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Light and Shadow in the Internet Era

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The progress of computer and telecommunication technologies has opened the "Internet era" – an era in which powerful communication channels diminish geographical, temporal, psychological, and cultural distances around the world. The impact of the Internet on business could even be compared to the impact of a large comet. As the Internet diffuses, its communication channels are enabling us to create the new "cyber community," which is free of many of the restrictions of the real world. In the economy, the cost structure of business processes is changing drastically and a revolution toward the new digital economy is in progress. This paper gives an overview of the favorable and sometimes unfavorable changes that the Internet is causing in society, describes some of the technological and social problems related to the Internet that must be overcome, and finishes with a brief look at the Internet future.

1. Introduction

Stepping into the new century, we are experiencing a new industrial revolution and the beginning of the Internet era, an era in which powerful communication channels diminish geographical, temporal, psychological, and cultural distances throughout almost the entire world. The changes are so great, that the impact of the Internet on business could even be compared to the impact of a large comet.

As pointed out in the famous Solow productivity paradox,[1),2)] the persistent development and diffusion of computer and information technology hardly make any drastic changes in the macroeconomic productivity statistics of developed countries such as the U.S. and Japan. Although, as is well understood, technological innovations have contributed to substantial productivity improvements in individual industrial sectors, their macroeconomical influences only became apparent after the Internet triggered the emergence of the digital economy.[3)]

Before the Internet, we had to make a compromise between distance and richness of information. But now the Internet has made distance virtually disappear and enables us to enjoy a much greater richness of information. We can search hundreds of millions of Web sites and many huge databases to find some specific information using a powerful search engine. However, the unmanageably large amounts of information that can be obtained from the Internet have to be selected or filtered by engines that are more intelligent.

Regarding availability, today's information and telecommunication technologies enable us to quickly and easily use the Internet anytime and almost anywhere. Fujitsu is leading the revolution in advanced communications and information technology (IT) in the Internet era. Innovative systems and devices in every layer are changing and shaping the way we live and work (**Figure 1**).

The essential characteristic of the Internet is its openness. From the beginning, the Internet

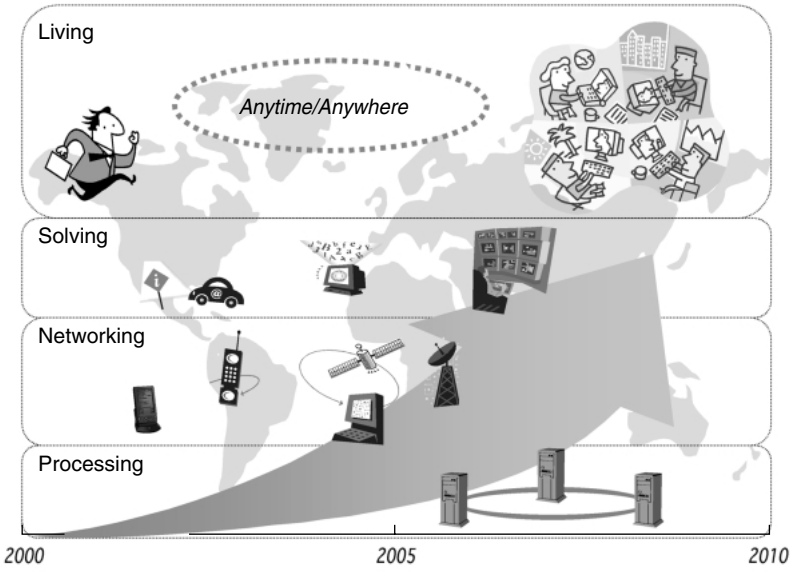

Figure 1
Evolution of the Internet.

was designed, developed, and maintained in a democratic manner through many voluntary activities in academic institutes. At present, the Internet Society[4] governs the Internet in much the same way as the United Nations influences world events. It also governs the Internet Engineering Task Force (IETF), which is an open community for selecting new technologies to form de facto standards.[5] As the Internet becomes more and more indispensable in our society, its proper management will become a very important issue, not only nationally but internationally. In response, the role of the Internet Society is becoming more and more important. Fujitsu is honored to have been asked to help support the Internet era with various kinds of leading-edge technologies, for example, advanced networks and associated technologies, next-generation products, solutions, and services.

The influence of the Internet is so widespread and profound that it is quite difficult to overview its entire scope. This special issue, "Information Technology in the Internet Era," describes some of the many contributions that Fujitsu is making in the IT field. This paper gives a brief overview and discussion of the good and bad changes that the Internet is causing in our society.

2. Internet characteristics

2.1 Size and structure

At the beginning, the Internet was relatively small, but when it was opened to the public in 1993, it expanded at breathtaking speed. Today it is still accelerating its pace of growth. The number of people worldwide who had Internet access in May 1999 was estimated to be more than 171 million, and this number is expected to climb to 360 million for July 2000.[6] By 2010, the number can be expected to be about 10 billion, which is more people than the current world population. In Japan, the number of Internet-connected people was reported to be 18 million in April 1999 and 27 million (21% of the population) in May 2000.[6] The number of Internet users in Japan made a big jump due to a dramatic increase in the number of mobile Internet users, who for the last three years have accounted for one third of all Internet users in Japan (**Figure 2**).[7]

The Internet consists of hundreds of Gigabit backbone networks and branch networks that span nations and continents. For historical reasons, the present backbone networks are U.S.-centric, but strong demand for bandwidth in Asia and Europe will soon make the network multi-centric.[8]

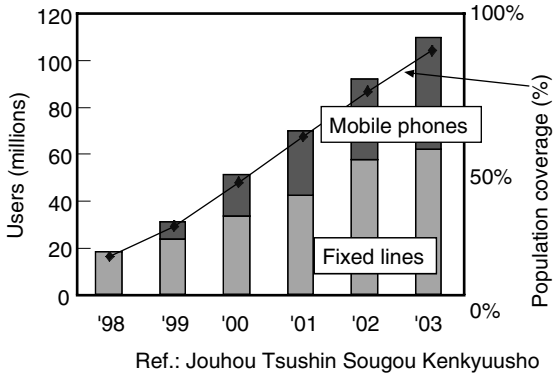

Figure 2
Internet users in Japan.

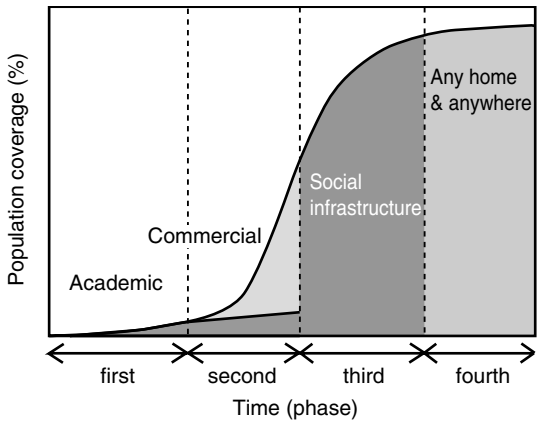

Figure 4
Four phases of Internet development.

Besides the physical networks of the Internet, there is the network of knowledge known as the World Wide Web, or WWW. This consists of a huge number of Websites that are interconnected with each other by URLs. The number of pages on the Web is growing rapidly; in September 2000, it was roughly estimated to be around 2.6 billion.[9)]

Recently, the Web has been described as having a "bow tie" configuration in which there are three types of nodes: the heavily connected core type, the originating and terminating edge types, and the isolated (disconnected) type[10)] (**Figure 3**). Of the nodes in the WWW, 30% are of the core type, 48% are of the edge type, and 22% are of the isolated type.

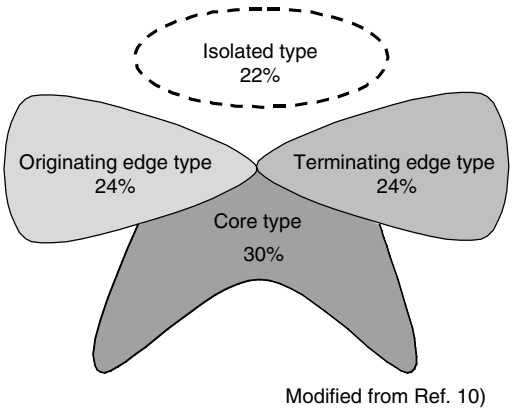

Figure 3
Bow tie hyperstructure of the Web.

The Web can also be described as being a scale-free network, which is a type of inhomogeneously wired network that has a higher proportion of intensively connected nodes than a homogeneous network.[11),12)]

2.2 Development history

The development of the Internet can be roughly divided into four phases (**Figure 4**). Some advanced countries, for example, the U.S., Canada, and several European countries, are currently in the early part of the third phase. These four phases are described below.

In the first phase, the Internet was created based on volunteer spirit and good will and then used exclusively within the academic community. The Internet was created in 1969 in the form of ARPANET, was used by the U.S. military, and then evolved into NSFNET in the mid 80s. The early users were scientists and engineers who wanted to interconnect various computer systems in academic institutes. The technologies that triggered the Internet's current popularity are the World Wide Web, the Mosaic browsing software, and the technologies of packet exchange and TCP/IP.[13)] Activity in Japan was systematized by the Widely Interconnected Distributed Environment (WIDE) project in 1987, which is still promoting the practical application of advanced technologies.[14)]

In the second phase, many commercial applications and business start-ups were attempted after the U.S. government decided to open the Internet to the public. During this phase, the rules of the game for the Internet changed dramatically. Many start-ups enjoyed success by using the advantages of the Internet and became net heroes. Mobile phones and other information appliances appeared on the market, adding the general public to the growing body of Internet users. Conflicts became inevitable between the many people of differing backgrounds and interests that joined the Internet in this phase, but the number of conflicts remained small and the conflicts were not serious ones.

In the third phase, which has yet to be completed in any country, the power and convenience of the Internet become recognized by almost all members of society and it evolves from a simple and natural human interface to a network of ultra-high-performance and ultra-high-reliability Internet data centers. In this phase, many public services, commercial activities, and governmental services start to be conducted on-line, the Internet becomes the main social infrastructure, and people are mainly concerned about reliability and security.

In the forth phase, the Internet diffuses into most homes all over the world. Whether it becomes accepted as a social commodity depends on the efforts made to make technological and social breakthroughs. Various negative aspects such as the "digital divide" and cyber crimes become serious problems. However, if the required social commitments and technological innovations are made, we can enjoy the efficiency and the richness of the new global information era. We can also cope with problems such as the social instability caused by the negative aspects.

As mentioned above, some advanced countries, for example, the U.S., Canada, and a few European countries are in the early part of the third phase. Japan and other developed countries are at the end of the second phase, and many developing countries are still in the first and second phases. The appropriate policies and guidelines, therefore, will differ from country to country.

3. Cyber society and the digital economy

3.1 Cyber society

As the Internet diffuses, we become freed from some of the restraints of geographical and cultural distance. We can communicate with people by voice and images and can exchange e-mails and document files. This multimedia communication in cyberspace enables us to form a new community called the "cyber community." An individual who has a very specific hobby and has difficulty finding a group with the same interest can now find such a group even if it is on the opposite side of the globe. Software agents and other software systems enable these distributed people to share their information and create a common ground or even a common culture, i.e., a cyber community that is free from the real world. The evolving cyber society is composed of various kinds of cyber communities.

The Internet environment has become suddenly ubiquitous in Japan through the medium of the mobile phone.[7] People exchange and retrieve information through the Internet every day – on the street, in the park, or even on a highway. Other information appliances and domestic electrical equipment will soon be embedded into the Internet so they can communicate with householders. These developments will change the cyber society into a communication-rich society.

Communication is bilateral by nature, and it plays a major role in all layers of daily social activities, ranging from local government to international organizations. It provides us with a mechanism for real democratic decision making in any social activity. As a result, we now need more self-discipline and common sense and need to be more responsible about our decisions and behavior.

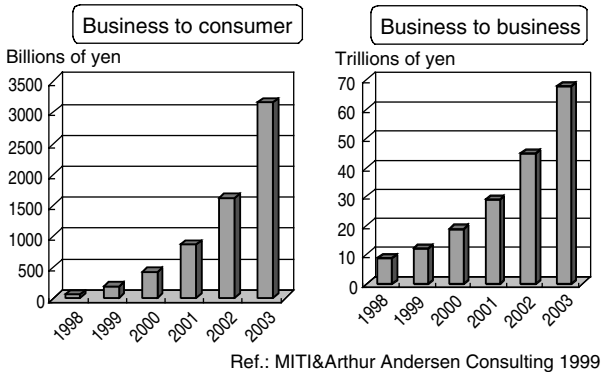

Figure 5
Growth of electronic commerce in Japan.

3.2 Digital economy

Electronic commerce changes every aspect of business and consequently changes business itself. Money, products, and information, which used to have separate distribution channels, are now being transacted in the same channel of the Internet, causing revolutionary changes that enable a digital economy to emerge. The emergence of a digital economy was reported by the U.S. Department of Commerce in 1998 and 1999,[3),15)] which analyzed how IT can cause a business revolution and how the digital economy is emerging in the U.S. The reports emphasized that aggressive transformation to a digital economy is the key to being at the leading edge of the world economy. As shown by the market growth of electronic commerce (**Figure 5**), the transformation to a digital economy in Japan is occurring at a steady but slower rate than in the U.S.

In the digital economy, the marketing cost for consumers, for example, decreases dramatically and businesses can perform Customer Relationship Management (CRM) to provide one-to-one marketing, whereby consumers' needs can easily be determined through the Internet and responded to individually by transferring customer information to producers and suppliers. Although, on one hand, conventional wholesale businesses face the threat of extinction, new Internet intermediary businesses will emerge and mass-personalization can be realized.

3.3 IT Revolution in business

Before the Internet, even in the production industries, proprietary IT has, from time to time, improved production lines in factories and business processes in offices; but the Internet thoroughly changes the business scene. It provides us with an inexpensive, easy-to-use, standard system that enables businesses to expand from independent production lines and business processes to inter-company production systems controlled through supply chain management (SCM).

Corporate intelligence becomes another important asset in business. Knowledge management (KM) is the key technology for activating and transforming tacit knowledge into commonly usable knowledge, especially for large companies. Again, the easy accessibility of the Web is the key that enables production experts and office professionals to manage their own knowledge and know-how within their own KM system. Systems engineers in Fujitsu are already using their own KM system, Solution Net. Sharing the best practices and finding the key persons inside and outside a corporation are examples of effective KM. A KM system can evolve into a corporate portal which forms the central source of all information and knowledge within a corporation.

3.4 Examples of public services: Education and emergency services

Education plays an important role in sustaining a cyber society for creating professionals and engineers and for enjoying high living standards and good culture. As emphasized in a report to UNESCO,[16),17)] higher education and lifelong education will be of great importance in the 21st century. The Internet can make education services available to home-based schools, hospitals, banks, shopping plazas, and almost any other place a connection can be established. Also, it can turn a humble kitchen into a sophisticated classroom. With just a panel for displaying Web pages, we can make huge amounts of useful data flow in

and out of our homes. Remote education programs are not just offered by the conventional institutes, but are also given by remote education programs and e-learning portals. The added flexibility provided by these new learning opportunities can make it possible, for example, to finish a college degree.

Another example of how the Internet is used in public services can be found in the emergency services. As is well known, Japan experiences frequent earthquakes, volcanic eruptions, and other natural events which sometimes threaten our lives and property.[18] From the experience of the Great Hanshin Earthquake of 1995, the Lifeline working group of the WIDE project has developed a service called "I Am Alive (IAA)" which provides assembly locations and other information such as the name, sex, age, address, and health status of people caught up in a disaster. In the recent destructive earthquakes in Taiwan and Turkey, IAA and a similar service were operated and shown to be quite helpful. Because of these cases, there is now general agreement that disaster communication services such as IAA should be standardized, scalable, and international.[19),20)]

4. Challenges

4.1 Technologies: Performance and availability

4.1.1 Devices and telecommunications

In the past decade, the improvements in CPU performance and storage capacity have obeyed Moore's law, i.e., a doubling every 18 months. According to Moore's law, the smallest device scale will enter the atomic realm between 2020 and 2025. However, a revolutionary breakthrough in technologies, for example, quantum computing will be necessary to sustain the pace of improvement. One breakthrough that is inevitable however is the system technology for large-scale integration.

In telecommunications, the worldwide diffusion of the Internet is increasing the demand for capacity in backbone networks. The innovation

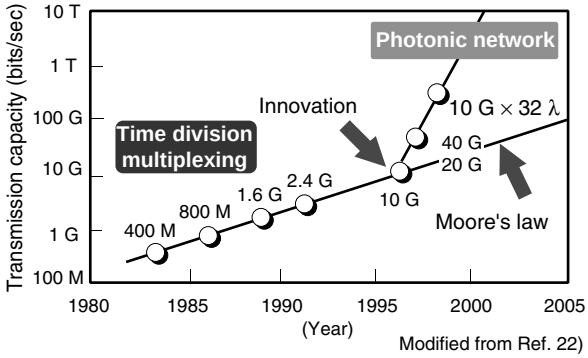

Figure 6
Speed of innovation in backbone network.

of optical amplification and wavelength division multiplexing (WDM) has made the photonic network a reality and can, at least for the near future, enable a 10-fold increase in bandwidth every two years, which is more than enough for Moore's law (**Figure 6**).[21] The Petabit network may come out on the market in 2005.[21),22)] Various topics of this field have been covered in previous issues of this journal and new developments will be covered in future issues.

4.1.2 Web centers

Because of the explosion in the number of Web users and the sharp improvement of backbone capacity, the availability of the Internet now depends on the performance of node servers and Web centers. In the major portal sites, the number of accesses at peak times is already three to four orders of magnitude larger than at non-peak times. Another important feature is data management of Web centers. Network area storage technology is a core factor in managing Petabit-size data centers. The Web center has to be reliable and scalable. In another article of this issue we describe our continued efforts to develop high-performance servers for high-reliability, high-scalability Web centers.

The ability to safely operate corporate information systems while keeping pace with innovations in computer technology has increased the demand for outsourcing centers. To offer a reliable environment and dependable system-

solution services, Fujitsu now has two system centers in Japan, one in the east and one in the west.

4.1.3 Network management and security

The Internet is a dynamic environment, and in many instances it has become a cyber lifeline. Everything transferred over the Internet, from money to products, is a form of information and is transferred in the same way. The Internet gives us an incredible opportunity, but it also comes with great risk, because an out-of-service system can result in huge financial losses and other disruptions to society. Network management for good quality of service (QoS) and reliability have therefore become major concerns.

Another essential requirement for the Internet to be accepted as a social infrastructure is a security system for personal identification and for authenticating the origin and integrity of sent/received information. Success in an Internet business requires a defense for preventing unauthorized accesses. A security structure that covers areas ranging from cryptography to national and international regulations has to be developed for each level of information handling. New cryptography technologies such as elliptic curve cryptosystems (ECCs) and quantum coding may provide us with a secure on-line life in the future. One of the papers in this issue introduces elliptic curve cryptography.

Since the Internet and many other networks are multinational, security mechanisms have to be adapted to the relevant national regulations. (This is particularly true in the case of encryption mechanisms.) To fulfill the requirements of individuals, business, and government agencies, there are some proposals for a security infrastructure that enables multi-level security and introduces services that can establish security policies between participants.[23),24)]

4.1.4 Human interface

As the Internet grows to include more elderly, young, and handicapped persons, the human-computer interface will need to be made easier to use and standardized so that it is common across all platforms. Language, of course, is another important aspect of the Internet. Information technologies such as voice recognition, inter-language translation, and text-to-speech transformation will enable powerful communications tools, for example, instant messaging between people who do not understand the same language. To ensure smooth unobtrusive communication in a cyber community, it is necessary to provide people with "awareness" information that indicates whether a potential communication partner is, for example, busy or free. This special issue includes a review of the Instant Message and Presence Protocol (IM&PP) and its application to electronic commerce.

4.1.5 Knowledge management and service architecture

Intelligent tools for processing and managing knowledge are indispensable for the huge amounts of contents that are stored and updated in the knowledge network known as the Web. Even a simple search for information about a specific topic by a search engine creates a flood of information. To cope with such a flood, powerful filtering and categorizing technologies and intelligent agents with machine learning mechanisms must be developed. However, regardless of the advances in technologies and content, true standards are indispensable for the sharing and wide dissemination of computer-based content. The language for structuring knowledge, XML (eXtensible Markup Language), will be a standard for contents. Some trial applications of XML to knowledge bases and to knowledge processing are described in this issue.

The Internet application services mentioned above will be designed and deployed by a service architecture. Service components are provided for contents, personalizations, interactions, and transactions. The basic platform technologies for the service architecture are language, object models, messaging, and security services (**Figure 7**).

Cyber services that completely satisfy our

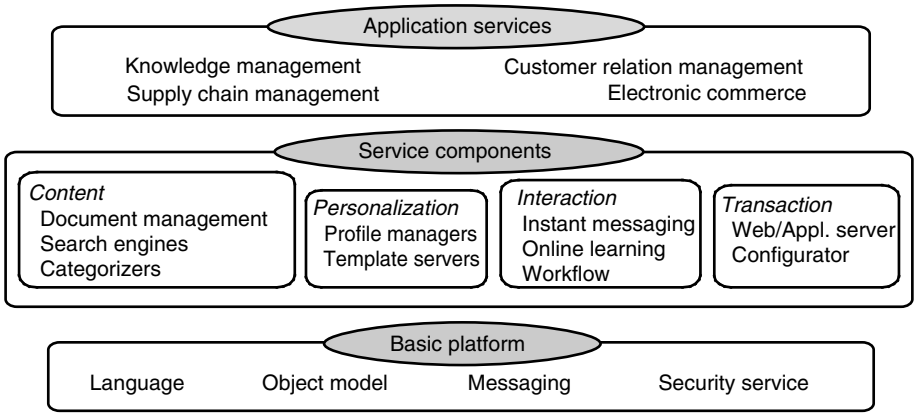

Figure 7
Service architecture.

needs will be realizable only when human-friendly interfaces and personalized intelligent service components are developed using powerful basic platform technologies.

4.2 Regulations and new ethics

A fundamental problem of the Internet era is that the Internet can easily change a local personal idea into a large-scale global reality, even if it is only acceptable locally. For example, a simple personal exchange system for MP3 files that is currently available has been strongly criticized by the music industry. Society is not yet ready for all the possibilities and influences of the Internet. New regulations must be established through extensive debates, and the new protection and pricing mechanisms for intellectual property such as music, movies, and books may be drastically different from what they are now.

Establishment of the laws, regulations, and security technologies needed to secure a safe cyber life is well behind the progress and diffusion of the Internet, so great efforts have to be made to close the gap in an efficient way.

The socio-psychological influence of the Internet is also a matter for investigation. In addition to the security structure to prevent cyber crimes such as computer virus attacks, Internet fraud, and denial of service (DoS) attacks, new Internet ethics need to be established to ensure a safe on-line life through public education and regulations.

4.3 Society: The "digital divide"

The rapid diffusion of the Internet into the organizations, cultures, and societies of industrialized nations may widen the multidimensional gap that already separates them from developing nations, exacerbating an already significant moral and practical problem.[25] This situation is precarious, and it fills many people with apprehensions that the "digital divide" between those citizens who have access to the Internet and those who do not may work to widen the economic gap.[26] Although it will not be so easy, the only way to close the digital divide is to educate the general public.

Consensus conferences held by the Danish Board of Technology have pointed out that education is an important way of helping the general population assess technology.[27] Future schools are predicted not to focus on transmitting knowledge but instead on teaching students to manipulate symbols so they can acquire and create knowledge throughout their lifetimes.[28]

5. Future perspectives

It becomes clear that the Internet revolution

will inevitably force society to reflect and reform itself. At Fujitsu, we are particularly concerned with how IT will be adapted to serve public interests around the world. To meet the needs of people in the private and public sectors as well as to serve the public interests of society and help people meet personal goals, we are striving to achieve a proper balance between theory and practice, training and building, tradition and change. In cyber society, we can easily obtain and evaluate huge amounts of information from all over the world. Therefore, in the Internet era, the uniqueness of individuals and the variety of local cultures will become more and more valuable. This is quite a contrast to the situation in the previous industrial revolution, in which individuality was lost in the machinery of mass production.

The Japanese government has a plan to establish a nationwide Internet authentication system by 2002,[29] but in Finland, electronic identification cards have been in use since 1999.[30] In the 21st century, people will be able to enjoy tailor-made services anywhere by using personal cards that carry biomedical, private, and public information.

It should be emphasized again that technologies and regulations that protect privacy are the keys to establishing the Internet as a social infrastructure. The Internet has made us more aware of an old problem: the more convenient our life is, the more vulnerable we are. As we enter the new century, with the rapid changes in demographies and the world economy, a plausible solution to these drastic changes could be acquired through the Internet revolution and by the promotion of cyber societies on a global scale.

The possibilities are infinite, but their realizations depend on us.

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