CHAPTER 2.
INFORMATION AND COMMUNICATION TECHNOLOGIES FOR DEVELOPMENT

2.1 ICTs in Our Lives

The convergence of development practice and the use of ICTs for sustainable and inclusive social and economic development is the newly emerging discipline of ICTD. The field emerged as a discipline during the last quarter of the twentieth century, and so, when compared to other fields of knowledge, it is still young and draws its knowledge base from several disciplines leading to both its interdisciplinary nature and its complexity.

Box 5. How ICTs have transformed our lives

Picture this:

A digital picture taken in Bangladesh on a mobile phone camera is transferred to a laptop computer. Though the Internet, the picture is e-mailed to a person in India and as a multimedia message to a person in Brazil. The picture also reaches international broadcasters through search engines such as Google. In one part of the world, the picture is used in a document, somewhere else it is inserted into a video production; elsewhere it is burned onto a CD and sold. In South Africa, the production is sent to South Africa Broadcasting Corporation and is broadcast across the country. Someone in the United Kingdom captures a single frame of the production as a digital still and he e-mails it to a friend traveling in the Pacific carrying a Web-enabled mobile phone. They in turn e-mail to a friend in Zimbabwe who mounts it on a local website. A person in Canada copies the picture from their site, puts it in a magazine and later is sued because the picture is found to be copyright protected. All of this is done within 24 hours.[62]

Or picture this:

A doctor from a remote rural area urgently needs expert medical advice to treat a poor patient who developed cardiac complications after the delivery of her third child. The doctor could not properly diagnose her condition due to the lack of proper medical equipment at the district hospital. Using the high speed communication links on a satellite link between the rural facility and a high specialty urban hospital, doctors at the latter location were able to diagnose and advise treatment—a possibility unheard of a decade ago.

The rural doctor, encouraged by the possibilities offered by the technology undertook a continuing medical education course through the distance mode and within a few years was able to provide expert medical advice without leaving his practice in the rural village.[63]

The two experiences described in box 5 illustrate both the excitement and the potential transformation that ICTs have brought into our individual lives. Today, an inexpensive mobile phone in the hand is enough to access these benefits; a person does not need a complex or expensive computer or access to high speed Internet. And if ICTs can be used for communication and for pleasure, they can also be used to speed up and ease the process of development.

62 David Walker, former Education Specialist for the Commonwealth of Learning, in a speech in 2003, used with permission from the author.

63 The author has observed several telemedicine initiatives in operation in villages of Andhra Pradesh and elsewhere in India. This description is a composite of several such observations.

2.2 Understanding ICTs – Scope and Definitions

What are these ICTs and what is the current understanding of their capabilities? ICTs are defined in so many ways in development literature that it can become quite confusing. Often, the term "ICTs" is used to describe the use of computers and the Internet. Sometimes, the term "ICTs" is associated with the most sophisticated and expensive computer-based technologies, and at other times, conventional technologies such as radio and TV and telephony are included in the discussions. Definitions of ICTs vary widely, depending on contexts and conditions of use.

A more comprehensive definition is available from TechTarget,[64] an online leading global technology media company catering to the specialized needs of the ICT market. TechTarget, which places emphasis on the different types of technology, describes ICTs as:

> An umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning. ICTs are often spoken of in a particular context, such as ICTs in education, health care, or libraries. The term is somewhat more common outside of the United States.
>
> According to the European Commission, the importance of ICTs lies less in the technology itself than in its ability to create greater access to information and communication in underserved populations. Many countries around the world have established organizations for the promotion of ICTs, because it is feared that unless less technologically advanced areas have a chance to catch up, the increasing technological advances in developed nations will only serve to exacerbate the already-existing economic gap between technological "have" and "have not" areas. Internationally, the United Nations actively promotes ICTs for Development (ICT4D) as a means of bridging the digital divide.[65]

For the purpose of discussion and clarity, it would be useful to accept the definitions provided by the UNDP in 2003:

> ICTs are basically information handling tools—a varied set of goods, applications and services that are used to produce, store, process, distribute and exchange information. They include the "old" ICTS of radio, television and telephone, and the "new" ICTs of computers, satellites and wireless technology and the Internet. These different tools are now able to work together, and combine to form our "networked world", a massive infrastructure of interconnected telephone services, standardized computer hardware, the Internet, radio and television, which reaches into every corner of the globe.[66]

64 TechTarget, http://www.techtarget.com.

65 SearchCIO-Midmarket.com, "Definition: ICT (Information and communications technology - or technologies)", TechTarget, http://searchcio-midmarket.techtarget.com/definition/ICT.

66 UNDP Evaluation Office, *Information Communications Technology for Development, UNDP Essentials: Synthesis of Lessons Learned* (New York, 2001), p. 2.

Traditionally, it was possible to distinguish ICTs in terms of their particular features (text—print; audio—radio; audio-visual—TV). But since the 1990s, such distinctions have become blurred as convergence, or the blending of what were discrete media, onto a single platform has become a reality.

With the rapid developments in technology, traditional analogue systems (signals based on continuous variance in both time and amplitude) have given way to digital systems that convert signals into discrete blocks, minimizing noise and distortion. Today, "digital" refers to digital electronic systems; and many previously analogue systems, such as magnetic tapes, have converted to digital-based technologies.

At this juncture, it is important to recognize that ICTs are now a part of everyday life beyond the typical uses referenced earlier. The evolution and use of ICTs have refined and redefined many traditional industry sectors and have made considerable impact on how industries and sectors operate and/or are managed.

These range from traditional sectors such as agriculture, where ICTs make crop management easier by helping to analyse and predict optimum planting and harvesting conditions. Technologies are also available to help run and monitor industrial processes such as factory and building management systems, which can control internal and external access to rooms and offices, and manage heating/cooling and lighting systems to save and conserve energy. ICTs are used in modern motor vehicles to control the efficient running of the vehicle's engine and fuel systems, and help guide drivers (e.g. through the use of parking sensors and global position systems [GPS]). All these systems use ICTs in various forms to function, to increase efficiency, as well as to relay information to other systems and the user, in order for appropriate decisions and actions to take place.

ICTs can be further unpacked into technologies, applications, services and content. The development of newer and faster computers and mobile phones running multiple applications, the building of more wireless towers, the laying of more fibre optic cables, and the embedding of smart sensors and related technology in various everyday items from cars to fridges form part of the ICT infrastructure and must be seen as part of technologies.

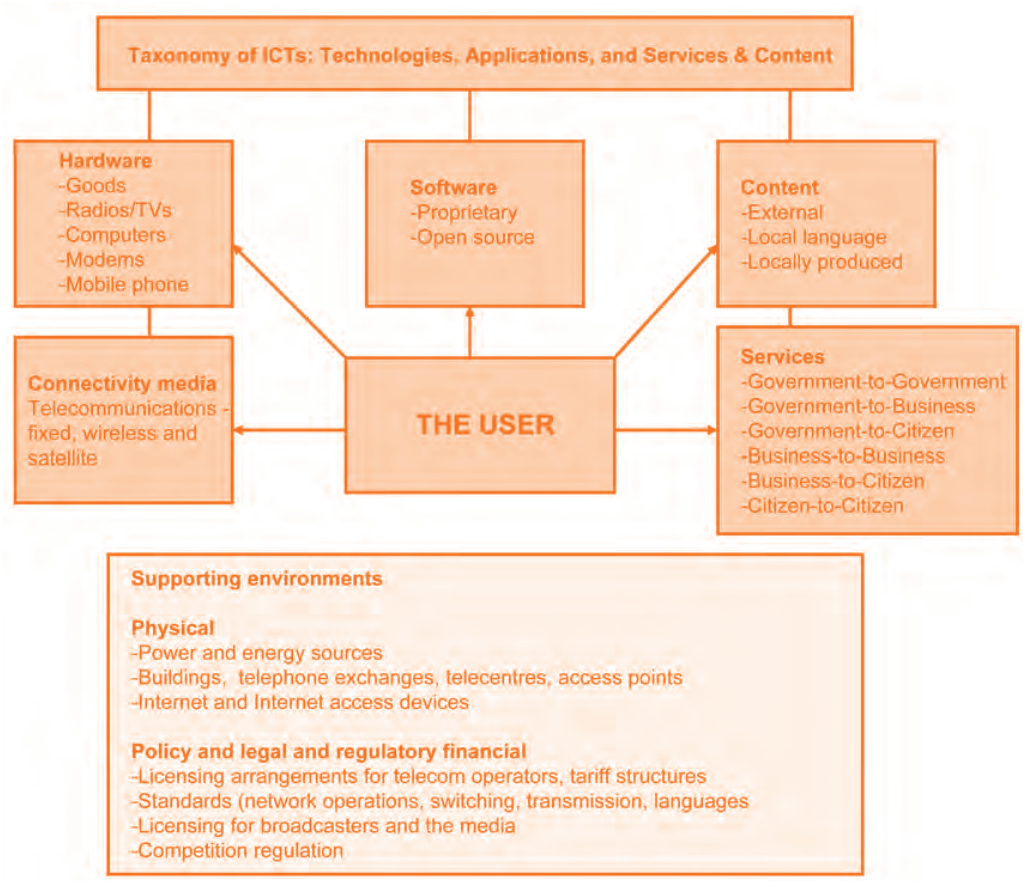
The development of software applications both in English and in local languages, whether these are proprietary or created from Open Source[67] consist of applications; and the tools provided through the technologies or the content of the applications—whether for business or for e-government—are the services that can be provided through the technologies or the applications. What forms the substance of the services is the content that is available or made available through the ICTs as carriers. For a user or citizen to benefit, there has to be a link between each of the elements of the taxonomy and the citizen.

To function successfully, ICTs require supporting physical, policy, legal, regulatory and financial environments. ICT systems require stable electricity, cables and wires, wireless solutions to run on, and buildings to house them. Appropriate technical resources to build, deploy, operate and maintain such systems are also required. Other enabling environments include laws and implementation norms, whether these are in licensing, competition norms and processes, revenue sharing mechanisms, or intellectual property rights (IPR).

Figure 7 describes ICTs in terms of their empirically observable and measurable characteristics.

67 There are many definitions of Open Source Software. Essentially, open source refers to computer software that is distributed under a licensing arrangement and which allows the computer code to be shared, viewed and modified by other users and organisations. For more definitions, see http://www.google.co.in/#hl=en&q=Open+source+software&tbs=dfn:1&tbo=u&sa=X&ei=qq_dTaGlC4i8vwPRtcW_BQ&ved=0CBgQkQ4&fp=2f48aba968b63bb2&biw=1280&bih=586 (accessed 26 May 2011).

Figure 7. Typology of ICTs



Credit: Usha Rani Vyasulu Reddi, 2011.

2.3 Unpacking the Technologies

Any person with a small mobile phone in hand, or a personal computer (PC) has the ability to access a world of information. This is done through a seamless network of technologies, applications, services and content, interlinked through a grid of telecommunications technologies. While it is immaterial to the final user as to how the system works, as long as it delivers what is wanted; for a student or for a provider of development services, a broad introduction to the diverse technologies and an unpacking or unbundling of the various terms is critical to understanding the conditions and contexts of their applications and effectiveness. This section explores the common understanding of the various terms used in figure 7.

Essentially, ICT devices and applications are used in the production, storage and sharing of information and knowledge. They consist of hardware and application software that run the hardware and also enable development of content. Together they enable the provision of services to the user through connectivity media. Underpinning the entire process is a set of supporting environments—physical, policy, legal and regulatory, and financial frameworks. Let us examine each in some detail.

Hardware

Hardware can be classified into:

- Information capture devices, e.g. cameras, keyboards, microphones and recorders, and scanners.
- Information storage devices, e.g. servers, hard disks, and external storage devices such as films and tapes, CDs, DVDs, memory sticks and memory cards.
- Information sharing devices, e.g. radios, TVs, telephones—fixed and mobile, hand-held devices such as e-book readers, and computers, including laptops and tablets.

Computers and mobile phones with their capture, storage and sharing capabilities have become very powerful hardware tools.

Software

To run and use the hardware devices, software applications are needed. These can be operating systems or application software. These can be proprietary or open source. Proprietary software is computer software licensed under the exclusive legal right of the copyright holder. The licensee is given the right to use the software under certain conditions, but restricted from other uses, such as modification, further distribution or reverse engineering.

On the other hand, Free and Open Source Software (FOSS) refers to computer software that is available in source code form for which the source code and certain other rights normally reserved for copyright holders are provided under a software license that permits users to study, change and improve the software. It is important to note that the term free software refers to the freedom associated with it (freedom to run the software, redistribute, study, adapt, improve and release the improvements for others to use) and not the price. However, as the source code has to be freely available for use and redistribution, FOSS can usually be obtained at no or very little cost. This has the advantage of freeing up budgets used otherwise for expensive licensed software and their respective upgrades.

There is little value for software vendors to localize or customize software for small markets and languages. However, a FOSS application can be customized to suit local configurations, to display character sets with the use of special fonts, or even perhaps to provide a better user experience through the modification of the user interface. Localization is made easier as there are set language templates that can be created and linked to the software, without disturbing the underlying software code.[68]

- Operating system (OS): When the computer or the hardware device is switched on, it starts the operating system that controls the machine. An operating system is a set of programs that help in controlling and managing the hardware and the software resources of a computer system and other hardware devices. Operating systems can be proprietary; where a company designs, develops and markets it as their own system. Windows is one, Mac OS is another. Operating systems can also be free and open source such as Linux.

- Application Software: Application software is also known as an application or an “app”. These are computer software programs designed to help the user perform singular or multiple tasks. Application suites often come bundled with several applications working together. Examples of proprietary software include Microsoft Office, iWork, enterprise software, accounting software, office suites, graphics software and media players. Examples of FOSS include the Linux OS applications such as Open Office and Firefox.

68 Rajnesh Singh, *Module 4: ICT Trends for Government Leaders,* 2nd edition, *Academy of ICT Essentials for Government Leaders* module series (Incheon, UN-APCICT/ESCAP, 2011), http://www.unapcict.org/academy/.

Content

Dictionaries define content as the subject matter, the substantive information or creative material contained inside a medium—a book or newspaper, a recording or playback device, and as distinct from the medium itself. The medium as a mode of delivery may vary; and the manner and format in which the creative material is presented may vary; but the content will remain the substance as opposed to the manner of its presentation. The medium without the content would be like a hollow tube. Content can be defined as:

- Text – written material
- Audio – sound bytes, pre-recorded materials
- Video – visual, moving TV footage
- Film – visual, moving film footage
- Graphics – graphs, charts, tables, photographs
- Animation – moving graphic animated objects

Content can also be defined as a narrative, interviews, dramatization, and/or any other form of matter. In addition, means of interaction between the creator and the user may also be included.

Content is perhaps the most important element of ICTD activities. Content may be globally, nationally, regionally, or even locally developed and used. It may be pre-recorded or obtained from other sources. It may be recorded originally for the purpose of the programme or project. It may be produced by a single agency for mass distribution over the Internet as in a website, or produced by many for a small group. It may be in an international language such as English, or in a national or local language and produced individually for wide distribution, as in a blog or a social networking site.

Services

Content is developed to meet a set of given requirements or services. Broadly, these can be categorized into information, education and entertainment. Within an ICTD context, the concern here is more with information and education, and less with entertainment. The various types of services that can be provided through the use of ICTs include:

- Government-to-Government (G2G) – Where ICTs are used in a closed system to link and network all government offices to ensure smooth, speedy and effective functioning of the various branches of government.

- Government-to-Business (G2B) – When a substantial percentage of government activities such as public works and services are provided by private firms; the use of ICTs for G2B activities helps governments to improve service delivery, increase cost efficiencies and savings in public expenditure. The use of ICTs in providing G2B services is known to reduce corruption.

- Government-to-Citizen (G2C) – Government's largest interaction is with the citizens of the country for whom government provides services in return for taxes levied. G2C includes information dissemination to the public, basic citizen services such as license renewals, ordering of birth/death/marriage certificates and filing of income taxes, as well as citizen assistance for such basic services as education, health care, hospital information, and libraries, among others.

- Business-to-Business (B2B) – Also known as e-biz when done through the Internet, B2B is the exchange of products, services or information between businesses rather than between businesses and consumers.

- Business-to-Citizen (B2C) – A B2C business is one that provides products or services direct to the consumer.

- Citizen-to-Citizen (C2C) – When citizens and citizen groups use ICTs, whether the Internet or the mobile phone, to communicate and network with each other for a particular cause or to share information about issues of public interest.

Most of these services today are enabled either by using the Internet or mobile technology as platforms.

Connectivity Media

The power and capabilities of ICTs come from linking the different parts to a seamless and convergent network through connectivity media. A network of telecommunications links that includes fixed phone landlines, line of sight transmitters, wireless networks, satellites and fibre optic cables are part of an extensive grid enabling the network. At the user end, connectivity media include cables, modems and routers (internal or external) to a computer or mobile phone.

The Internet rides on this convergent network, using only a small portion of the total portion of telecommunications resources available worldwide. Sometimes called simply "the Net", the Internet is a worldwide system of computer networks—a network of networks in which users at any one computer can, if they have permission, obtain information from any other computer (and sometimes talk directly to users at other computers). Today, the Internet is a public, cooperative and self-sustaining facility accessible to more than 2 billion people worldwide. The most widely used part of the Internet is the World Wide Web (often abbreviated "WWW" or called "the Web"). Using the Web through one of many available Web browsers, an individual anywhere in the world can have access to millions of pages of information.

Telecommunications operate within environments, with physical and infrastructural on the one hand; and policy, legal, regulatory and financial on the other (i.e. the rules of the game). Without going into much detail on each of these different environments[69] it is necessary to understand their importance. The use of ICTs in any social system, especially in developing countries, needs to be placed within a context of supporting environments—physical and socio-political. Without these environments, ICTs cannot function effectively.

Supporting Environments: Physical

Underlying the practical use of current developments in telecommunications and computing are important but related aspects of the physical infrastructure. These are sometimes called the "last mile" connectivity issues. The last mile is the final leg of providing connectivity to a consumer. This could mean simply the cable link from the computer to the nearest telephone pole; it could also mean linking one village to the nearest telecommunications tower through a cable running for more than 1 kilometre. Or it could mean providing a wireless tower whose signals reach the village. The last mile for the telecommunications service provider is often the first link that the user has to connect to the world either through a landline or mobile phone; and if it does not work, there is no connectivity.

Without basic connectivity, there can be no access to the Internet. Stable electric power or alternate energy sources are essential for the use of ICTs. Physical and topographical constraints continue to inhibit line of sight communication especially in hilly terrains, and pose problems

69 The modules of the *Academy of ICT Essentials for Government Leaders* module series explore various aspects of the different environments. For instance, Module 2 explores ICTD policy and processes; Module 3 focuses on e-government applications; Module 4 on ICT trends; Module 5 on Internet governance; Module 6 on security aspects; Module 7 on ICTD project management; Module 8 on the financial aspects of ICTD; Module 9 on the use of ICTs in disaster risk management; and Module 10 on ICTs and climate change abatement. All of these modules are available from http://www.unapcict.org/academy.

of signal strength in wireless communications. Some satellites are highly sensitive to tropical rain storms; and computers in hot dusty climates have to be designed purposefully or they fail. Laying of fibre optic cables is expensive, as is the replacement of outdated equipment. Similar problems arise with access points such as buildings, telephone exchanges and telecentres, as with access devices such as modems and routers. All of these physical conditions impede the practical use of ICTs in development.

Therefore, in parallel with the installation of transmission towers, fibre optic cables and similar wireless technology infrastructures, care has to be taken to ensure that stable electric power is provisioned for; that ground terminals and telephone exchanges and access points are built; and that computers, modems and routers are also provided. Along with establishing infrastructure, maintenance and upgrading of technology is a major issue in developing countries, alongside the building of technical capacity to establish, operate, maintain and update technology.

It is important to recognize that there are other factors, not physical, but socio-political, legal and financial that determine the context in which ICTs are to be used. These, to a large extent, determine the pace and spread with which growth in ICTs takes place; the way in which these technologies are used to meet development goals; and the manner in which the citizens benefit from the economic and social advantages that ICTs enable.

Supporting Environments: Social and Regulatory

Governments have policies, laws, and regulations that govern different sectors of society. A policy can be defined as a guiding principle, a procedure or course of action intended to influence and determine decisions and actions considered to be in the best interests of the society at large. Since it is very difficult to anticipate and plan for new technologies, governments often have to develop policies and procedures sometimes long after the technology is implemented in society. Nevertheless, governments do develop policies and procedures by which such technology will be introduced, implemented or regulated. Take for example an analogy of the aviation sector. If there were no policies and procedures governing the way in which the airways are managed, and if there were no regulations to manage this very important sector, there would be chaos in the skies.

So it is also with ICTs. Governments worldwide are increasingly focused on understanding and managing ICTs as a major economic and social resource. Decisions on how to harness ICTs for development purposes are part of this wide ICT policy. Specifically, the laws and regulations by which this sector is governed are part of the environment in which ICTs will grow, operate and meet societal needs. Therefore, ICTs operate within a set of policies, regulations and procedures that govern this sector, just as aviation policies, regulations and procedures govern aviation. ICT growth in a completely free market will be different from a planned economy; and will be different in terms not just of laws and rules, but also in the way in which financial allocations are made, spectrum allocation (because telecommunications depends on the wireless spectrum) is done, costs of services to the user are regulated, and so forth.

And specifically, without a clear cut ICTD policy in place, it would be difficult to prioritize and promote the use of ICTs for meeting development goals. Without a policy and governance framework, governments cannot measure and benchmark their progress against those of other countries.[70]

70 An extensive discussion of the policymaking process is given in Emmanuel C. Lallana, *Module 2: ICT for Development Policy, Process and Governance*, 2nd edition, *Academy of ICT Essentials for Government Leaders* module series (Incheon, UN-APCICT/ESCAP, 2011), http://www.unapcict.org/academy.

Box 6. India's IT revolution and the role of policy frameworks

The Indian experience provides an example of how fundamental, focused changes in policy and legislation in the IT sector can unleash forces that transformed India.

The IT industry experienced a temporary boost in 1994 when then-Prime Minister Rajiv Gandhi identified telecommunications and IT as a "core sector," together with traditional industries such as electrical power generation, steel, oil and automobiles. Within a few years the National Informatics Centre and the National Centre for Software Technology had been established.

The New Industrial Policy (1991) saw a shift in perspective from a regulated economy to a freer and less regulated private sector. The new policy contributed to the rapid growth of the IT industry.

Internet had been in India for many years in the form of an Education and Research Network. However, it was not possible for many people to have access to it, as it was meant only for the educational and research communities. This followed the policy laid down by the American Internet manager, the National Science Foundation, at that time.

India's telecomunications monopoly, the Videsh Sanchar Nigam Limited (VSNL) introduced Internet in India via dialup in six cities on 14 August 1995. By 1998, India introduced a new ISP policy that ended VSNL's monopoly on the Internet.

Soonafter, the IT Act 2000 was passed by the Indian Parliament, further spurring ICT interventions and innovations. Both foreign portals such as Yahoo and MSN launched Indian sites; while Indian players also created online sites such as Indya.com and Baazee. The large multinational company ITC launched e-Choupal taking Internet to the villages enabling farmers to connect to the market.

States such as Andhra Pradesh and Karnataka took the lead in e-goverment initiatives in procurement, land registration and citizen services, and by 2006, the National e-Governance Plan laid down a policy and a road map for the use of ICT, especially Web technologies for transforming government.

A Universal Service Obligation Fund[71] was created in 2002 and later strengthened. This fund required all telecommunications providers to commit 5 per cent of their gross adjusted revenues to providing basic services to rural areas.

By 2009, the Internet became central to the new vision of India as an IT power in many respects. The uses of the Internet and telecommunications technologies have become central to the growth of the export-oriented software industry that have powered India into a global leadership position.

Adapted and repurposed from Usha Rani Vyasulu Reddi, "The Internet in a Developing Society", in *netCh@kra: 15 Years of Internet in India - Retrospectives and Roadmaps*, Madanmohan Rao and Osama Manzar, eds. (New Delhi, Digital Empowerment Foundation, 2011), p. 155.

That is why it is important to understand that although ICTs seem to be all powerful, they are dependent on various external factors for their use. Their use is also dependent on what each technology's intrinsic attributes and limitations are and how these will impact upon successful use.

71 Ministry of Communications and Information Technology, Department of Telecommunications, "Universal Service Obligation Fund", Government of India, http://www.dot.gov.in/uso/usoindex.htm.

2.4 Attributes of ICTs

When one compares the different technologies, there are both commonalities and differences that determine the conditions of use, and consequently, the likelihood of success or failure in their application. All the ICTs promote individualization of use (different people can have a different use for the technology), enable high speed delivery, wide reach, and have a low cost per unit. Many are distance and climate insensitive; and can serve multiple needs, functions and user groups. However, there are many conditions and factors that enable use of ICTs, these factors range from access and availability, to issues such as literacy and ownership of ICTs. These conditions are summarized in table 4.

Table 4. Attributes and limitations of different ICTs

ICT	Attributes	Limitations
Print technologies	• Familiarity • Reusable • Can provide depth • Allow economies of scale • Allow uniform content and standards	• Limited by literacy • Static in time • Updating difficult • Passive, one way technology with little or no interactivity
Broadcast technologies (radio and TV)	• Familiarity • Speed of delivery • Provides vicarious experience • Allow economies of scale • Uniform content and standards possible • Rugged, ease of use	• Limited access • Static in time, • Require people to be tuned in at the time of broadcast • Updating difficult • Not problem or location specific • Passive, one way technology with little or no interactivity • One size fits all content for all groups of people • High start up, production and distribution costs
Digital (computer and Internet-based technologies)	• Interactive • Low per unit cost • Allow economies of scale • Uniform content and standards possible • Can be updated easily • Problem and location specific • User-friendly • Unbundling of content possible • Enable people-to-people contact (social networking)	• Limited access still • High development costs • Dependent on capacity of providers • Computer literacy essential for use • Lack of local content • Impeded by physical constraints such as stable electric power and bandwidth availability

ICT	Attributes	Limitations
Mobile technologies	• Interactive • Low per unit cost • Allow economies of scale • Uniform content and standards possible • Can be updated easily • Problem and location specific • User-friendly • Unbundling of content possible • Local content possible • Computer literacy not essential for use	• Impeded by physical constraints such as signal strength • Limited by social factor inhibiting access to and ownership of instrument

Credit: Usha Rani Vyasulu Reddi, 2011.

Compared to the older ICTs, digital ICTs are transformationally different. For the earlier technologies such as print, radio and TV, the regulation, shaping and production of content and the delivery methodologies remained one way and in public hands. The new digital ICTs are potentially more open and can be owned and operated by an individual or social group, that is ownership has shifted to the hands of the person who can control the remote, the mouse or the mobile phone, and therefore, vary the purpose for which the technology is being used. At the same time, the user can define the ICT in terms of one's own needs and wants, and in terms of one's own private space. For example, the Internet allows unbundling (no need to buy a whole CD, just download the song and bypass traditional means of dissemination). Similarly, on a mobile phone, it is possible today to download "just that bit of information" and "just in time" to meet a need; and later to simply delete it.

What this has resulted in are structural changes in the way that content is produced, stored, and diffused and disseminated. This leads to diversity in both form and content; and the possibility of localization in terms of language, culture, design, content and use. Because the newer ICTs address the weaknesses of the older ICTs, they are seen as key tools in the campaign toward the achievement of the MDGs.

The variety of use and the number of ICTD initiatives are many. They include the provisioning of access and infrastructure, development of policy and regulatory frameworks, and capacity building. There are also many ICTD initiatives that aim to improve the management and delivery of various sectors including agriculture, climate change abatement, disaster risk management, education, environmental management, gender, government and governance, and health, to cite a few. The uses will be explained in a later section of this primer.

The comparison of attributes and limitations of different ICTs shows that digital technologies have a definite comparative edge as information tools, and for this reason, the exploration of the history of use of these technologies is essential before discussing the contribution that digital ICTs make in addressing developmental goals.

Points To Remember

- ICTs can be defined as a basket of tools—a varied set of goods, applications and services that are used to produce, store, process, distribute and exchange information. They include the older technologies of radio and TV, and the newer digital technologies of computers, the Internet, and mobile phones.
- ICTs can be further classified into technologies, applications, services and content.
- ICTs operate within an external environment that consists of a physical infrastructure such as power and energy sources; and legal and regulatory framework.
- To use ICTs effectively for development, it is necessary to understand their attributes and limitations, and choose the appropriate technology in a development context.

Practical Exercise

An NGO in a small district of a country in a mountainous Central Asian republic is keen on exploring the use of voice mail technologies to deliver messages on preventing pulmonary diseases caused by air pollution to a large segment of the local population. The NGO is unsure as to where to start and how to go about using this mobile technology.

Help the NGO by:

1. Identifying the different hardware that will be needed by the producer of the voice mail, the service provider and the beneficiary for the capture, storage and distribution of voice mail messages. Make a comprehensive list of what you think are absolutely essential, and what are add-ons.
2. Identifying what may be the physical constraints that the mobile technology is likely to face; and what you would recommend as a solution.
3. Identifying what may be the social and cultural barriers to the use of mobile phones for delivering voice mail messages. Identify potential solutions and determine their relative costs, advantages and limitations, physical and social.
4. Modify your list made in question 1, after analysing your answers in questions 2 and 3.

Test Yourself

1. An e-governance portal in your country through which you file a complaint with government would be part of which aspect of ICT?

   a. Hardware
   b. Software application
   c. Content
   d. Service

2. Supporting physical environments for ICTs include:

   a. Laws and regulations
   b. Power and energy, buildings and access devices
   c. Licensing procedures
   d. Open standards

3. Hardware can be classified into:

   a. Capture, storage, process and distribution equipment
   b. Proprietary and open source
   c. Large and small
   d. Websites and networks

4. An "app" is an:

   a. Operating system
   b. Website
   c. Application software programme
   d. None of the above

5. Which of the following is not an attribute of an ICT-based system:

   a. Sensitivity to distance and slow in speed
   b. Low cost per unit
   c. Just in time information
   d. Personalization of system

2.5 Trends in ICTD Evolution and Growth

When Arthur C. Clarke[72] wrote in 1945 of radio broadcasts through extra-terrestrial relays, few would have realized that the transformative power of telecommunications, satellites and computers would impact the world and make it into the "global village" envisaged by Marshall MacLuhan[73] in his pioneering work in 1964.[74] Within three decades and before the arrival of the new century, the information revolution was well underway and moving with a speed that no one could predict.

Predicting the trends in ICTs, their evolution and growth can be a tricky business. The evolution of ICTs has not stopped with the invention of satellites, computers, mobile phones and the Internet. Moore's Law, propounded by Gordon Moore, one of the co-founders of Intel in 1965, described a long-term trend in the history of computing hardware, in which he argued that, at the pace of 1965, technology growth doubled every two years. Today, the law has been reinterpreted to assert that data density is doubling every 18 months. More important than the law is the recognition that technological progress has been so fast that it is hard to predict the course of technology change.

72 Arthur C. Clarke, "Extra terrestrial Relays", *Wireless World*, Vol. II, pp. 305-308 (October 1945). Sir Arthur C. Clarke was a British science fiction writer who lived in Sri Lanka. Famous for his short stories and novels, he was also the author of *2001: A Space Odyssey*, the host of a science fiction series on BBC television, and was considered one of the "big three" of science fiction along with Isaac Asimov and Robert A Heinlein.

73 Marshall MacLuhan was a Canadian educator, philosopher and scholar, known for his writings on communication theory. His work is one of the cornerstones for the study of media theory; and he predicted the global village and the World Wide Web almost thirty years before it was invented.

74 See "Marshall McLuhan Foresees The Global Village", http://www.livinginternet.com/i/ii_mcluhan.htm.

But what one can say with relative comfort is that innovation within ICTs will most likely take place in improved platforms and services, such as cloud computing[75] and Web 2.0[76] applications; and they will fit into a broad umbrella of features discussed below.

Changes taking place in the first two decades of the twenty-first century and the trends that they indicate show that innovation will take place in technology and hardware, and in applications, content, services, interaction, income generation models and the like.

Technology, Hardware and Telecommunications

Earlier models of technology development and diffusion looked largely at PCs connected through a landline or at most, a broadband connection to the Internet. This model proved costly and unfeasible in poor countries as it was neither sustainable nor scalable. Telecommunications links and teledensity was just too limited and too expensive, and supports such as stable electric power were missing.

Innovation in technology development has led to work focused on developing low-specification, low-cost, robust terminal devices that could work in large numbers of poor communities. But these developments in low-cost computing have to some extent been upstaged by the phenomenal growth in mobile technology as today's mobile phones have features that resemble and have the capability of a low-end laptop computer.

Box 7. My phone is my computer

The small mobile phone in the hand of a person is a very powerful device. Not only does it allow us to make phone calls at very cheap rates, but it has many functions, and can serve as a simple calculator and address book, as well as a radio, music and video player. We can send text (SMS), photos and videos (MMS), and voice messages. It can capture, store and share information.

Apart from supporting voice calls, some of the current generation phones can offer functions that include:

- Multimedia recorder and player, supporting music and video recording and playback
- Voice recorder
- Camera, supporting video and still photography, with zoom facilities and high resolution photography; some have two camera's (front and back)
- Flashlight
- Radio tuner
- GPS and compass, for location referencing and navigation

Some more advanced mobile phones, also called smart phones, allow for the ability to install applications with features such as:

- Internet applications: Web browser, e-mail client, instant messaging clients, voice over Internet protocol (VoIP) client
- Personal Information Manager applications: Calendar, To-do List, Alarms, Reminders, Notes and Contacts, Synchronize Tool to connect to Microsoft Exchange and other enterprise-type services

75 Cloud computing is Internet-based computing, whereby shared resources, software and information are provided to computers and other devices on-demand, like electricity. It is also understood to be the use of a Web service to perform the functions that were traditionally done with software installed on an individual computer.

76 Web 2.0 is the popular term for advanced Internet technology and applications including blogs, wikis, RSS and social bookmarking. It also describes the changing trends in the use of Web technology and Web design that promotes participatory information sharing, user-centered design, interoperability, collaboration and creativity on the World Wide Web.

- Productivity applications: word processor, spreadsheet, presentation, Acrobat Reader for PDF files, zip file utility, file manager
- Support for direct printing to Bluetooth or Wireless Fidelity (WiFi) enabled printers
- Support for virtual private networking

To provide such functionality, these smart phones also need to have suitable hardware. Some of the hardware (depending on the model of the phone) includes:

- QWERTY keyboard (physical or virtual), with a layout similar to that of a standard keyboard, as well as a navigation joystick or optical trackball for easier system interaction
- Touchscreen display
- Large built-in system memory (256MB-512MB is common for smart phones) and additional storage capacity through add-on storage memory cards that can support 32GB (or more)
- High-speed processor (some smart phones run at 1GHz or more)
- WiFi Wireless local area network support
- Bluetooth and USB support
- Accelerometer or gyroscope for three-dimensional interaction and orientation

By being able to provide such functionality, current generation smart phones are able to provide most, if not all, of the office/work related and other functions that a typical user needs on a daily basis, regardless of time or location. It really can become a computer rather than just a humble telephone.

Adapted from Rajnesh Singh, *Module 4: ICT Trends for Government Leaders.* 2nd edition, *Academy of ICT Essentials for Government Leaders* module series (Incheon, UN-APCICT/ESCAP, 2011), http://www.unapcict.org/academy/.

With access to stable electric power and energy remaining a distant dream in many rural communities in poor countries, land-based telecommunications solutions are giving place to low-cost wireless systems, such as WiFi and WiMax.[77]

At the end of 2010, there were 2,649 million mobile subscriptions in Asia-Pacific, compared with 880 million in the Americas and 741 million in Europe.[78] Much of the growth is coming from the world's most populous nations—China and India. Another aspect of the growth is the willingness of consumers to experiment with new technologies and the various types of content these technologies can deliver. Many of the innovations now being tried out by marketers in the West, such as Quick Response or QR codes, were born in Asia.[79] Opportunities to experiment with different services on mobile phones exist—whether it is m-agriculture, m-banking, m-learning or m-health, among others.

77 See Glossary for definitions of WiFi and WiMax.

78 See MobiThinking, "What Makes the Asia Pacific the Most Exciting Mobile Market in the World?", http://mobithinking.com/mobile-asia-pacific-mma-interview.

79 Ibid.

Youth In Action 1. Kopo Kopo

In Kenya, a group of young entrepreneurs established Kopo Kopo that integrates microfinance and mobile technologies to help poor communities. Kopo Kopo allows small- and medium-sized enterprises to leverage mobile money as a payment channel. Mobile money allows people to make payments using their mobile phones. People can add credit to a mobile account and then use their phone to pay for goods and services, transfer money and pay bills. Users no longer need to close their shops and travel across town in order to pay loan installments, thus save time, reduce transport costs and increase income.

Sources: Kopo Kopo, http://www.kopokopo.com and http://genvcampaigns.org/2011/05/17/the-entrepreneurial-path-tech4btrworld.

Trends in Applications

Dramatic changes are taking place in the development of applications, in operating systems and in computer software programmes designed to help users perform singular or multiple related specific tasks.

The earlier PC revolution and later the Internet were systems that invited innovation by others. Both were generative: that is they were designed to accept any contribution that followed a basic set of rules (either coded for a particular operating system, or respecting the protocols of the Internet). Both were overwhelmed by large businesses and ventures that were essentially proprietary, non-generative competitors, such as the makers of stand-alone word processors and proprietary online services like CompuServe and AOL. In other words, if you bought a PC, it came bundled with the proprietor's software and you were dependent on the same company for upgrades and changes. In the year 2000, applications based on Windows OS would not work on a Mac OS and vice versa.

But the future unfolding right now is very different from this past. The first is that the revolution in FOSS offers low cost and equally robust and efficient operating systems and application software.

Box 8. Free and open source software

FOSS (also referred to as FLOSS or Free/Libre Open Source Software) has come to public attention in recent years. The relative success of software applications such as the Mozilla Firefox browser and OpenOffice office productivity suite has helped establish FOSS as an alternative to closed source (or proprietary) software.

So what exactly is FOSS?

The Free Software Foundation founded by Richard Stallman defines free software as follows:

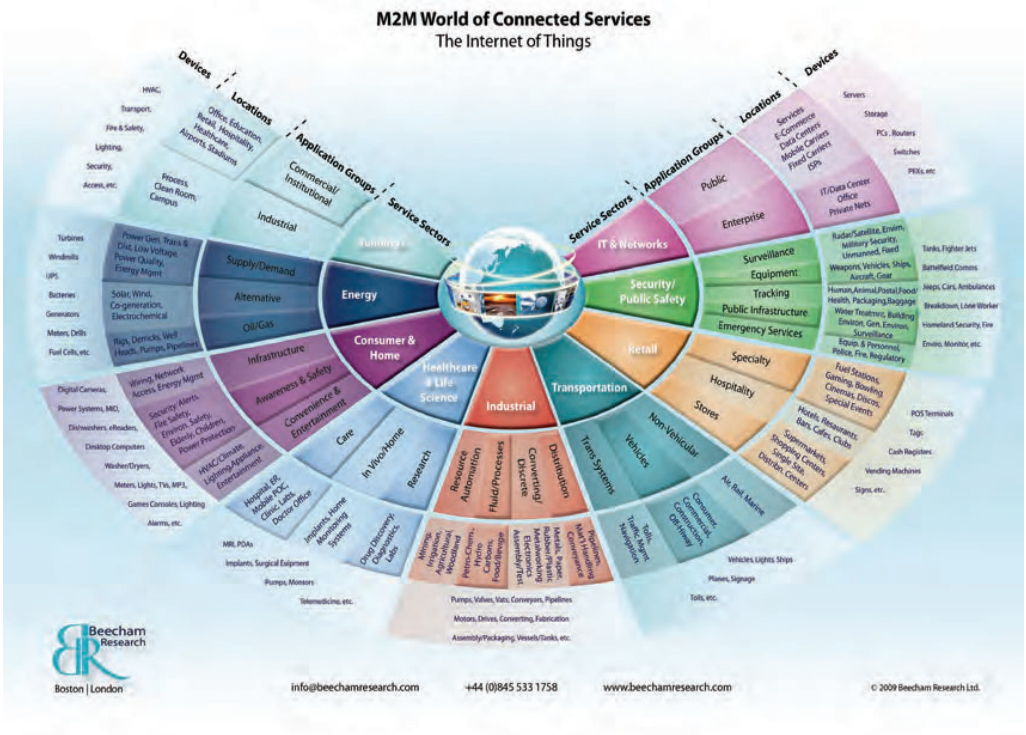
> Free software is a matter of liberty, not price. To understand the concept, you should think of free as in free speech, not as in free beer.
>
> Free software is a matter of the users' freedom to run, copy, distribute, study, change and improve the software. More precisely, it refers to four kinds of freedom, for the users of the software:

- The freedom to run the program, for any purpose (freedom 0).
- The freedom to study how the program works, and adapt it to your needs (freedom 1). Access to the source code is a precondition for this.
- The freedom to redistribute copies so you can help your neighbour (freedom 2).
- The freedom to improve the program, and release your improvements to the public, so that the whole community benefits (freedom 3). Access to the source code is a precondition for this.[80]

Abridged from Rajnesh Singh, *Module 4: ICT Trends for Government Leaders*. 2nd edition, *Academy of ICT Essentials for Government Leaders* module series (Incheon, UN-APCICT/ESCAP, 2011), http://www.unapcict.org/academy/.

From expensive proprietary systems, the trend in both operating systems and application software is to move to open systems and software. New applications will allow not just people to communicate with each other through the Internet, but will also evolve into new scenarios, including what is understood as Web 2.0 and the Internet of Things.

Figure 8. The world of connected things and services: The Internet of Things and Machine-to-Machine communications



Source: Beecham Research, "M2M world of connected services. The Internet of Things", http://www.beechamresearch.com/Downloads.aspx.

The term Web 2.0 is not so much technology transformation as it is concerned with Web applications that facilitate participatory information sharing, interoperability and user-centered design, and address some of the limitations of the earlier World Wide Web. Web 2.0 refers to various Web-hosted services and software that facilitate user-generated Web content and the technologies these software are based on, including social bookmarking, social writing platforms,

80 GNU Operating System, "The Free Software Definition", Free Software Foundation, http://www.gnu.org/philosophy/free-sw.html.

and other Internet tools that facilitate the creation and saving of information.[81] A Web 2.0 site allows users to interact and collaborate with each other in a social media dialogue as creators of content in a virtual community, in contrast to websites where users are limited to the passive viewing of content that was created by others for them. Examples of Web 2.0 include social networking sites, blogs, wikis, video sharing sites, hosted services, Web applications, and others.

Box 9. The Internet of Things

The Internet of Things refers to the evolving nature of technology towards a future where everyday objects around us are all linked via a network (the Internet), for example the washing machine, or air conditioner at home being activated by a message from a distant mobile phone.

The concept revolves around such objects all having Internet protocol (IP) addresses and the user being able to interact with these objects. Such a network would depend, for example, on embedding sensors and radio frequency identification or RFID tags in objects around us and being able to access and interact with them for information and status updates. Such information could include updates on how much fuel is in the car (without having to get inside the car and look at the fuel gauge), to checking if there is milk in the refrigerator (without opening it).

Abridged from Rajnesh Singh, *Module 4: ICT Trends for Government Leaders*. 2nd edition, *Academy of ICT Essentials for Government Leaders module series* (Incheon, UN-APCICT/ESCAP, 2011), http://www.unapcict.org/academy/.

The new forms of applications have begun to address the weaknesses and the gaps left unattended by earlier software and software platforms. For instance, the emergence of Wiki as part of the FOSS movement allows the creation and editing of any number of interlinked or connected web pages via a Web browser using a simplified markup language or a "what you see is what you get" (WYSIWYG) text editor.[82] Wikis are typically powered by wiki software and are often used collaboratively by multiple users. In yet another instance, FOSS facilitates the development of local language support enabling localization of content.

The trends in the development of the FOSS movement; the move from expensive landline-based PCs to the more affordable, robust, wireless and user-friendly mobile telephony; and the increasingly simplicity of use have major implications for the development of content that will be addressed next.

Content and Content Development Trends

Earlier models of content development posed many problems and impediments for developing countries. The use of English as the language of IT, and consequently of the Internet became the first impediment as concerns of both literacy and language emerged. Equating the poor in developing countries with illiteracy led to the belief that minimum literacy was essential for benefitting from ICTs. Finding a literate person in a village was not a problem; however, finding one proficient in English to be able to access the Internet or to develop content remained an obstacle. Large software application companies did not find it economically profitable to develop local language fonts.

For a long time, older ICTs such as radio and TV scored over the Internet as favoured media for accessing information and knowledge. The ability to use rich audio-visual and graphic elements as part of Internet-based content was limited both by the size of the computer memory required to store them and by issues of low connectivity and bandwidth. This changed with new forms

81 Andrea Lin and Kavita Karan, "Internet and Information Circulation: Motivations for Passing on the Message Online", *ASCI Journal of Management*, Vol.39, No. 2, p. 45 (2010).

82 See Wikipedia, "Wiki", http://en.wikipedia.org/wiki/Wiki.

of content development, from learning objects, digital stories, and Web 2.0 applications (such as blogs, wikis and social networking sites) that facilitate the development of user-generated content.[83]

Box 10. Some types of user-generated content

- Blogs: A type of website or part of a website. Blogs are usually maintained by an individual with regular entries of commentary, descriptions of events, or other material such as graphics or video. Most blogs are interactive, allowing visitors to leave comments and messages, and it is this interactivity that distinguishes them from static websites.

- Social Networking Sites: A social network service focuses on building and reflecting on social networks or social relations among people, e.g., who share interests and/or activities. Social networking sites allow users to build online profiles, and share information, pictures, blog entries and music clips. Common social networking sites include Facebook, LinkedIn and Twitter.

- Learning Objects: A digital self-contained and reusable entity, with a clear educational purpose and at least three internal and editable components: content, learning activities and elements of context. Learning objects are a new way of thinking about learning content. Traditionally, content comes in a several hour chunk. Learning objects are much smaller units of learning, typically ranging from 2 to 15 minutes. They are reusable, can be used independently or in multiple contexts, and can be combined by the user to meet specific needs. An Internet-based reservoir of learning objects is called a Learning Object Repository.[84]

- Digital Stories and Digital Storytelling: The terms cover a variety of new forms of digital narratives (Web-based stories, interactive stories, hypertexts and narrative computer games). Here, ordinary people tell their own "true stories" in a compelling and emotionally engaging form. These stories are usually short (less than eight minutes) and can be interactive. A mobile phone with a camera and a recorder is enough to create a digital story and share it through MMS or any simple application that may be downloaded or enabled on a mobile phone.

Services

The number and variety of services that can be provided or developed through the options offered by new developments in technologies, applications and content are limited only by the imagination. From banking to health care, education to gaming, music and live streaming of TV content, government, travel and tourism, news and emergency information, education, culture and heritage—a variety of services can be offered, made possible by the advent of affordable high-speed connectivity, enabling inclusion of all sectors of a population into the mainstream of development.[85] Recent research has also shown that Asian audiences are open to receiving relevant, useful content on their mobiles and are willing to engage in mobile experiences that add value to their lives.[86]

83 User-generated content refers to online content that is produced by users of websites, as opposed to traditional media producers such as broadcasters and production companies. It reflects the democratization of media production through new technologies that are accessible and affordable. These include digital video, blogging, podcasting, mobile phone photography and wikis. Prominent examples of websites based on user-generated Content include eBay, Facebook, Flickr, Twitter, Wikipedia and YouTube. For definitions of different kinds of user-generated content, see Open Content and Public Broadcasting, "Glossary", WGBH Educational Foundation, http://opencontent.wgbh.org/report/glossary.html.

84 A good example of such a repository is available at MERLOT, http://www.merlot.org/merlot/index.htm.

85 The website http://mbillionth.in/ provides an insight into the range of services that can be provided using mobile services and when combined with existing Internet-based applications.

86 mobiThinking, "What makes Asia Pacific the most exciting mobile market in the world? Interview with Rohit Dadwal, MD Asia Pacific, MMA", http://mobithinking.com/mobile-asia-pacific-mma-interview.

Summary

As one looks back at the various inventions that have transformed society over the past hundred years, the revolution in ICTs, with the Internet riding on it, emerges as the one invention that has managed to unleash unparalleled social and economic changes. The world today is very different from what it was even twenty years ago. Today, it best fits the description of a global village, where everyone can be connected irrespective of time, space, culture, language and distance. Riding on this revolution, some very poor countries have suddenly become market leaders and global powerhouses.

The growth path of ICTs and, consequently, ICTD, is on a continuum beginning with the humble radio in the early part of the twentieth century and moving on to today's versatile mobile phone. The success and direction of its growth will depend not so much on the ingenuity of its developers but rather, on the inventive capacity of its ultimate users—whether in a rich metropolis or in a poor mountainside village. The factors that will also determine the direction of ICT growth will largely remain the same as they were earlier, these being:

- Adaptability – The extent to which it can be adapted to a range of tasks
- Leverage – How well it makes a difficult task easier—the more capable it is of producing change
- Ease of mastery – How easy it is for broad audiences to understand how to adopt and adapt it
- Accessibility – How easy it is to obtain and access
- Affordability – How much it costs
- Participatory – How much it engages it users and is interactive with them
- Transferability – How easily its use can be transferred to others
- Generative capacity – How easily it enables the user to create and build on its features for his/her own benefit and use

All of these factors are also important in ICTD programmes and activities. Keeping the features of ICTs in mind, it is now important to study the link between ICTs and development goals.

Practical Exercise

Consider this situation:

Your old mobile phone is damaged; and you need to purchase a new mobile phone. List the features that you want your mobile phone to have.

Consider that you are also buying a mobile phone for your grandparent. Make a list of the features that you will like to have on his/her mobile phone.

Assess both mobile phones on the basis of the factors listed in the summary of this section. Compare notes with your best friend and ask his/her help in purchasing the phones.

Now make a list of all the discussion points you have had with your best friend. Present and defend your findings before an open classroom among your classmates and your teacher.

Test Yourself

1. The generative capacity of any innovation is:

   a. The extent to which it re-invents itself
   b. The extent to which the system invites innovation by others
   c. An ICT-based system where you buy both the hardware and the software from the same company
   d. None of the above

2. The Internet is a:

   a. Generative system
   b. Locked down system
   c. Both
   d. Neither

3. To use FOSS, one has to:

   a. Buy it from the market
   b. Sign an agreement not to pirate it
   c. Download and use freely from the Internet
   d. Write your own programme

4. Web 2.0 refers to:

   a. A New IP
   b. New kinds of Internet-based services that allow and encourage networking among people
   c. The Internet of Things
   d. New ways in which individuals can use mobile phones

5. “User-generated content” refers to:

   a. An online website of a broadcasting company
   b. Online content produced by Web users
   c. Both
   d. Neither