Evolving Global Information Society[1]

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> **Motto**: *Transport of the mails, transport of the human voice, transport of flickering pictures - in this century as in others, our highest accomplishments - still have the single aim of bringing men together.* [Antoine de Saint-Exupéry, French aviator and writer (1900 - 1944)]

1. These are just my notes for the Opening Lecture at the 2002 School on Radio Use for Digital and Multimedia Communications, the Abdus Salam International Centre for Theoretical Physics (www.ictp.trieste.it). Accompanying slides are presented separately. We shall review basics issues related to the evolution of global information society embracing the developed countries and the developing ones. Since to cover the topic in detail one would need much more time, we shall concentrate on a few selected problems, and the original sources should be consulted for more information. Needless to say, the choice of topics reflects the research interests of the author. Beware of misprints!

Introduction

2. After interviewing many leading scientists, Michio Kaku, an internationally acclaimed physicist, put the computer and telecommunication technologies on the top of the three developments that "*will revolutionize the twenty-first century*".[2] (The two remaining are molecular biology and quantum physics.) Information technology, embracing the computer, telecommunication and related technologies, is shaping the way people live, learn and work and the way governments interact with citizens. It pushes societies into a new age of "information society", whether we like it or not. For many, it is the dawn of a new era of the humanity, much better than any other period we known from history, in which great achievements of science and technology will be used for the benefit of all people. The Okinawa Charter on Global Information Society defines the information society as one that "*better enables people to fulfil their potential and realize their aspirations*".[3] The transition we witness

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[2] Michio Kaku: Visions - How Science Will Revolutionize the Twenty-First Century; Oxford University Press, 1998

[3] Documents of the G-8 Summit on Global Information Society, Okinawa 21-23 July 2000

today is considered as a vital engine of sustainable growth for the world economy, offering enormous opportunities.[4,5,6,7]

3. However, any change brings with it also side effects. Some scientists and politicians warn that the negative side effects associated with the present changes could destroy the existing social order, unless some countermeasures are taken. Information technologies result in greater productivity and fewer jobs. The Nobel laureate economist Wassily Leontief has warned that with the introduction of computers, "*the role of humans as the most important factor of production is bound to diminish in the same way that the role of horses in agricultural production was first diminished and then eliminated by the introduction of tractors.*"[8] At the same time when new technologies reduce workplaces, they create new jobs. But there are doubts if the new workplaces could really absorb the surplus labor. Others are worrying that the new technologies allowing spying and tracing everybody's activities, threat privacy and freedom, as Orwell described it in his book.[9] Studies have been initiated in various countries and international organizations to understand the process better and react correctly.[10,11,12,13,14] The changes develop fast and we "*are in the mist of a great revolution, perhaps the greatest that humanity has ever experienced*" as we can read in an ITU publication on the World Summit on the Information Society. The problem has been under discussion at highest levels. The world leaders have published the Okinawa Charter on Global Information Society.[15] Kofi Annan, the UN Secretary General and Nobel Peace Prize laureate, included the issue in the list of major problems the humanity confronts today, in his report to the Millenium Assembly of the United Nations. He renamed the issue as the "*Digital Revolution*", which stresses the special role of electronic communications.[16] The discussion continues. It will culminate in the World Summit on the Information Society to be held in two sessions: first in 2003 in Geneva and then in 2005 in Tunis.[17]

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[4] Ericsson D, Harvey-Jones J, Keen P, Saffo P, Scott-Morgan P: Virtual Integration. Information Technology the Enabler in Globalization; Unisource 1996

[5] Gates B, Myhrvold N, Rinearson P: The Road Ahead, Penguin 1996

[6] Gates B, Hemingway C:Business@ the Speed of Though Using a Digital Nervous System, Penguin, 1999

[7] Rheingold H: The Virtual Community. Homesteading on the Electronic frontier; HarperPerennial, 1994

[8] Rifkin J: The End of Work: The Decline of the Global Labour Force and the Dawn of the Post-Market Era, 1996, p. 5

[9] Orwell

[10] Preparing Canada for A digital World. Final Report of the Information Highway Advisory Council, 1997 (also available at http://strategis.ic.gc.ca/IHAC)

[11] Green Paper on the Convergence of the Telecommunications, Media and Information Technology Sectors, and the Implications for Regulation; Commission of European Communities, 1997 (also available at http://www.ispo.cec.be/convergencegp)

[12] E-Work 2001. Status Report on New Ways to Work in the Knowledge Economy, 2001 (also available at http://www.eto.org.uk)

[13] Telecommunications Visions of the Future, ITU, 1993

[14] The Changing Role of Government in an Era of Telecom Deregulation, ITU 1993

[15]

[16] We, The Peoples: The Role Of The United Nations In The Twenty-First Century. Report Of The UN Secretary General, 2000 (also available at http://www.un.org/millennium/sg/report/full.htm)

[17] Further information about the summit can be found at the ITU website www.itu.int/wsis.

4. The beginning of the change is often associated with the introduction of Internet in 1990s, but the process is actually a continuing development. The first effects of the changes can already be seen. Information and electronic technologies are transforming and enhancing almost all human activities, as well as network of mutual interdependences within and among societies at worldwide distances.[18] Markets have spread and tied people together, but environmental, military, social, and political interdependence also increased.[19] That process coincides with the liberalization, privatization and deregulation, emergence of trans-national enterprises, and a new role of governments. A brand new sector is emerging from the convergence of electronic, telecommunication, computer, entertainment, and broadcasting industries. In the economy, services are displacing manufacturing as a source of wealth. Mental labor tends to replace physical one. New methods of work at distance are emerging. Computer applications become pervasive. Qualifications of workers increase and so does the work efficiency. The cost of production and services decreases. Dropping costs of transportation and communication enhance globalization. High technology applications offer wealth, freedom, and quality of life that were unthinkable earlier.

5. These benefits are not restricted to rich countries only. For instance, Costa Rica's economic growth surged to 8.3 per cent in 1999, the highest in Latin America, thanks to the microchip industry exports, which accounted for 38 per cent of all exports. India software exports alone reached about 9 per cent of India's total exports, with projection to rise from about $4 billion in 2000 to $50 or 80 billion by 2008. Indian companies have become world leaders in designing Internet web-based applications. They have successfully built their own telecommunications systems, beaming their software products by satellite around the world. Access to the Internet in India is also increasing rapidly and it is estimated that about 6 million people in India are using the Internet, after the deregulation of the telecommunication and information technology sectors.[20] The development of information and communication technologies opened also unexpected financial opportunities. By the time the United Kingdom and Germany had completed their licensing of new generation mobile services, more than US $80 billion had been spent even before the services started.[21] Tuvalu, a South Pacific country of population 10'000 and area of 10 sq km sold its Internet suffix ".tv" to an American company for US $50 million, and leased its telephone prefix "688" to a telephone-sex operator for $1.5 million yearly.[22]

6. However, the world is fragmented, and different countries move with different pace. The transition towards global information society will not be easy for poor developing countries and for remote regions. Competition is becoming global, and so do economic disturbances in one country propagate around the

[18] Keobane R 0, Nye Y S Yr: Power and Interdependence in the Information Age; Foreign Affairs Sep-Oct 1998 - Volume 77 No. 5, p. 81-94
[19] Nye J S: Globalization's Democratic Deficit; Foreign Affairs, Vol.80. No.4, p. 2
[20] Data excerpted from: We, The Peoples: The Role Of The United Nations In The Twenty-First Century. Report Of The UN Secretary General, 2000
[21] ITU Annual Report 2000, p. 4
[22] Wechsler W F: Follow the Money; Foreign Affairs, Vol. 80, No. 4, p. 43

globe and hit the poorest societies. New vulnerabilities occur, unknown earlier with network crashes due to computer viruses.[23] Increased work efficiency makes many workplaces unnecessary.[24] New workplaces require new skills, and unskilled workers turn out to be superfluous. These phenomena resemble the Industrial Revolution in the 18th century in the UK, when the transition from agricultural society to industrial one took place in that country. Although industrialization led to a rise of national wealth, it also led to dramatic changes in the distribution of income, in living and working conditions, and in social conduct. The Industrial Revolution has turned British peasants into paupers, but the colonization of Africa, North America, Australia, and New Zealand helped to solve the problem. At the same time it strengthened the power of United Kingdom for many years.

7. The negative effects of the great transitions have been usually associated with the introduction of new technology, as "Industrial Revolution" and "Information Revolution" names imply. But technology *as such* is neutral. Only the effects of its use can be good or bad, purposely or unintentionally, depending on how, where, and for what purpose a given technology is applied. As societies are made of various groups, and some uses that are good for one group could be bad for another one. Technology helps to raise wealth, but how that wealth is created and distributed is determined by the social order. The technologically most advanced societies are governed by the neo-liberal capitalism, by the principle that Noam Chomsky described shortly as "*profit over people*".[25] The world leaders plan its expansion, convinced that it is the best way to follow.

8. However, also critical opinions circulate about neo-liberalism and "consumption society". The critics indicate that neo-liberalism does not automatically guarantee a continuing success, as dramatic blowups of the past decade in Argentina, Thailand, Indonesia, and Russia (all following the IMF), have indicated.[26] European and American farmers are being compensated for non-cultivation of their grounds because of over-production and saturation of the market. For the same reason, manufacturing enterprises are bankrupting in the USA and elsewhere. At the same time many people suffer from poverty and starvation. Social conditions deteriorate, what Francis Fukuyama called "*the great disruption*" of the society.[27] People fear that the rich-poor gap would increase beyond any acceptable limits, and so would the economic, political, cultural, and military domination of a few richest countries. There are warnings that continuation of the present trends would create problems worse than those experienced in the past, during the Industrial Revolution, as today much more people are affected in a shorter time, and there is no more land to be colonized. The World Economic Forum 2002 held two weeks ago in New York found a counter-balance in Porto Allegre gathering seeking possible alternatives for the globalization we have know until now. Public

[23] Denning D: Information Warfare and Security; Addisson-Wesley, 1999

24 Rifkin J: The End of Work: The Decline of the Global Labour Force and the Dawn of the Post-Market Era, 1996

[25] Chomsky N: Profit Over People. Neoliberalism and Global Order; 1999

[26] Engardio P: Another emerging market in too much of a hurry; Business Week / Jan 21, 2002, p. 52

[27] Fukuyama F: The Great Disruption; Simon & Shuster, 1999

manifestations against the vision of global society proposed by the world leaders are organized. These manifestations culminated on 11 September 2001 in the tragic terrorist attack on the New York World Trade Center and Pentagon where thousands of innocent people lost their lives.

9. Until now, however, no better workable alternative has been found. Communism, with the full employment policy and proud declaration "*people over profit*", has been abandoned as soon as people could make free choice in Central Europe and Soviet Union, after decades of experience. Communist China, now being admitted to the World Trade Organization, is moving fast to free-market. In spite of all criticisms against liberalism, many young people from around the world dream to live and work in the liberal USA. In 2000, non-USA nationals made up 50 per cent of master's degrees and 57 per cent of doctorate degrees, according to the American Association of Engineering Societies.[28] Only the best of them are admitted to work there.

10. The following section deals with the role of technology in general. Then, we will discuss various types of information, how much information is produced and how it is consumed, as well as how the access to information is distributed, protected, and intercepted.

Technology and Information

11. Technology, which actually is applied science, has immense impact on the life of individuals and societies. In fact they affect the life on the planet, as environmental sciences and other disciplines have evidenced during the last 50 years or so. Communication has played a special role here. Actually communication, or "*the exchange of thoughts, messages, or information, as by speech, signals, writing, or behavior*"[29], is fundamental to any social activity. In a sense, communication embraces also exploration, as exploration is a form of communicating with nature, where natural signals carrying information are received and processed.[30] Seeking, acquiring and sharing information is at the very roots of human development, from which all the spiritual and material wealth of humanity emanates.

12. During the process of evolution, we have developed curiosity that pushes us to explore the unknown and to gather knowledge. Humans have developed intelligence, the capacity to acquire and apply knowledge, above any other creature. They have also developed abilities to share knowledge in the education process within social groups, as we do it at this school now. According to vocabulary, *information* and *knowledge* are synonyms of what is known, as by having been acquired through study or experience. *Knowledge* includes facts and ideas, understanding, and the totality of what is known, whereas *information* often implies a collection of facts and data.[31] *"Science is organized knowledge",* according to Herbert Spencer, a British

[28] Quoted after The Institute (IEEE), Jan. 2002, p. 6
[29] Excerpted from *The American Heritage Dictionary of the English Language*, 1996
[30] Spoelstra T H: Communication with Nature; Global Communications, Asia 1997, p.96-101
[31] Excerpted from *The American Heritage® Dictionary of the English Language,* 1996

philosopher (1820-1903). Extending knowledge, creating new technologies and transforming discoveries and inventions into practical applications is a continuous process that helps people to survive, to benefit from natural resources, and to improve the quality of life. It has started with the appearance of hominids and will continue as long as the human race exists.

13. The Earth - the unique planet in the Universe carrying intelligent life - has limited resources that must be shared among all living creatures without disruption of their complex interdependences. This means also a balanced equilibrium between various human groups. The history of humanity is a series of periods when the material and spiritual wealth was created. These periods were periodically disrupted by natural disasters, violence, and wars, and the wealth was devastated. Science and technology has successfully been used for both aims: to create and to destruct. It is ironic that the greatest technological advances were made in relation with war. Even the radio and Internet, around which the concept of information society has emerged, were developed with military applications in mind. Even more ironic is that war-related expenditures are used to fuel national economies and lower the unemployment figures.[32]

14. As Francis Fukuyama noted, human nature has not changed much during five million years of evolution. Group solidarity is still based on aggression against other communities, and social cooperation is undertaken to higher levels of organized violence. Military force still plays a major role in relations between states, and military aspects still outrank many other issues in foreign and domestic policy.[33] Today, the worldwide arm stockpiles total some 22'000 nuclear warheads, 70'000 tons of chemical warfare agents, and unknown tons of germ warfare agents, according to Jean Kumagai, not to mention classical military hardware.[34] We have known from archeological excavations that the violence in the past resulted in wiping-out whole tribes and nations. Such mass killing might be necessary in ancient times to keep a balance with limited natural resources, as wars and diseases were the only means to limit the human population and assure "*lebensraum*" to the survivors. However, is it really necessary to continue such practices today? There would be enough food and goods for everybody on the earth, as there is a huge potential evidenced by the overproduction mentioned earlier. Mass killing could be replaced by more rational ways to control the population growth. Environment-friendly technologies could stop poisoning the environment and killing the life. The recent UNESCO report indicates the way to be followed. It is through *Learning to live together, Learning to know, Learning to do, and Learning to be*. The phenomenal success of India in embracing the Information Revolution is directly related to its success in producing large numbers of highly qualified technical and science graduates. The information networks these graduates are

[32] Rifkin J: The End of Work: The Decline of the Global Labour Force and the Dawn of the Post-Market Era, 1996p. 83
[33] Fukuyama F: Women and the Evolution of World Politics; Foreign Affairs, Sep/Oct 1998, p. 24-40
[34] Kumagai J: A call to Disarm; IEEE Spectrum, Jan 2002, p. 31

now building have a huge potential for spreading the benefits of education to the less fortunate. [35] Education, however, implies access to information.

Types of Information

15. Keobane and Nye classify information in three types: free, commercial and strategic.[36] *Free information* (or public-domain information) is information that is produced and offered without financial compensation. Motives vary. Propaganda and marketing operations are carried out because its authors want it to be believed, while their true aims and gains are often hidden. Marketing expenses in the USA alone reach one trillion dollars a year, as Noam Chomsky indicated in his 1996 book mentioned earlier. It is a powerful machine to manipulate public opinion. Political parties exploit fully the experience of business marketing operations. Each election campaign absorbs millions of dollars. Microsoft distributed free its Explorer to eliminate competition. More recently, the same motives pushed IBM to launch its $1 billion commitment to Linux and $40 million Eclipse open source project to release development software tools into the public domain.[37] Scientific communities exchange free software because it is felt beneficial to the community members. Computer software may be distributed freely for malicious purposes, as the instance of computer viruses has evidenced. The explosion in the quantity of free information is perhaps the most dramatic effect of the information revolution. As a plenitude of information leads to a poverty of attention, it creates a new problem that must be solved by the future information society - selection of information. Attention becomes a scarce resource, and those gain power that can select valuable knowledge from chaos.

16. *Commercial information* is information that people create and offer only at a price. It is protected in many countries by law as "intellectual" private property. Intellectual property rights are justified by the costs of information production and distribution, which might be high. Those who consume information should compensate these costs. This is the only mechanism that encourages creativity and generation of new information, if other mechanisms supporting innovation are lacking.[38] Some kind of intellectual protection is thus in the public interest, conclude Keobane and Nye. Copyright protects the literary expression of an idea from unauthorized copying. Patents protect not only the expression but also the useful features of a novel product or process. Trade secrets, protected by contracts not disclosed publicly, ensure confidentiality on the part of the licensed user. If intellectual property rights are enforced, accessing commercially valuable information before competitors can generate enormous profits. The US copyright income only on information

[35] Delors J: Learning: The Treasure Within. Report to UNESCO of the International Commission on Education for the Twenty-first Century; UNESCO 1996
[36] Keobane R 0, Nye Y S Yr: Power and Interdependence in the Information Age; Foreign Affairs Sep-Oct 1998 - Volume 77 No. 5, p. 81-94
[37] 2001: Bad News, and Good; IEEE Spectrum, December 2001, p. 9
[38] Lehman B A, Brown R H: Intellectual Property and the National Information Infrastructure. The Report of the Working Group on Intellectual Property Rights; Washington 1995

assets reached 6 per cent of GNP in 1990, which was three times the contribution of agriculture sector, according to Oppenheim.[39]

17. *Strategic information* is protected to the highest degree, as it confers great advantages on actors only if their competitors do not possess it. Competition involves often protecting strategic information on the one hand, and spying on the other hand, which absorbs considerable efforts and expenses. These activities sometimes degenerate to oversized secret espionage/ counter-espionage organizations that operate beyond any control and exercise enormous power. The border between strategic information and commercial information is often blurred, as is the border between military, political, and economic espionage activities. Economic espionage refers to government intelligence operations aimed at acquiring economic secrets of a foreign country, including trade secrets of its companies. For instance, the US Central Intelligence Agency and National Security Agency were used to ferret out in 1994 a commercial transaction planned between the French-led Airbus consortium and Saudi Arabia airlines, which resulted in awarding a US$ 6 billion contract to US Boeing and McDonnell Douglas instead of Airbus.[40] The border between strategic information and free information is sometimes blurred, in view of disinformation practices.

Intellectual Property

18. The Internet has revolutionized the way people obtain information and "works" protected by intellectual property rights. Telecommunication networks make it possible for users around the world to access a vast amount of data for little more than the cost of a local telephone call. Businesses, governments, and individuals are able to use and enjoy copyrighted products online, or download them onto their computers for later use, or send further, without leaving their office or home. However, specific restrictions imposed by intellectual property rights have not been observed in many cases. The Business Software Alliance claims that in 1996 alone, software developers suffered over US $11 billion in lost revenues to software piracy.[41]

19. On the other hand, unauthorized software copying represents a massive opportunity for low-cost technology transfer, and probably helps to accelerate the time when developing countries can contribute to the global supply of computer software, as Oppenheim noted.[42] It also avoids investment of scarce resources in costly exercises of technology reinvention. Rather, unauthorized copying allows developing countries rapidly to access the international frontier for software technology, and to devote their intellectual resources to development new products.

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[39] Oppenheim J et al.: Turkey - Informatics and Economic Modernization; A World Bank Country Study, 1993

[40] Denning D: Information Warfare and Security; Addison-Wesley, 1999, p. 136

[41] - The WIPO Copyright Treaty: Temporary Copying and the Fight Against User Piracy, Business Software Alliance, July 1997

[42] Oppenheim J et al.: Turkey - Informatics and Economic Modernization; A World Bank Country Study, 1993, p. 180

20. During centuries, educational and scientific information was treated as a public good, with full and open access to it with minimum cost. Following the neo liberal approach, a new "copyright philosophy" has been launched in leading countries and the World Intellectual Property Organization (WIPO), which is totally different from the scientific tradition, says Risbeth.[43] Steps have been taken in to protect computer-based material, while the border between science and commerce is blurred. The definition of database is very wide and applies to paper-based data as well as to electronic material. Risbeth worn that it raises the threat of a "data market" with endless charges, copyright fees, and accompanying paperwork, and that scientists will have to bear the burdens.

21. It is clear that the new approach is beneficial to those who control the production of commercially valuable data. Scientist involved in the production of such data might welcome the new philosophy. However, that approach might induce serious long-term impact on research activities, especially in view of decreasing budget for government-sponsored research. Risbeth appeals that scientists should press for reasonable "*fair use*" provisions in the copyright laws for teaching and research purposes. Another issue is the 15 years protection period, he mentioned, which contrasts drastically with the lifespan of electronic technology, measured in months. He also appeals to keep as much as possible all data in the "public domain", for the common benefit. Kofi Annan, in his millenium report mentioned earlier, raises similar appeal specifically in relation to biotechnology: "*...we must not neglect the inherent risks. In particular, we must ensure that free access is provided to the information compiled by researchers deciphering the genetic code. The genetic key to human life belongs to all humanity*". Does scientific information in general belongs to all humanity?

22. Seema Singh has announced recently a grandiose project. A team of Indian and US computer scientists plan to place one million books on the Web, freely accessible by anyone.[44] The project goes along the vision launched by Al Gore, Vice-President of the United States, at the ITU Telecommunications Development Conference in Buenos Aires in 1994. He urged the conference to determine how every school and library in every country could be connected to the Internet, in order to create a Global Digital Library. Each library could maintain a server containing books and journals in electronic form, along with indexes to help users find other materials. As more and more information is stored electronically, this global library would become more and more useful. It would allow millions of students, scholars and business people to find the information they need whether it be in Albania or Ecuador.[45] In the Singh's project, the US National Science Foundation will provide special scanners and some funding. Were the project to be carried out in the USA alone, it would cost $40 million or so. With the participation of developing countries the cost can be scaled to $5 million. This library will feature material that is out of

[43] Risbeth H: Copyright of Databases; The radio Science Bulletin No. 282, September 1997, p. 5
[44] Singh S: Multilingual Digital Library Hopes to Outdo Rest in Scope, Capabilities; IEEE Spectrum, Jan 2002, p. 26
[45] Remarks by Vice President Al Gore to the International Development Conference in Buenos Aires, Argentina on March 21, 1994

copyright, or whose publishers have granted the right to electronic publication. Classic works, such as ancient Indian Vedic texts and Michelangelo works, were mentioned, and libraries willing to contribute items for digitization will be invited to join the project. Unfortunately no mention has been made on works that would contribute to narrowing the technology gap between the developing countries and developed ones.

Table 1. Worldwide estimate of production of original content, stored digitally using standard compression methods, in terabytes (10^{12} bytes) circa 1999.

Storage medium	Type of content	Terabytes/Year Upper estimate	Terabytes/Year Lower estimate	Growth rate, %
Paper	Books	8	1	2
	Newspapers	25	2	-2
	Periodicals	12	1	2
	Office documents	195	19	2
	Subtotal	**240**	**23**	**2**
Film	Photographs	410,000	41,000	5
	Cinema	16	16	3
	X-Rays	17,200	17,200	2
	Subtotal	**427,216**	**58,216**	**4**
Optical	Music CDs	58	6	3
	Data CDs	3	3	2
	DVDs	22	22	100
	Subtotal	**83**	**31**	**70**
Magnetic	Camcorder tape	300,000	300,000	5
	PC Disk Drives	766,000	7,660	100
	Departmental Servers	460,000	161,000	100
	Enterprise servers	167,000	109,000	100
	Subtotal	**1,693,000**	**635,660**	**55**
Unique computer-mediated information	Email	11,285	11,285	
	Usenet	73	73	
	Subtotal	**84,285**	**84,285**	
Non-digital communication flow	Radio	3,274	3,274	
	TV broadcast	108,638	62,769	
	T-phone (USA)	576,000	576,000	
	Postal (USA)	150,000	150,000	
	Subtotal	**835,426**	**789,557**	
Total		**3,040,250**	**1,567,772**	**50**

Excerpted from: Lyman P, Varian H R: How Much Information? Report of the School of Information Management and Systems, University of California at Berkley, 2001.

Information Produced

23. A recent study by Lyman and Varian indicated that in the year 2000 the world produced, in average, roughly 250 megabytes of information per person i.e. for

every man, woman and child on the earth.[46] We should note, however, the quantity of information available means little by itself. The quality and reliability of information are more important. Unfortunately, there is no objective or agreed measure of information quality or reliability. The total amount of information produced, about 1 to 2 exabytes, increases with a rate of about 50 per cent a year (1 exabyte = 1018 bytes). Table 1 gives a rough estimate of yearly worldwide production of original stored content as of 1999. If the information is not systematically stored (e.g. telephone conversations), it shows how much storage would be required to archive it. The upper estimate is based on the raw data, while the lower estimate reflects an attempt to adjust for duplication and compression.

24. Note that printed documents of all kinds comprise only 0.003 per cent of the total. Magnetic storage is the most popular and the most rapidly growing medium for storing information. The cost of magnetic media is dropping from about $10 for a gigabyte of storage in 2000 to expected $1 by 2005. In 2000, the World Wide Web consisted of about 21 terabytes of static HTML pages, and is growing at a rate of 100 per cent per year. About 500 times as much email is produced yearly. It appears that about 610 billion emails are sent per year, compared to 2.1 billion static Web pages. The table contains only the US data because the authors of the report considered the reliability of worldwide data concerning radio, television, telephone and post unsatisfactory.

25. A vast amount of unique information is created and stored individually. Original documents created by office workers are more than 80 per cent of all original paper documents. Photographs and X-ray photographs are 99 per cent of all original film documents. In the past, an individual could produce only a small amount of information. Now, on a personal computer anybody can create gigabytes of data and publish it instantly via the Internet. Lyman and Varian name this phenomenon the "*democratization of data*". Note also the dominance of information in digital format. Digital optical and magnetic storage shipments are doubling each year.

26. Table 2 summarizes the yearly production of information by individuals, and that published. Note that the amount of "individual" information is over 600 times larger as the amount of published information. Although the Web, Usenet, and email include a great amount of information, the authors omitted it in these tables, since they found difficult to know whether to classify this material as "individual" or "public". Lyman and Varian conclude: "*It is clear that we are all drowning in a sea of information. […] Better understanding and better tools are desperately needed if we are to take the full advantage of the ever-increasing supply of information…*" This is certainly true from the perspective of an information-rich society.

27. However, there exists a huge gap between those who are benefiting from the Information Revolution and those who are not. In most countries significant portions of population living in poor and/or remote regions still have

[46] Lyman P, Varian H R: How Much Information? Report of the School of Information Management and Systems, University of California at Berkley, 2001 (also available at: how-much-info@sims.berkley.edu)

insufficient access to information, continuing to face the "digital divide" challenge. And digital divide is a manifestation of poverty. On the eve of India's fiftieth anniversary as a constitutional republic, the President of India confirmed that his country has "*one of the world's largest reservoirs of technical personnel but also the world's largest number of illiterates, the largest number of people below the poverty line, and the largest number of children suffering from malnutrition.*"[47] Digital divide is meaningless for those who lack essentials: safe water, adequate nutrition, and basic education… Technology alone does not eradicate poverty. The 1970-2000 technological boom in the USA did not change the poverty rate (about 10%). On the contrary, it increased the income gap between the rich and the poor by ~50%.[48] The social order and not technology decides how the wealth is created and shared

Table 2. Yearly production of individual and published information

	Item	Amount	Terabytes
Individual information	Photographs	80 billion images	410,000
	Home videos	1,4 billion tapes	300,000
	X-rays	2 billion images	17,200
	Hard disks installed	200 million drives	13,750
	Subtotal		**740,960**
Published information	Books	968,735 titles	8
	Newspapers	22,634 titles	25
	Journals	40,000 titles	2
	Magazines	80,000 titles	10
	Newsletters	40,000 titles	0.2
	Office documents	7,500,000,000 titles	195
	Cinema	4,000 titles	16
	Music CDs	90,000 titles	6
	Data CDs	1,000 titles	3
	DVD-video	5,000 titles	22
	Subtotal		**285**

Extracted from: Lyman P, Varian H R: How Much Information? Report of the School of Information Management and Systems, University of California at Berkley, 2001

Information Consumed

28. Detailed statistics on how information is "consumed" in every country are not available. Table 3 shows information consumed in US households in 1992. The authors did not find good data on information use at the workplace.

29. Note that the greatest part of information consumed is in the form of television, and its volume does not chance much in time. Note also that time devoted to printed information decreases. The greatest increase in information consumption was observed in Internet applications, video games and home video. However, the total time spent in media access has hardly changed in eight years. The table reflects culture, taste, wealth, habits, and technological

[47] Excerpted from the Kofi Anan Millenium Report
[48] K. Venkat: Delving into the Digital Divide; IEEE Spectrum Feb 2002, p.16

development of American society, and great care is required in extending conclusions drawn from these data over other societies.

Table 3. Average media use in hours per year, with estimated megabytes equivalent. (US households, year 2000)

Item	Hours	Megabytes	% change, 1992-2000
TV	1571	3,142,000	4
Radio	1056	57,800	-8
Recorded music	269	13,450	15
Newspaper	154	11	-10
Books	96	7	-4
Magazines	80	6	-6
Home video	55	110,000	30
Video games	43	21,500	126
Internet	43	9	2.050
Total	**3,380**	**3.344,783**	**1.7**

Extracted from: Lyman P, Varian H R: How Much Information? Report of the School of Information Management and Systems, University of California at Berkley, 2001, Table 1

Accessing Information

30. Table 4 illustrates the distribution of TV receivers, telephones, and personal computers per 100 inhabitants among the world's population (averaged per country). The table illustrates the degree of difficulty in accessing information due to inadequately developed information transmission infrastructure.

Table 4. Distribution of TV receivers, main telephone lines, mobile phones, and personal computers averaged per country in 2000*

No. of items per 100 inhabitants	Upper 20% of world population (rich)	Lower 20% of world population (poor)	Index (Lower20%-to-Upper20%-ratio)
TV receivers (182 countries, 1995)	>31	<5.4	0.17
Main telephone lines (206 countries, 2000)	>12	<3.5	0.29
Mobile telephones (190 countries, 2000)	>12	<0.35	0.03
Personal Computers (154 countries, 2000)	>5	<0.4	0.08

*) Source of data: ITU

31. The number of TV receivers, telephones, and computers per 100 inhabitants is strongly correlated with the Gross Domestic Product per capita. Table 5 illustrates that fact. Following the profit, the telecommunication infrastructure in liberal economies has been developed in urban and rich regions only. Its extension over poor, sparsely populated and inaccessible regions requires

investments that are not justified economically. The role of investment is crucial. (For discussion of problems related to building information infrastructure in rural / remote areas please refer e.g. to material of earlier ICTP schools.[49])

Table 5. Number of telephones, computers, TV receivers, and Internet users

	GDP/capita (1995)	Main Telephone Lines/ 100 inhabitants (1996)	Cellular Phones/ 100 inhabitants (1996)	Personal Computers/ 100 inhabitants (1996)	Internet users/ 100 inhabitants (1996)	TV Receivers/ 100 inhabitants (1996)
Africa	713	1.85	0.16	0.64	0.99	5.6
Asia	2527	6.02	1.35	1.26	2.90	18.2
World	**5104**	**12.88**	**2.46**	**4.65**	**9.19**	**23.8**
Europe	12422	34.6	4.57	9.56	16.97	43
Americas	12446	30.38	6.92	15.87	31.56	44.4
Oceania	14855	40.39	15.05	30.31	80.89	50.2

Data extracted from: World Telecommunication Development Report, ITU 1996

32. Even if copyright barriers would be removed, and even if people would have physical access to Internet, they might be unable to benefit from it. About 20 per cent of the world population is illiterate, according to the UNESCO statistics (other sources indicate much greater percentage). For those people, the only information accessible is that transmitted mouth-to-ear via more educated compatriots and via radio and television. Even rich societies suffer from illiteracy. For instance, one out of every three adults in the United States is functionally, marginally, or complete illiterate, according to Jeremy Rifkin.[50]

33. Language difference is another serious barrier. There are about 6000 languages spoken in the world. Although literary creative production (poetry, novel, religious writings) is available in almost all languages, the most of science / technology-related information is available in a few languages only, with English keeping a dominant place. And it is science and technology that counts in the competition we see today.

34. The software revolution in India has been accelerated by the creation of government-supported software technology parks and assisted by economic liberalization and foreign investment. A study was performed on the investment in developing Commonwealth countries[51] Net long-term private capital flows to developing countries raised six fold from 1990 to 1998, reaching $256 billion. Private direct foreign investment has become the largest single source of external development finance for developing countries. By contrast, official development finance has fallen to only 14 per cent of the

[49] Struzak R: Building Information Infrastructure in Rural Areas; Global communications, Asia 1997, p. 227-233
[50] Rifkin J: The End of Work: The Decline of the Global Labour Force and the Dawn of the Post-Market Era, 1996p. 37
[51] Deol H: Promoting Investment in the Commonwealth; Commonwealth Secretariat and Worldaware, 1998

total. In spite of that amount and its phenomenal growth, there was opinion that the investments were not as efficient as they could be. The study identified main obstacles influencing the flow of foreign direct investment. Corruption was perceived to be a major obstacle to doing business in developing countries. Although corruption exists in all countries, only developed countries have made visible efforts to combat it. The 1997 OECD Convention on Bribery in International Business has been the first multilateral agreement among governments to combat the bribery of foreign officials, and Transparency International, a global non-governmental organization, to do the same with international and national (through its National Chapters) businesses. Policy instability emerged as a second major constraint to investment. The foreign direct investment by its nature requires commitment over the long term.

Intercepting Information

35. Information age carries also new challenges, information interception being one of them. The European Parliament requested studies on unauthorized access to information, from the viewpoint of communications security aspects. The results were reported to The Director General for Research of the European Parliament in 1999. The report describes how communications intelligence (Comint) organisations have made arrangements for the interception of communications from commercial satellites, of ground communications using satellites, of undersea cables using submarines, and of the Internet. Comint involving the covert interception of foreign communications has been practised by almost every advanced nation since telecommunications became available. It is now a large-scale industrial activity providing clients with intelligence on diplomatic, economic and scientific developments. The following is a summary from the report, after Manuel Wik.[52]

36. The highly automated UK-USA system for processing Comint, known as ECHELON, has been widely discussed within Europe. Comint information derived from the interception of international communications has long been routinely used to obtain sensitive data concerning individuals, governments, trade and international organisations. The report sets out the organisational and reporting framework within which economically sensitive information is collected and disseminated, summarising examples where European commercial organisations have been the subject of surveillance. It identifies a previously unknown international organisation – "ILETS" – which has, without parliamentary or public discussion or awareness, put in place contentious plans to require manufacturers and operators of new communications systems to build in monitoring capacity for use by national security or law enforcement organisations. Comint organisations now perceive that the technical difficulties of collecting communications are increasing, and that future production may be costlier and more limited than at present. The perception of such difficulties may provide a useful basis for policy options

[52] Wik M: Revolution in Information Affairs; Global Communications Americas 2000, p. 2-26

aimed at protective measures concerning economic information and effective encryption.

37. Comprehensive Comint systems exist to access, intercept and process every important modern form of communications, with few exceptions. Contrary to reports in the press, effective "word spotting" search systems to select automatically telephone calls of interest are not yet available, despite 30 years of research. However, speaker recognition systems – in effect, "voiceprints" – have been developed and are deployed to recognise the speech of targeted individuals making calls. There is wide-ranging evidence indicating that major governments are routinely utilising communications intelligence to provide commercial advantage to companies and trade.

38. Diplomatic initiatives by the United States government were seeking European agreement to the "key escrow" system of cryptography masked intelligence collection requirements, and have formed part of a long-term program which has undermined and continues to undermine the communications privacy of non-US nationals, including European governments, companies and citizens. The United States National Security Agency (NSA) – the signal intelligence agency directly under the President – has about 20.000 employees and can command another 20.000 people from the defence. NSA has the capability to intercept all wireless and cable communications including voice telephony. Softly encrypted information (perhaps up to 56 bit coding) is decoded in real time. One billion messages are filtered every day and about 0,1 per cent is analysed manually. There are links between the NSA and the Department of Commerce. One conclusion is that there is no possibility to avoid the risk of fax, telephone, or E-mail messages being intercepted and analysed, even if they are softly encrypted. Thus the only countermeasure is to encrypt all messages thereby saturating the system. The report indicated that globally, about 15-20 billion Euros was expended annually on Comint and related activities. The largest component in this expenditure was incurred by the major English-speaking nations of the UK-USA alliance. In excess of 120 satellite systems were in simultaneous operation collecting intelligence. Glenn Zorpette has recently updated that information. In the USA only, a total of 13 government agencies have intelligence responsibilities of some kind, for which they share a budget put at $30 billion for 2001 and roughly $33 billion for 2002.[53] However, the 11 September terrorist attack has evidenced that all efforts and expenses can be useless when fanatical devotion to a case is involved.

39. Mobile GSM phones can be used for industrial espionage, even when switched off, without putting anything special into the phone, and without the owner knowing that the telephone is being bugged, as wrote Manuel Wik in his paper quoted above. Other sources deny that this is possible. Until a clear statement is at hand, it is recommended not to bring mobile phones into places where highly secret matters are being discussed. Information on the location of mobile phones is monitored and there are special computer centres that can

[53] Zorpette G: Making Intelligence Smart; IEEE Spectrum, Jan. 2002, p. 39

handle and record a great number of mobile phone positions. Such information is used by law enforcement agencies."

Concluding Remarks

40. It took 38 years for radio to reach 50 million people, and 13 years for television. The same number of people adopted the Internet in just four years. And the Internet already has a far wider range of applications than any previous tool of communication ever invented. There were 50 pages on the World Wide Web in 1993. Seven years later, in 2000, there were more than 50 million. The market for e-commerce was $2.6 billion in 1996; it is expected to grow to $300 billion, about one per cent of the world GDP, by 2002. A mere 143 million people logged on to the Internet in 1998; by 2002 the number of users will exceed 700 million. But it will be only about 12 per cent of the world population. How many years will be needed to increase that percentage to 80 per cent to reach the status of really Global Information Society?

41. "*The greatest change in our time has not been effected by armies or states or international organizations; it has been driven by the spread of information*", as Shimon Peres once said.[54] Manuel Wik, a Swedish defence scientist, adds: "*Information is the key to all activities, and knowledge is the core of strength*".[55] Without access to telecommunication means, the people of developing countries will not be fully part of the modern world. Nelson Mandela, the President of Republic of South Africa, put it clearly: "*Eliminating the distinction between information rich and information poor countries is … critical to eliminating economic and other inequalities, … and to improving the quality of life of all humanity..."* And he stressed further: "[T]*elecommunications issues must become part of general public debate on development policies. Telecommunications cannot be simply treated as one commercial sector of the economy, to be left to the forces of the free market.*"[56] The ITU Plenipotentiary Conference in Nairobi created an Independent Commission for World Wide Telecommunications Development. The commission reported in 1984: "*While telecommunication is* […] *a key factor in economic, commercial, social, and cultural activity in industrialized countries and as an engine of growth, in most developing countries the telecommunications systems is not adequate even to sustain essential services. In many areas there is no system at all.*"[57]

42. Ten years later, Vice-President Al Gore, declared at the ddevelopment conference of Buenos Aires: "*...we now have at hand the technological breakthroughs and economic means to bring all the communities of the world together. We now can at last create a planetary information network that transmits messages and images with the speed of light from the largest city to*

[54] After: Wik M: Revolution in Information Affairs; Global Communications Americas 2000, p. 2-26
[55] Wik M: Global Information Infrastructure: Threats; Global Communications Interactive 1999, p. 30-40
[56] Mandela N: Opening Address at the ITU World Telecommunications Conference and Exhibition, TELECOM Geneva 1995
[57] Maitland D: The Missing Link. Report of the Independent Commission for World Wide Telecommunications Development. ITU 1984

the smallest village on every continent…" Fifteen years after the Independent Commission report, and six years after the Buenos Aires conference, Kofi Annan, in his millenium report, wrote: "*At present, a yawning digital divide still exists in the world. There are more computers in the United States of America than in the rest of the world combined. There are as many telephones in Tokyo as in all of Africa*". It would instructive to evaluate quantitatively the progress made during the fifteen years that passed between the Maitland's and Anan's reports.

43. The transition to Information Society will not be easy for developing countries, especially the very poor. Lack of resources and skills is part of the problem, inadequate basic infrastructure another, illiteracy and language a third, and there are concerns about privacy and intellectual property. Technical solutions will become available for many of these problems, even simple automatic translation programmes, enabling us to communicate and engage in e-commerce across language barriers, as Kofi Annan mentioned. However, the greatest hopes are related to potential benefits of radio technologies that can offer immediate access to information networks anywhere and anytime, at minimal cost where telecommunication infrastructure does not exist. And the recent progress in that area is phenomenal. Industry estimates indicate that a record 46 geostationary satellites were ordered for the year 2000 alone. This represents a US$ 5.3 billion investment expected to generate more than 20 billion in operating revenues over the fifteen years lifetime of the satellites.[58] Other lectures at this school will discuss various aspects of radio in detail.

44. The individual consumer model of using information technology that prevails in the industrialized countries will prove too expensive for many developing ones, at least for the immediate future. But that constraint can be overcome through Public Telecentres and Technology Access Community Centres to bring the phone, fax, and Internet services to poor and rural areas in remote corners of the globe. Some pilot programs have already been established in places from Peru to Kazakhstan. One of them, called Health InterNetwork, will establish and operate 10'000 on-line sites in hospitals, clinics and public health facilities throughout the developing world. It aims to provide access to relevant up-to-date health and medical information, tailored for specific countries or groups of countries. The equipment and Internet access, wireless where necessary, will be provided by a consortium, in cooperation with other foundation and corporate partners.

45. To conclude, I would like to come back to the address by Nelson Mandela mentioned earlier. He stressed that a massive investment in education and skills transfer is essential if developing countries are to compete in the global marketplace. He added: "*Many of us here today spent much of our lives without access to telecommunications or information services, and many of us will not live to see the flowering of the information age. But our children will. …And it is our responsibility to give them the skills and insight to build the information societies of the future. The young people of the world must be empowered to participate in the building of the information age. They must*

[58] Data extracted from ITU News 10/2001, p. 18

become the citizens of the global information society. And we must create the best conditions for their participation." I hope that the ICTP School will contribute to this program.