).

Table 7.4. **Overview of microarray applications**

Application	Brief description
Diagnostic and personalised medicine	Diagnostic of infectious agents Diagnostic of, for example, drug metabolisation of individuals to aid physicians in drug dosage and treatment selection
Gene expression analysis	Differential gene expression information (*i.e.* which genes are turned on or off in a given tissue or disease state) obtained from pairs of RNA samples
Confirmation of gene sequences	Confirmation of which base pairs (molecular building blocks) are present in the sample, *e.g.* for identifying variants of infectious diseases
Genotyping Single-nucleotide polymorphism (*i.e.* a special DNA sequence variation) analysis and mismatch detection	Determination of which specific gene variations are present Specific genotyping application able to detect a single-nucleotide substitution on a microarray platform
De novo synthesis of DNA	Multiplex synthesis of DNA
Peptide synthesis	Creation of peptide via microarrays
Strain differentiation	Discrimination of specific strains of bacteria, fungi and viruses
Aptamers	Aptamers (small molecules with an affinity for another molecule) for drug development as well as for screening and capturing of proteins

Source: OECD based on Dill and McShea (2005), and Roche Diagnostics (2006).

In January 2005, a DNA microarray, analysing how different individuals metabolise drugs, received the first US Food and Drug Administration (FDA) approval for *in vitro* diagnostics. Then, in March 2005, the FDA published new guidelines that make it easier to get FDA approval for new DNA microarray content. This increased interest in the development of DNA-based tests (Dill and McShea, 2005).

The microarrays market began as a niche market characterised by upscale, high-end products for basic research and drug development, with most firms selling to this market (Harbert, 2005). Estimations on market growth are difficult to compare because of differing definitions of the technology, but they usually include the major instruments and services in the different steps of microarray-based analyses (*i.e.* instruments, reagents and consumables as well as software). The microarray market was about USD 2 billion in 2004 and was projected to grow to about USD 5.1 billion by 2009 (Fuji-Keizai USA, 2005). The point-of-care and clinical diagnostics markets in particular are expected to grow (Harbert, 2005). For point-of-care, companies are also developing simpler and less expensive products and for clinical diagnostics growth is driven by efficiency gains and faster response times. A third "point-of-need" market is emerging for microarrays that are able to detect diseases and toxins; for example, a microarray able to detect strains of avian flu is under development (STMicroelectronics, 2006). An increasing number of semiconductor companies are entering the market as revenue growth is seen as higher than in traditional component and mobile phone markets.

Neuroprosthetics

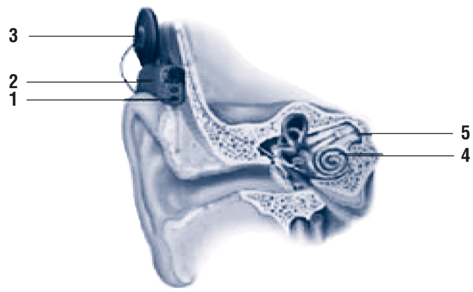
Neuroprosthetics is emerging as a promising example of the convergence of nano-bio- and information technology, which are increasingly integrated in recent research. Neuroprosthetics is a sub-area of the neurotechnology market. Neurotechnology is the application of electronics and engineering to the human nervous system. The total neurotechnology market was estimated to reach around USD 3.1 billion in 2006 and projected to reach USD 7.6 billion in 2010 (Neurotech Reports, 2005).

Neuroprosthetics aims to create interaction between physical devices and neural tissue or the brain in order to augment, restore or otherwise change function (Hall, 2003). Devices range from auditory and visual prostheses to bionic members such as hand prostheses. Nanoscale materials, sensors and microsystems are increasingly incorporated into research projects on neuroprosthetics. For example, the Healthy Aims EU FP6 project aims to develop nanoscale applications for medical implants. Among these implants, auditory devices are currently the most successful. Cochlear implants were the first devices to get FDA approval in 1984 and are widely commercially available. Different forms of visual prostheses are currently under clinical trial and many research teams are working on hand prostheses. Owing to the commercial availability and the advanced development stage of cochlear implants, these devices are discussed in more detail, followed by an outlook on visual implants.

Cochlear implants treat sensori-neural hearing loss which occurs when the cochlear does not function properly and is unable to transfer sounds to create neural impulses (Med-El, 2006). This hearing loss takes different forms, ranging from mild to profound, and is generally permanent. Hearing aids can help in the case of mild to severe sensori-neural hearing loss. Severe or profound hearing loss is usually treated with auditory implants as hearing aids are not an ideal solution. Hearing aids amplify sound which means that only the sounds a person can already hear are turned up. A person with severe or profound hearing loss will not benefit from hearing aids as the sound is still delivered through a damaged part of the ear. The cochlear implant bridges the damaged tissue and sends the sound to the auditory nerve. The implants are composed of several devices: an internal implant that usually comprises an electrode array and the electronics housing and external devices which include a speech processor containing the microphone, the cable and transmitting coil (Med-El, 2006).

The cochlear implant converts sound into electrical pulses that stimulate the auditory nerve. The key technology is a nanoscale biomaterial interface (a silicone elastomer) situated between the metal electrode implant and the stimulated nerve endings (Australian Government, 2005). Loudness is a function of the intensity of the stimulus (Hall, 2003). Figure 7.11 illustrates how cochlear implants operate. The market for cochlear implants was estimated to reach USD 528 million in 2006 and USD 1.07 billion in 2010 (Neurotech Reports, 2005). The upward trend is driven by the rapid growth of implants in children and market expansion beyond the profoundly deaf to the severely hearing impaired. New devices are also being developed which combine a cochlear implant with a hearing aid for persons with little residual hearing who previously had to wait until their hearing loss was more severe (*Business Week*, 2005a, 2005b). Besides the limited target group and the fact that cochlear implants can only be used for sensori-neural hearing loss and not for other forms, current medical reimbursement policies are a challenge: implants may cost USD 25 000 plus equivalent costs for surgery. Current reimbursement levels may be an obstacle both for individuals and surgeons and hospitals (Hall, 2003). Nonetheless, cochlear implants are currently the most successful neuroprostheses.

Figure 7.11. **Mode of operation of cochlear implants**



1. Sound is picked up by the microphone of the speech processor.
2. The speech processor analyses and converts sounds into a special code.
3. This code is sent to the coil and transmitted across the skin to the implant.
4. The implant interprets the code and sends electrical pulses to electrodes in the cochlea.
5. The auditory nerve picks up this signal and sends it to the auditory centre in the brain. The brain recognises these signals as sound.

Source: Med-El (2006).

The field of visual implants is at an earlier stage of development, owing for example to the extreme complexity of encoding three-dimensional objects. Retinal implants aim to restore (partial) vision to persons with retinal diseases (European Commission, 2004). As about 50% of all blindness is due to damage in the retina, there is major potential for epiretinal and subretinal implants (Zrenner, 2002). Epiretinal implants consist of several devices: a tiny external video camera, a processing unit and a component implanted on the innermost layer of the retina which consists of silicon photocells coupled to electrodes (Hall, 2003). The processor translates the visual information from the camera, which could be installed in a pair of glasses, into radio signals which are sent to the implanted component (Termen, 2006). This generates electrical impulses that reach the brain through the optical nerve.

Subretinal implants do not require external cameras or external image processing (Zrenner, 2002). The microphotodiodes of subretinal implants directly replace damaged photoreceptor cells; these may be described as the "light-sensing" cells of the eye which convert light into electrical signals within the retina (Medical News Today, 2005). These electric signals are then "injected" into remaining neurons of the retina network. Both methods are currently in clinical trial. So far, patients have reported improved visual functions, including the ability to detect light and recognise shapes, expansion of the visual field and improved colour vision. Developments in nanotechnology will make it possible to improve these implants further (European Commission, 2004). Retinal implants could be on the market in as soon as three to five years (Medical News Today, 2005).

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Economic and social impacts

Social benefits in the field of health care include the development of new diagnostic possibilities and new ways to treat diseases. New robotic applications make daily life easier. Neuroprosthetics in particular can contribute to better integration of patients in society. Developments in ICT infrastructure allow for better monitoring of the environment through ambient devices. In the area of environment and energy, CT enable the development of new technologies to secure energy supply.

CT also entail challenges. Besides the inherent risks of the technologies involved (see OECD, 2004a, for a discussion of issues related to nanotechnology health hazards and fears of "grey goo"), these include: *i)* cross-disciplinary and cross-sectoral research has to be organised across widely differing companies and research institutions; *ii)* new applications need to be cost-effective and have commercial or quasi-commercial promise; *iii)* social acceptance and ethical concerns for human integrity and dignity have to be addressed in some application fields (*e.g.* blurring man-machine boundaries). These and similar challenges will determine to what extent new and promising applications are developed, the extent to which they are commercialised and used, and their final acceptance and uptake.

Conclusion

This chapter examines ubiquitous networks, location-based services, natural disaster prevention and warning technologies, the participative Web and the convergence of nano-, bio- and information technology within the framework of emerging technology applications.

All these technology applications are increasingly interlinked and converging, and ICT plays a fundamental role in the interaction of the different technologies. There is very large potential for the development of new applications but their increasing complexity and uncertainty about their development paths makes the impact on the economy and society difficult to assess. There is for example a tendency towards greater interconnectedness and tracking of persons and objects. While this allows fast reactions (*e.g.* in the field of disaster prevention and management) it can transform social structures significantly and challenges privacy.

At the same time, the Internet paves the way for more interaction, participation and exchange of information and opinion. This may transform the way content is perceived and used in daily life. The participative Web automatically provides more visibility to content to which users attribute high importance (*e.g.* Google, Technorati). While traditional media rely on centralised human decision making (*e.g.* editorial committees, TV programme directors) for prioritising content, the participative Web makes it possible to reflect users' interests more directly. Online content produced by Internet users, including discussions, opinions and debates, has reached critical mass. This enormous conversation addresses all possible topics and, as such, affects all aspects of society, business, education and politics. Search for information on a given subject retrieves a vast amount of data and opinions and potentially sensitises users to complexity.

Developments in the areas analysed are only at their beginning but as they mature they will have an impact on how converging technologies are perceived and be addressed.

Notes

1. However, a distinction is often made between RFID and contactless smart cards, see for example *www.smartcardalliance.org/pdf/alliance_activities/rfidvscontactless_final_121704.pdf*.
2. Reports by AMR Research and ABI Research.
3. For instance Katherine Albrecht, a vocal opponent of RFID, in Albrecht, K. and L. McIntyre (2005), "Spychips: How Major Corporations and Government Plan to Track Your Every Move with RFID", Nelson Current, Nashville, Tennessee.
4. Integrated Regional Information Networks, part of the UN Office for the Coordination of Humanitarian Affairs.
5. A disaster is plotted in Figure 7.4 when at least one of the following criteria is fulfilled: ten or more people are reported killed; 100 people are reported affected; there is a declaration of a state of emergency; international assistance is officially requested (EM-DAT: The OFDA/CRED International Disaster Database, *www.em-dat.net*).
6. This new system, called Internet protocol interoperability and collaboration systems (IPICS), was developed by Cisco and has been available since December 2005.
7. See papers from the conference, "The Future Digital Economy: Digital Content Creation, Distribution and Access", where this new development was a major theme: *www.oecd.org/sti/digitalcontent/conference*.
8. The Korean market is dominated by a few service providers, which are reluctant to provide data on their business, making it very difficult to get information on the number of blogs.
9. Although some reports use an expanded definition of converging technologies, this section uses the term with a focus on nano-, bio- and information technology.
10. European strategy for a European knowledge society and a knowledge-based economy.

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Table of Contents

Boxes

Tables

 OECD INFORMATION TECHNOLOGY OUTLOOK 2006 – ISBN 92-64-02643-6 – © OECD 2006

Figures

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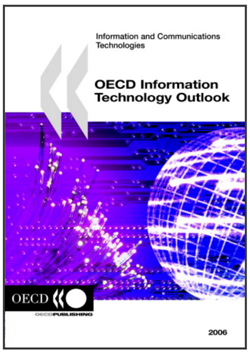

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