Visions of the Information Society

FOSTERING GLOBALLY ACCESSIBLE AND AFFORDABLE ICTs

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1. Introduction: the global information society

1.1. Technology

The information and communication technology (ICT) is evolving by leaps and bounds. The word "ICT revolution" will soon be a dead language and people in many societies will take it for granted that they live in the land of ubiquitous communication. We could even speak of a great migration of mankind toward the digital continent.

On the technology front, ICT will collaborate with biotechnology, environmental technology, genome technology, and nanotechnology or quantum technology to lead mankind into the unknown terrain. The transmission speed of digital information will reach gigabits, terabits, or even yottabits and googabits per second enabling us communicate with other people or device without feeling any stress. The cyber world will become superposed on the real world.

The rapid changes that ICT brings in create tension and friction in society. True, any technological change has some impact upon society if it is worth to be called as such at all. However, ICT's impact is wholesale. Not only is it limited to part of our daily lives, but also it affects every phase of our existence. The reason is simple: ICT works between people. It is a societal technology. By its very nature, ICT transforms the way individuals and corporations communicate with each other forever[1].

Changes will not only be confined to economics; politics, diplomacy, education, communities, culture, sports, religion, meaning of life and even war will not be the same as they used to be. It is often said that ICT makes the world smaller for mankind. But the truth may lie in the opposite proposition that human being as a living creature is becoming a giant in the physical environment of the earth.

This creature with ICT augmented sensor and nerve system can look into the deepest core of the earth, the inside of living chromosomes, and the universe in the light year's distance. In the physical world, this creature is eating up energy and environment provided by the earth. The meaning of democracy and freedom would be different for the whales in a little inlet and for the small fish in the big ocean. So our basic social infrastructure will need an overhaul to fit the size of our existence.

1.2. Communications transcending borders

ICT is often said to have imperatives to unify the world because it enables people to communicate across many borders. National borders are surpassed by the internet. Free flow of information within an organization will make the multitude of echelon borders obsolete and demand a flatter hierarchical structure. Accountability and transparency requirement on bureaucracy and government will hopefully make the distinction between insiders and outsiders less meaningful. Even the sense of belongingness or association will assume a new dimension: families, companies, voluntary organizations, religious groups,

and political parties may need a redefinition over their extended forms. All these trends point to the emergence of a borderless communication environment.

On the other hand, the diversity of ideas, perspectives, thoughts, cultures and values will remain to be the source of gains from communication just as the diversity of endowment and technology is the source of gains from trade. *Quid pro quo* lies at the heart of information *catallactics*. This is to mean that the less diversity, exoticism and surprise there is, the less need for communication and hence the less opportunities for mutual enrichment. The irony of the global information society is that if it leads to a convergence of systems and values in the world, then there will be less reason and less need for information society.

However, we need not worry about the extreme situation: the richness of diversity will remain to be the source of our inspiration and the new value is being created every moment. For one thing, digitized information covers only a very limited scope of human senses; auditory, visual and perhaps contact in a limited sense. Olfactory and palate senses are yet to be transmitted electronically. Technology has not found a way to transfer senses transmitted through the nerve system in a human body to the other: I still cannot feel your pain. Moreover, the contact that is the most fundamental means of communication for any form of life is not yet electronically transferable. That is to say, no life can breath or nourish or reproduce without having a direct contact with outer environment or other genes.

For another, bits of information are only a metaphysical matter that is different from human knowledge or thought. Information needs to be deciphered and interpreted before it becomes part of our knowledge. The frame of reference is provided by our living experiences. Food, climate, family, relationships, and all natural environment help us form the frame by which we interpret information. In other words, it is only after information passes through our internal barrier called “culture” that it becomes meaningful and urges for reaction. Thus there is still plenty of room for untransmittable information in the cyberspace. This fact will continue to play the vitally important role in our total communication experience.

It is indeed important to have a sense of reality as to how far ICT will transform our society and how soon. However, it is overwhelmingly clear that ICT has already been changing many facets of our society. Naturally the change will open new opportunities for some and close old opportunities for others. As with the major inventions like railroad, light and electric motor, combustion engine, petrochemical product, and public health system in urban areas, ICT will undoubtedly lead the world into the road of history which is entirely different from the one the real world has been following[2].

1.3. Country-wise approach

Looking at the bright side of ICT, it is only natural that governments in many countries adopt various policy measures to foster ICTs. Depending on the country’s endowment in human resources, technology and the strategy for economic development, each country places varying priorities on particular policy measures[3]. Table 1 is just a brief summary of the policy emphasis of selected countries and region.

Table 1. ICT policy measures of selected countries and region

	Japan	Korea	E U	Finland
Technology development	• Super high speed internet • Networked home appliances • IP telephony • High speed wireless internet • Convergence of communications and broadcasting	• Next generation internet • Photonic communications • Digital broadcasting • Mobile communications • Software development	• Information society technologies programme • microelectronics, information processing, fixed and mobile communications, interfaces • Multimedia content and tools • Technology marketplace	• Support by Tekes • Digital signatures • Data security • Freedom of speech, privacy and confidentiality of communication
Technology diffusion	• School ICTs • eGovernment • Information security • Consumer protection	• ADSL for homes • CALS for business • Small and medium sized enterprises • eGovernment	• Technology implementation plan • Health case, transport and tourism • Telework • Socio-economic benefits	• No direct subsidies • Support for SMEs • Promotion of eCommerce • Government as purchaser
Business Environment	• Environment for eBusiness • Distribution of digital contents • Small and medium sized enterprises	• Electronic settlement • Intellectual property • Standardization	• Ecommerce • Small and medium sized enterprises • Business clusters	• Government portal for business • Electronic settlement • Standardization
ICT skills	• Developing IT skills • Instructor for basic IT skills • Accepting foreign engineers • Nurturing content creators	• Program for informatization of 1000 • Distance learning by CATV		• Universities and polytechnics • Project citizenship skills • Computer driving license

Note: Items in the table were taken from "Priority measures 2002 for e-Japan" (May 18, 2002) for Japan and OECD, *Information Technology Outlook*, 2002, for other countries on a selective basis by the author.

Although this table is not intended to be an exhaustive study, we can observe some outstanding characteristics emerging from each country. In Japan emphasis is placed on technology development with a clear focus on a particular type of technology. Also noteworthy is the Japanese attention on networked home appliances. This is envisaged as the next generation system of communication terminals, refrigerators, lightings, ventilators, washing machines, and other appliances that are connected to the next generation internet with Internet Protocol version 6 (IPv6). Relatively less emphasis is placed on social impact of new ICTs.

Korea presents another case of technology-oriented policy objectives. ADSL, CALS and CATV are given particular attention. It is to be noted that in an effort to develop IT skills, Korean government has launched an ambitious program to informatize 10 million citizens or some twenty percent of the total population[4].

In the case of EU, emphasis seems to be placed more on socio-economic benefits from the technology than on technology *per se* and this tendency is most visible in Finland. "Project citizenship skills" intends to enhance citizen's technical skills, commercial skills, skills in acquiring and using information, consumer skills and the skill to influence on information society policy. Its aim seems to empower citizens not only as informed consumers but also as active participants in the formation of public policies[5].

1.4. Global policy imperatives

Since information transcends national borders and new values are created by new encounters, we can clearly see where the issues of fostering ICTs on a global scale lie. The global information society needs the new global social infrastructure.

The basic question is whether we can rely on private incentives and market forces alone to deploy worldwide information infrastructure. If it is an international public good we know how market fails to provide the optimal level of architecture or service. Hence it must be contended that fostering accessibility and affordability of ICTs is the international public policy objective that must be pursued for the benefit of citizens in the global information society no matter where and how they live.

However, the basic tenet of a global policy agenda applies here. How should policy be formed and how should it be implemented without recourse to the coercive power that a sovereign nation would have over her citizens? Many global policy agenda already suffer from the absence of the world government. All the existing international bodies including United Nations, International Bank of Development, International Monetary Fund or World Trade Organization lack the ultimate power for coercive sanction and taxation. Even international treaties as they are binding under international law are based on a cooperative or non-cooperative game between sovereigns.

In addition to this reality, cyberspace offers another complication because it is spanned over all nations as digital information flows freely among them. In cyberspace all segments of all nations are seamlessly connected with each other and no single sovereign country can control or administer the integrity of the global network system in its entirety[6]. We will have to bear this in mind when proposing any policy measure for the global society.

2. The new social infrastructure

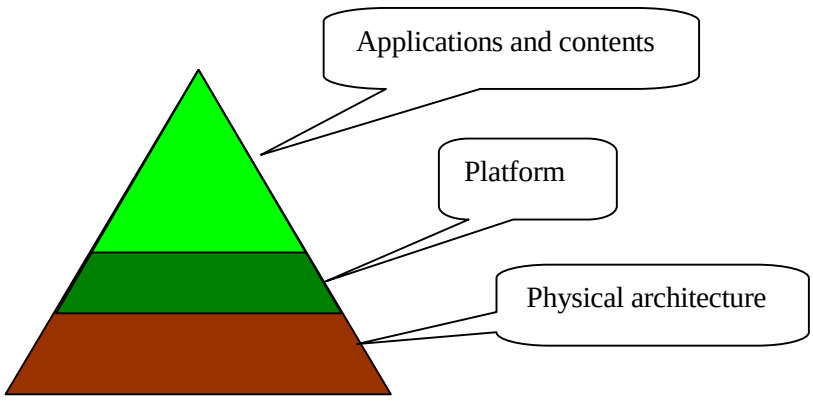
When we talk about ICT, it must be made clear at the outset that the new social infrastructure involves not only the physical architecture for information transmission but also the platform and the applications and contents. The discussion on "digital divide" often focuses on the lack of accessibility to the physical infrastructure including computers and the internet for various groups of people categorized by geography, income, education, race and ethnicity and household type[7].

However, mere connectivity in terms of wire or wireless technology to the internet does not warrant accessibility to the social infrastructure. We need to take into account the usability of the network, for which the availability of dependable platform software and also the availability of application software and services provided by them are indispensable. Information network without software would be like a highway system in a region where people cannot drive cars or an airport without air traffic control facility.

2.1. The three layers of network

Thus we must conceive of the network infrastructure of the global information society as consisting of basically three layers: physical architecture, platform and applications and contents. The three-layer characterization is analogous to computer's hardware, operating system and software. Altogether they comprise the network infrastructure. The accessibility and affordability question must be addressed to all these three layers of digital network.

Figure 1. Three layers of network infrastructure



2.2. Network architecture

The network architecture includes physical network system consisting of wires and cables, switches, ATMs, storage facilities, routers, wireless connections, antennas, and so forth. Together with buildings, offices, poles, conduits, computers, the architecture provides services of voice, data and image transmission. In terms of industrial classification it is the telecommunications industry that fall into this category. Related industries are manufacturers and vendors of materials, devices and equipment, and construction and system maintenance engineers.

When telephone was the only service that was provided on the network, the architecture was relatively simple. Basically it consisted of wires and switches and the buildings that housed them. Various switches allowed calling parties to occupy the paired wires from one end to the other. Telephone rate was essentially the opportunity cost of letting the calling parties occupy a portion of network resource for the length of conversation time.

With the inset of packet transmission technology that eventually led to the internet, network resources became used more efficiently. The digital signal sent by the sender is chopped into packets each with the address to which it is designated and packets are thrown into the network. Packets then travel through the network each choosing a different route and are consolidated at the receiver's end. Network architecture became the "commons" through which information travels at the speed of light[8].

2.3. Platform

In the platform layer we can think of number portability, billing system, payment system, the internet protocol of various versions, authentication system, and IP address management system. Increasingly becoming important is the digital platform for digital broadcasting and communications. For example, the pay-per-view system for the digital broadcasting, package of communicable software for games, the technological standard for DVDs, the billing system for connection and content services for cellular phones, cryptographic system, and electronic money and other payment system for electronic commerce belong to the platform layer of the network.

As the degree to which transactions rely on the business model in the real world decreases, certainly the scope in time and space and the speed of execution increases. The global market for a product may become a possibility, the delivery and payments can be made any time of the day, and business can be conducted at the speed of light. However, in exchange for such efficiency enhancement, the digital business carries with it a particular difficulty that accompanies communications with limited channel of information.

Contracts can be processed quickly but with whom? A big order may have come from a cat walking on the keyboard if not from a criminal trying to steal someone else's identity. Confirming the transactor's

identity, establishing the transactor's credit-worthiness and authenticating the transactor's credit card or other digital code become all the more important.

2.4. Applications and contents

Applications are systems and software that enable eCommerce, eGovernment, eLearning, eDemocracy or eSociety. Contents refer to digital texts, sounds, images and movies. When the infrastructure allows broadband communications, such contents as music, games, and high definition moving pictures will become increasingly affordable for the general public. People who are involved in this layer are creators, contents right holders, contents service providers and contents aggregators.

Most of eCommerce and eGovernment applications are not self-contained within the network. They must rely on physical delivery system or personal appearance in order to complete the service. However, the market for digital contents is self-contained. Orders are placed, payments are made, and the deliveries are completed all within the network. As such the market for applications and contents casts a new challenge to the existing laws and business practices.

Especially important is the copyright and business model question. Since the digital technology allows for almost costless reproduction of original contents and software, the traditional method of keeping track of distribution and payments may not be the optimal business solution. Packaged software with copyright protection follows the traditional distribution model rather closely. However, software or digital contents need not come with a physical container or medium. Transactions can be all done on the network in a much more efficient way.

Then the whole question of copyright springs up. Should copyright be protected for digital products in the same way as it is protected for real products? By imposing copyright protection by way of watermark backed by a huge database of digital records, are we not hindering otherwise more efficient circulation of digital contents as the case of Napster led us to wonder?

Also, if the marginal cost for multiplication of digital contents is practically zero, what kind of business model will become relevant? In the traditional market system, competition will drive down the price of such a product to zero thus making it impossible for creators to retrieve the initial set-up cost of software or content development. Can we find an implementable solution in technology, business model or legal system? This and other important questions need to be answered[9].

2.5. Perspectives on accessibility and affordability

The purpose of categorizing three layers for information infrastructure was because we can obtain a clearer picture of what needs to be done. Policy measures needed to foster accessibility to the physical network are different from those needed to foster affordability of contents or applications. Table 2

summarizes the necessary principle and measures that must be applied to each of the policy objectives in a matrix form.

The table reads as follows. Vertically we take the three different layers of information and communications network. Horizontally, we place the two policy objectives i.e., accessibility and affordability. Thus, in order to make ICTs affordable, competition policy is effective in the applications and contents market. However, it is questionable if the same principle applies to the provision of network infrastructure. We will go into some detailed discussion for each of the points summarized in this table.

Table 2. Policy imperative for accessibility and affordability

	Accessibility	Affordability
Applications and contents	• Raising computer literacy • Deregulation • Removing cultural impediments • Establishment of cyber society convention	• Competition policy • Fair-use principle of copyright • Developing new business models
Platform	• Development of platform technology • Setting technical standards • Securing security, privacy, decency • Harmonization of tax, payment, regulation and copyright protection	• Alignment of nexus technology and institution • Preventing lock-in effects • Preventing tie-in sales
Network	• Choice of technology; wired (coaxial cable, optical fiber, power line), wireless (microwave, microdesic, satellite) and mobile phone. • Investment in infrastructure building	• Public works or subsidy • Regulated tariff or facility based competition • Providing universal service

3. Accessible ICT infrastructure

3.1. Choice of technology

In order to make the communications infrastructure accessible to the citizens and corporations, the first question to be resolved is the choice of technology. All developed countries have a well-developed wired network for telephone. The accessibility is concerned with connectivity to the network. There may be geographical areas where the last one-mile between the closest switch and the telephone equipment at home is not connected.

The reasons for missing connectivity may be found on the demand side, the supply side and the government policy. On the demand side it may be because of the high cost of telephone service that

citizens choose not to subscribe. On the supply side, it may be because of geography or other natural environment that make the carriers hesitate to make investment. Also, the government regulatory policies on tariff structure and universal service affects the degree of accessibility. We will come back to the economics of infrastructure investment. But, before doing so, we will pay attention to the fact that the choice of technology is highly relevant to the resulting accessibility. The basic choice is between wired and wireless technology.

In advanced countries, the traditional wired network is extending into and incorporating wireless networks. In Scandinavian countries, United States, Japan, European countries, Korea, Singapore, Malaysia and China, the cellular phone network is proliferating at a great speed bypassing and substituting for the existing networks. Wireless LAN technology is becoming available in informationally advanced countries as well.

Traditionally it took a huge amount of investment to cover the entire nation by the network of copper cables. In fact, the regulatory policies for telecommunications industry were geared toward their peculiar technological characteristics where various services are provided on the large-scale physical infrastructure. The main concern was how to recover the infrastructure investment cost from the telephone usage.

However, a replacement from coaxial cables to optical fiber and the expansion of wireless network are changing the cost structure of the infrastructure industry. These technologies offer a more economical and efficient network construction. It is particularly relevant to the countries where the wired infrastructure is underdeveloped. Instead of covering the country by wires anew, it may make more sense to start with wireless technology. We will just take a look at two examples to that effect in India and Bangladesh.

Here is an excerpt from “Indian Villagers Pedal Wireless”[10].

> Raw muscle power might achieve what the Indian government so far hasn't been able to: spreading the telecom revolution to the 700 million rural people of the country.
>
> This month, 5,000 young men on bicycles carrying mobile phones equipped with CDMA Wireless Local Loop will ride into 5,000 West Bengal villages. Not only will the endeavor provide these men with a steady source of income -- they keep 25 percent of profits from all calls made -- but they will also bring telephone services to village doorsteps for the first time.
>
> In a country where just over one phone exists per hundred people in rural areas, this is a big leap.
>
> The group behind the initiative is the nonprofit Grameen Sanchar Seva Organization, known as GRASSO. Its goal is to use telecom and IT to strengthen the distribution network of agricultural

produce -- rural India's mainstay -- and make it more profitable for villagers whose livelihoods depend on it.

But phones and the Internet aren't enough, said Soumitra Shankar Das, GRASSO's working chairman.

…

"The idea is to build three networks -- phones, Internet and transport -- each sustaining the other," said Das.

This integrated approach stands out among some spectacular stunts carried out in the name of bridging India's digital divide.

…

First, each village will receive one phone operated by a man on a bicycle. ("Only 2 percent of applications were from women," said Das. Cultural orthodoxy keeps most rural women at home.)

After telephones comes transport. One small truck will serve 10 villages by carrying produce to city markets and warehouses. "Today trucks come from cities, running empty one way, so transportation costs are high for farmers," said Das.

…

The third network, one Internet kiosk for every 10 villages, will keep farmers on top of which markets offer the best prices.

Grameen Bank started their microcredit business in Bangladesh. Now they go into “Grameen phones”[11].

Grameen Bank members have entered the age of information technology by leasing cellular phones. They receive special loans from the Bank for purchase of cell phones. They are popularly known as the village phone ladies. By the end of 2001, there were more than eight thousand village phone loanees who have together taken loans amounting to Tk. 123.48 million. Average loan size is about Tk. 15,000. During the year nearly 5,000 new loans were distributed.

Tele-density in Bangladesh is very low. Telephone services are not available in most of villages. Demand for telephone services operated by the village phone ladies is, therefore, very high. Grameen Bank in collaboration with Grameen Telecom will lease finance nearly 12,000 phones to its members during the next year.

The village phone ladies of Grameen Bank sell services to earn additional income, which is almost double that of the per capita national income.

3.2. Digital divide

Traditionally the accessibility question of the network has been cast in terms of "digital divide". In the United States, Department of Commerce published four annual reports entitled *Falling through the Net* from 1995. In the second report they used the word "digital divide" for the first time[12], which soon became a household word in ICT literature. The problem received the attention in the G8 summit held in Okinawa in 2000 where the so called IT charter was adopted in which the heads of the states agreed that the elimination of digital divide was a common policy objective among advanced countries[13].

In the third report from Department of Commerce, *Falling though the Net: Defining the Digital Divide*, 1997 the digital divide was defined to be the "divide between those with access to new technologies and those without". New technologies they referred to were telephone, computer and the internet. The concept focused on the availability of physical connectivity. If a citizen is not connected to the digital network for some reason, the person is denied of opportunities that network makes available to other members of the society.

Digital divide or the accessibility gap exists between nations, regions in a country and among individuals. If we compare the number of the internet users by international regions, North America 33.3%, Europe 31.5%, Asia Pacific 28.9% add up to 93.7% of the world total of 540 million in January 2001. The number of internet users is very low in the rest of regions including South America, Africa and Middle East. Europe and Asia Pacific are increasing the respective shares in internet usage from 2000 to 2002, while South America, Africa and Middle East's shares are relatively stagnant. Country study reveals that those with a higher internet penetration ratio are concentrated in North America, Europe and Asia Pacific regions. There is no sign to indicate that this divide is closing.

Within a country there is a regional divide. For example, the internet penetration ratio is 44% of total population in Japan in 2001. However, the penetration ratio is different between big cities and small towns. The average penetration ratio is 54.4% for big cities with more than a million populations whereas it is 45.3% for other cities and 36.4% for rural towns. The tendency is that the penetration ratio rises as the size of the city increases. Also, the metropolitan Tokyo area and the Kansai area around Osaka have a higher ratio compared with other areas in Japan. This shows that there is a regional divide in terms of the internet penetration[14].

Divide by individuals is related to such personal characteristics as income, age, gender, occupation, race, education, family or physical handicaps. Take, for example, the age factor. The internet penetration ratio by age group is 72.8% for the teens, 98.5% for the twenties, 68.4% for the thirties, 59.0% for the forties, 36.8% for the fifties, and 15.9% for the sixties. There is a clear and wide difference between individuals below 30 and those above 30 years in age[15].

If we compare by annual household income group, we observe that the penetration ratio is 30.2% for the class below 4 million yen, 44.3% for the class between 4 and 6 million yen, 50.1% for the class 6 to 8 million yen, 50.3% for the class 8 to 10 million yen and 55.7% for the class above 10 million yen. Clearly the higher income households are the more frequent users of the internet[16].

Also, it seems to be a general tendency that females rather than males, white color workers rather than blue color workers, those with longer educational history rather than shorter history, families with two parents rather than otherwise, the non-handicapped rather than the handicapped, and Caucasians and Asia Pacific rather than blacks and Hispanics have a higher internet penetration ratio[17].

3.3. Will competition do it?

As a mechanism to insure the availability of accessible and affordable service, which was conceptualized as a policy toward "universal service"[18], various regulatory measures were introduced from the early days. The question was first cast in the choice between universality by the state or private monopoly, or universality through competition assisted by government regulations. The policy debate went to the latter and in many countries state monopoly was privatized. In Japan Nippon Telegraph and Telephone was privatized in 1985, competition was introduced in the long distance market, and formal government regulation started with a mandate from the telecommunications business law of 1985.

The history of regulation thereafter was the history of deregulation and expanding the sphere of competition in telecommunications markets. Of particular relevance to the question is the concept of facility-based competition. It was held that with the introduction of new technology and services, economies of scale that once dominated the nation-wide network dwindled down leaving more room for competition. Telecommunications networks need not be a single solid system administered by a single management from end to end, but it can work as network of networks. Each segment or sub-network may be exposed to open competition.

In fact, there followed new entries first in the long distance market, then into local service, cellular phone, wireless service, optical fiber service, Internet Protocol telephony service. The entry by public utilities via power line communications technology is also being contemplated. It looks as though network service became a commodity just like any other service; market competition solves the efficiency question most effectively.

However, as it turned out, competition in the infrastructure market was a premature concept perhaps ideologically tainted by the political fad of neo-conservatism in the 1980s. Two observations came to the fore. One is the demise of infrastructure industry in the United States; financial services, telecommunications, electricity and airline industries went through a series of financial ordeal without making consumers better off at all[19]. The other example is the case of auctioning for airwaves or bandwidth. In the United States and Europe, bandwidth was put to auction in which the highest bidder

acquires the exclusive right of usage. The theory behind it was, of course, that the competition will pick the most efficient user of the bandwidth be it a cellular phone company, a broadcaster or some other imaginative bidder. The end result was that the price of bandwidth went sky high hurting even the successful bidder and leaving the spectrum unused.

These observations suggest that there must be a generic reason why competition in the infrastructure market fails if unaccompanied by supporting policy efforts. From the economics point of view the reason is simple. Infrastructure services are characterized by a relatively large fixed cost and more or less constant average cost so that the typical total cost function of supplying q units of service can be written as

$$C(q) = F + cq,$$

where F stands for the fixed cost and c for the average variable cost.

As a result of competition market price will be made equal to the marginal cost, which is nothing but c in this case. If there is cost differential among competitors the firm with the lowest marginal cost will survive and other firms will be driven out of the market. Hence $p = c$ will entail for the smallest c. This is to mean that for the least cost firm, the net profit is just $-F$. Thus even the most efficient firm would suffer a financial loss in its best effort. The fixed cost or the cost for infrastructure investment becomes unrecoverable[20].

The situation is the well-known phenomenon called "public utility dilemma". Competition in the industry where a large fixed cost is required will not only drive out the less efficient suppliers but also make the most efficient supplier financially non-viable. The consequence is the total collapse of the industry from which consumers will be hurt most severely or else a bail out by government, which unwinds the clock at least two decades.

3.4. Sustainable infrastructure

Thus it is clear that the pure competition policy is not the solution for sustainable infrastructure[21]. Nor was it politically feasible for a country with history of government monopoly or incumbent regulated monopoly. Take, for example, the case of the United States.

In the telecommunications act of 1966 it was provided that competition need be brought in to the local telephone service market where regional Bell operating companies (RBOC) are the dominant carrier. Upon this mandate the Federal Communications Commission (FCC) paved three paths of entry into the local telephone market: full facility-based entry, purchasing of unbundled network elements from the incumbent local exchange carrier (ILEC) and resale of the incumbent's retail services. The new entrants are called competitive local exchange carriers (CLEC).

Competitive carrier's market share rose at a rapid pace. As of June 30, 2002, CLECs reported 11.4% of the nationwide switched access lines in service.

Table 3. End-User Switched Access Lines Reported

Date	ILEC Lines	CLEC Lines	Total	CLEC Share
December 1999	181,307,695	8,194,243	189,501,938	4.3%
June 2000	179,761,930	11,557,381	191,319,311	6.0
December 2000	177,683,672	14,871,409	192,555,081	7.7
June 2001	174,485,706	17,274,727	191,760,433	9.0
December 2001	172,043,582	19,653,441	191,697,023	10.3
June 2002	167,472,318	21,644,928	189,117,246	11.4

FCC, *Local Telephone Competition: Status as of June 30, 2002.*

CLECs reported providing about 29% of switched access lines over their own local loop facilities. Here a reporting carrier should own the "last mile" of wire, cable, or optical fiber that connects to the end-user premises if it reports providing the local telephone line over its own facilities. The remaining 71% of access lines are either obtained on an unbundled network element (UNE) contract or on a resale contract from ILECs. In fact, more than 50% of end-user lines provided by CLEC were UNEs as the next table shows. As the *UNE-Platform Fact Report* (January 2003) emphasized, "UNE-P is unmistakably the principal driver of competitive growth in the local market today."

UNE-P Report says "one of the principal benefits of UNE-P is that it fosters geographically broad competition, bringing competitive benefit to urban, suburban and rural areas." It is certain that facility-based competition and service-based competition are bringing wider choice of end-user services for residential and small business users in increasing number of areas. It may also be claimed that a wholesale of unbundled network elements by ILECs brings about more efficient use of the already installed facilities. However, there are some down- side effects to this increased competition in infrastructure market.

Table 4. Reporting Competitive Local Exchange Carriers

(End-User Switched Access Lines in Thousands)

Date	CLECS Reporting	Total End-User Lines	Acquired from Other Carriers				CLEC-Owned	
			Resold Lines	Percent	UNEs	Percent	Lines	Percent
Dec 99	81	8,194	3,513	42.9%	1,959	23.9%	2,723	33.2%
Jun 00	78	11,557	4,315	37.3	3,201	27.7	4,042	35.0
Dec 00	89	14,871	4,114	27.7	5,540	37.3	5,217	35.1
Jun 01	81	17,275	3,919	22.7	7,580	43.9	5,776	33.4
Dec 01	84	19,633	4,250	21.6	9,332	47.5	6,072	30.9
Jun 02	96	21,645	4,478	20.7	10,930	50.5	6,236	28.8

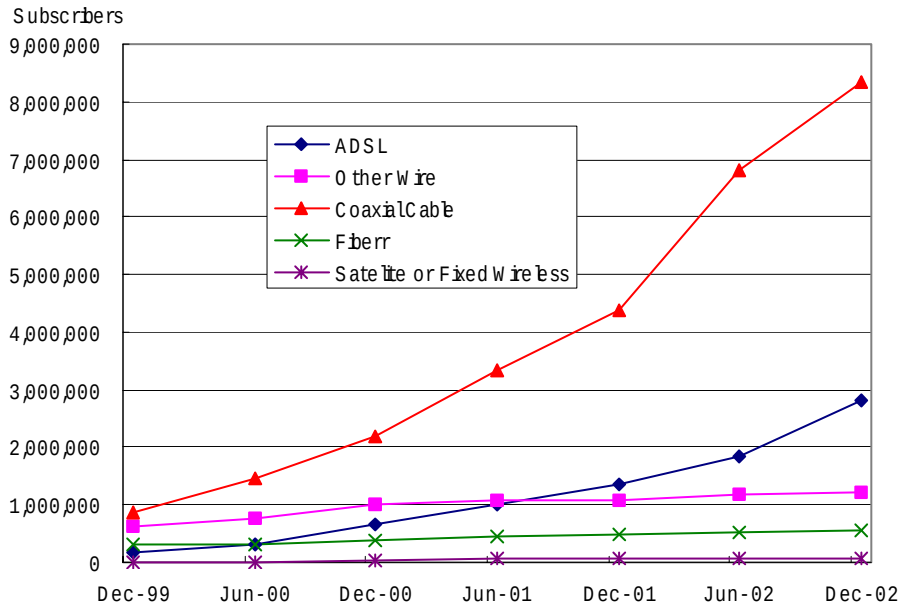
We must pay attention, first, to the fact that the facility-based competition that has materialized to date has employed traditional copper loop technology. Facilities are being constructed with an eye toward short run competition. It may yet to be seen if the copper loop will be upgraded to coaxial cables or optical fibers, which will be the infrastructure for broadband communications.

Another point is concerned with the price regulation placed on the wholesale of unbundled network elements. Prices for the use of facilities are regulated under the Total Element Long Run Incremental Cost (TELRIC) model. This is the approach in which carriers agree on the basic model of network architecture and prices of network elements are set at the forward looking cost level assuming the most efficient technology currently available is deployed.

TELRIC serves as countervailing mechanism to hold down the access charge that is prone to the incumbent's dominant monopoly power. However, since historical costs are not taken into calculation, there leave stranded costs or unrecoverable sunk costs yielding a financial strain on the part of ILECs. In other words, TELRIC under-prices network elements from ILEC's point of view[22]. This gives disincentives for LRICs to modernize and upgrade their facilities much to the detriment of all end-users concerned[23].

As side evidence, we quote the Fiber to the Home (FTTH) penetration ratio for U.S. as is illustrated in Figure 2. Taking into geographical and other factors into consideration, FTTH in the U.S. is very slow to come. In Japan as a comparison, the national average rate of optical fiber coverage is currently 59% and in major cities it comes to 95%. Optical fiber deployment is even higher in Italy, Norway and Korea than in Japan[24]. Clearly U.S. is lagging behind.

Figure 2. Advanced Services Lines by Types of Technology (Over 200 kbps in Both Directions)



Source: FCC, *High-Speed Services for Internet Access: Status as of December 31, 2002*.

Thus we have indicated that competition with transient regulations in the local access facilities may work in the short run to bring in lower usage price and increased choice of services but it gives disincentives for improving already installed facilities and deploying new technologies for the owners of infrastructure. We must pay attention to the possibility that this negative effect will outweigh in the long run.

4. Affordable ICT infrastructure

The government of each country, from the most economically developed to the developing, is taking policy initiatives to foster ICTs within its national border. However, a global policy framework is needed to foster global ICTs. Such a mechanism will also benefit each network subscriber in each country since the network effect accrues to all the members connected to the global network. In the global information society, increasing people's accessibility to the advanced information network in one country benefits the rest of the world. By this very reason, a concerted effort by the international community is called for.

4.1. Pricing strategy for penetration

The pricing strategy for the network service played a central role in each country's telecommunications

policy. Under state monopoly or regulated private monopoly, the mechanism was called cross subsidization that was built into the tariff structure. Usually long distance callers subsidized local callers, business users subsidized household users, and offices and houses in densely populated subsidized those in sparsely populated area.

The implicit subsidy given to households whose needs were mostly in local calls was justified on the basis of network externalities. As more and more people subscribed to the network, the opportunity for reaching a wider range of people expanded for all the subscribers thus making the network more attractive to them. The enlarged accessibility was the reward for paying a price that was higher than the marginal cost.

As countries moved into the privatization and competition phase, the cross subsidization scheme became increasingly unsustainable. Competition was introduced into the long distance market, for example, as a result of which the source of subsidies dried up. A delicately controlled tariff structure is still maintained in many countries. At the same time, a scheme called "universal service" was introduced in the United States, European Union countries and Korea, to which we will come back later again.

In case of internet pricing, the dynamic nature of network externalities may justify a non-linear pricing over time. The optimal strategy from the business point of view may involve a very low introductory price at the early stage of network build-up, later compensated by a higher price in order to recover the cost of investment. Such a strategy should not be condemned as predatory pricing[25].

4.2 Government subsidy and WTO principle

The optimal time profile of the internet usage price may be realized with a help from the government. The government may wish to give explicit or implicit subsidies to the internet subscription by individuals or ICT investment by corporations. Will such subsidies go against WTO's principle of trade and competition?

If a subsidy is given to domestic information equipment manufacturers in order to gain a competitive edge in the global market, it goes directly counter to the WTO principle. However, if a subsidy encourages increased subscription among households and corporations and thereby making the economy's industrial structure more efficient with added competitiveness, there will be less of an infliction on WTO. They fall within the legitimate policy investment just like public investment on such infrastructure as ports or roads or modernized legal system.

However, unlike other system technology such as railroad, ICT might bring about a leapfrog effect where the latecomer jumps over the front-runners. Economic theory has not yet come to grips with the role of government subsidy in the face of the leapfrog effect. The traditional infant industry theory presupposes that infants grow up slowly to meet the world competition. Pragmatically the matter will have to be

discussed in the international platform like ITU or WTO. In any case, the WTO's core principle of transparency, non-discrimination and procedural fairness must be applied to each country's policy implementation.

4.3. Evolving notion of universal service

In many countries the connectivity to telecommunication network is considered to be a basic social infrastructure that must be available to anyone who wishes to participate. However, the notion of universal service has evolved over time. AT&T first used the phrase "universal service" in the 1920s. In the age of local private telephone companies in competition, AT&T's slogan "One Policy, One System, Universal Service" was on "universal service" which meant that a telephone with Bell System was fully interconnected on a national level through its long-distance network. Other independent carriers were not mutually interconnected. Thus the universal connectivity was the gist of the notion.

It then came to mean that a citizen is entitled to a telephone access at affordable cost no matter where he or she lives. It became the obligation for the incumbent telephone companies to provide access if requested to anyone at more or less the same cost. This was made possible by a regulated tariff system through which a cross subsidization was effectuated.

Today the notion is still evolving and the means to guarantee universality are also changing. Soon the availability of e-mail service, access to the internet, a higher transmission speed, broadband and other advanced services will be included in the universal service list. To ensure increased physical accessibility, a universal service fund approach is adopted in many countries, which is an explicit cross subsidization scheme for infrastructure building and maintenance.

In fact, Claire Milne suggested that the choice of policy to realize universal service is different according to the stage of network development of the country concerned. Based on the telephone penetration ratio (the number of main lines telephones per 100 population), Milne differentiates five stages of development[26].

For countries belonging to the stage one, universal service policy typically focuses on the acquisition of new technology and the need to link all major population centers with a network. According to ITU, average telephone penetration ratio in most low-income developing countries will not reach 5 until year 2010[27]. Stages two and three are characterized by conditions where telephone service has wide geographic reach within the country and is available to a majority of households and businesses.

A majority of developed countries belonging to stage four have a penetration ratio well above 40. In those countries, the goal of universal service is to make telephone service affordable to all. The policy designed to bring about this is the system of explicit subsidies or cross subsidization targeted to the low income and those who live in high-cost areas. In the language of 1996 Telecommunications Act of the

United States, universal service policy is defined as "a public policy to spread telecommunications to all members of society, and to make available, directly or indirectly, the funds necessary to do so."[28]

The goals of Universal Service, as mandated by the act, are "to promote the availability of quality services at just, reasonable, and affordable rates; increase access to advanced telecommunications services throughout the Nation; advance the availability of such services to all consumers, including those in low income, rural, insular, and high cost areas at rates that are reasonably comparable to those charged in urban areas."

The ultimate stage, stage 5, is where telephone service, effectively, is an entitlement and every citizen's basic communications are met.

4.4. United States Approach

The 1996 Act states that all providers of telecommunications services should contribute to Federal universal service in some equitable and nondiscriminatory manner; there should be specific, predictable, and sufficient Federal and State mechanisms to preserve and advance universal service; all schools, classrooms, health care providers, and libraries should, generally, have access to advanced telecommunications services; and finally, that the Federal-State Joint Board and the Commission should determine those other principles that, consistent with the 1996 Act, are necessary to protect the public interest.

It is to be noted here that universal service now refers to the availability of quality services not just simple telephony. In many countries, the notion of civil minimum evolves over time as the citizens' standard of living rises. Similarly the notion of universal service undergoes changes according to the technology and economics of communications network. It is soon expected that digital communications with sound, text and images at a reasonable speed will be included in the quality of services for universal service

Following the act and a series of FCC decisions, Universal Service Fund was created in 1997 and Universal Service Administrative Company (USAC) came into existence as the administrator of the federal Universal Service Fund[29]. USAC is an independent, not-for-profit corporation regulated by FCC. USAC's purpose is to ensure that all Americans receive the benefits of universal service--affordable and efficient access to telecommunications and information services.

Universal Service Fund is contributed by telecommunications companies in the United States. These companies are required to pay a specific percentage of their revenues from interstate and international revenues-- the contribution factor-- into the USF. The contribution factor changes quarterly.

Making use of the fund thus collected, USAC provides the funding for four universal service support mechanisms; high cost support mechanism, low-income support mechanism, rural health care support mechanism and schools and libraries support mechanism. According to the USAC annual report 2002, $2.98 billion was provided over 1,500 companies serving customers in rural high cost areas.

Low-income support mechanism helps qualified consumers establish and maintain discounted local telephone service. In 2002, USAC distributed $673 million to provide nearly 7 million households with discounts on the monthly and one-time costs of telephone service. Rural health care support mechanism supports telecommunications costs for qualified rural health care providers, ensuring that they pay no more than their urban counterparts for comparable services.

The most ambitious program is schools and libraries support mechanism. This, also known as the "E-Rate, " makes advanced telecommunications, internet access, affordable for the nation's schools and libraries. The E-Rate provides discounts on the costs of the services, with the highest discounts going to entities serving the most disadvantaged sections of the population.

As it is clear from this overview, USF is a private fund administered by a not-for-profit company under strict FCC oversight, contributed mainly by long distance carriers, interstate and international, and distributed to local exchange carriers and non-traditional carriers that cater to the telecommunications needs of the high cost and/or needy customers. It is also noted that in the schools and libraries support mechanism, access to the Internet service by these institutions is emphasized.

4.5. The global universal fund

Looked at from the global perspective, we need to give a serious consideration to the possibility of launching and operating the "global universal service fund" (global-USF). Such a fund will be contributed by established international carriers and help construct the network infrastructure in less developed countries and thinly populated areas. Global-USF will also set global platform standards and help raise the information literacy on a worldwide scale.

There is a natural analogy between the universal service fund within a country and the global universal service fund that operates across countries. The basic idea is to provide financial assistance to those regions or sectors in countries that need be subsidized to install communication infrastructure. A pool of funds to which telecommunication carriers in richer regions contribute will finance such assistance. The fund will have to be administered by a not-for-profit corporation with a strict oversight by some international governance organization like ITU.

Of course, uncertainties abound and disputes will arise as to who should contribute how much and who should receive how much. However, practical questions must be resolved on a practical basis. The

global-USF will be an evolving international entity that works on the principles of “transparency”, “non-discrimination”, and “procedural fairness” much like those of WTO.

If global-USF embarks on the equity consideration or takes the access to information infrastructure as entitlement, difficulties will multiply. However, the notion of global-USF can theoretically be justified on the utilitarian ground alone.

4.6 Utilitarian ground for the global-USF

In this section we would like to give some theoretical background to the idea of the global universal fund scheme.

Let there be two countries; country 1 and country 2[30]. Let p_1 and p_2 stand for the price of communications service and q_1 and q_2 the volume of information flow in the respective countries. Demand functions for information service are written as $p_1 = p_1(q_1)$ and $p_2 = p_2(q_2)$. In order take the network effect into consideration, we assume that the marginal utility of the representative individual in the two countries can be written as

$$u_1(q_1; q_2) = p_1(q_1) + \eta_2 q_2,$$

and

$$u_2(q_2; q_1) = p_2(q_2) + \eta_1 q_1,$$

where η_1 and η_2 represent the degree of network effect in both countries. We are assuming the effect is reciprocal but with asymmetric coefficients.

The consumer surplus in the two countries can be represented by

$$S_1(q_1; q_2) = \int_0^{q_1} \{p_1(t) + \eta_2 q_2\} dt - p_1 q_1,$$

and

$$S_2(q_2, q_1) = \int_0^{q_2} \{p_2(t) + \eta_1 q_1\} dt - p_2 q_2 .$$

On the supply side we assume that information service is provided to the two countries at the marginal cost c_1 and c_2, respectively, and the common fixed cost K. Thus the global social welfare as the sum of each country’s consumer surplus and the profit from network service can be expressed as

$$W(q_1, q_2) = S_1(q_1; q_2) + S_2(q_2; q_1) + p_1 q_1 + p_2 q_2 - c_1 q_1 - c_2 q_2 - K .$$

If this global social welfare is to be maximized subject to the condition that network service provision breaks even, we obtain the so-called "Ramsey optimal" pricing in the two countries.

Let the Lagrangian be L so that

$$L(q_1, q_2) = W(q_1, q_2) - \lambda\{K + c_1 q_1 + c_2 q_2 - p_1 q_1 - p_2 q_2\}$$

$$= \int_0^{q_1} \{p_1(t) + \eta_2 q_2\} dt + \int_0^{q_2} \{p_2(t) + \eta_1 q_1\} dt - c_1 q_1 - c_2 q_2 - K$$

$$- \lambda\{K + c_1 q_1 + c_2 q_2 - p_1 q_1 - p_2 q_2\}.$$

Partially differentiating with respect to q_1 and q_2, we can derive the optimality condition as follows:

$$\frac{p_1 - c_1 + (\eta_1 + \eta_2) q_2}{p_1} = \frac{\lambda}{1+\lambda} \frac{1}{\varepsilon_1}$$

and

$$\frac{p_2 - c_2 + (\eta_1 + \eta_2) q_1}{p_2} = \frac{\lambda}{1+\lambda} \frac{1}{\varepsilon_2},$$

where ε_1 and ε_2 are the own-elasticity of demand for the information service[31].

Taking the ratio we obtain

$$\frac{\dfrac{p_1 - c_1 + (\eta_1 + \iota_2) q_2}{p_1}}{\dfrac{p_2 - c_2 + (\eta_1 + \eta_2) q_1}{p_2}} = \frac{\varepsilon_2}{\varepsilon_1} \quad .$$

The formula may be called the modified Ramsey optimal condition in the presence of network effects. Clearly if there were no such effects, *i.e.*, if $\eta_1 = \eta_2 = 0$. this is reduced to the usual "inverse elasticity" condition for the Ramsey optimum.

Now, suppose the revenue from information service is greater in country 1 than in country 2 so that $p_1 q_1 > p_2 q_2$ at the optimum. We are assuming that country 1 is larger than country 2 in market size. Moreover, suppose country 1 has less elastic demand and hence $\varepsilon_1 < \varepsilon_2$. This is tantamount to say that information service is a necessity in the larger country and it is less so in the smaller country.

Then we can derive from the above equality the following.

$$\frac{p_1 - c_1}{p_1} > \frac{p_2 - c_2}{p_2} + (\eta_1 + \eta_2)(\frac{q_1}{p_2} - \frac{q_2}{p_1}) > \frac{p_2 - c_2}{p_2}.$$

The first inequality follows from the assumption about the relative elasticity condition and the second from the assumption on relative size of the markets.

We can derive some important conclusions from this simple model. First, if information service is a necessity and its demand is less elastic in country 1 than in country 2, the Ramsey optimality requires a wider mark-up for country 1 than for country 2. Secondly, the mark-up differential is greater, the larger the combined network effects are. Thirdly, the network effects in the two countries play a symmetric role in determining the mark-up differential. And fourthly, the mark-up differential is greater, the larger is the market size differential.

When applied to the well-developed advanced country and the less-developed informationally developing countries, this conclusion suggests that the developed country must pay a higher price as compared to the marginal cost in order to make up for the global infrastructure investment. As is seen from the inverse elasticity condition for the optimum, $p_2 < c_2$ may result when the combined network effect $(\eta_1 + \eta_2)$ is sufficiently large. We take this to give a theoretical foundation for the global-USF[32].

We should also bear in mind that the affordability does not presuppose a complete penetration of the network nor a full participation by each and every individual. This is not to deny the importance of conquering digital divide. But rather, we must respect the individuals' choice not to actively participate in the information society if they choose to do so. Besides, if some 20 % of individuals or businesses in a society become active citizens of the cyber world, they will exert enough impact on the society in terms of value added and life style.

5. Governance of global information society

5.1. ITU and other global organizations

In order to maintain the integrity of the global telecommunications network, standard setting, rule making and monitoring of the system is necessary on the global scale. Such a task has been performed by ITU, ICANN and IETF. ITU is administered as part of the United Nations on the traditional international legal framework, i.e., its membership comprises individual sovereign nations, decisions are made on the unanimity basis, and the agreements are concluded as international treaty between ITU and the participating nations.

On the other hand, the internet technology requires new forms of global organization. For example, the Internet Corporation for Assigned Names and Numbers (ICANN) handles IP address space allocation, protocol parameter assignment, domain name system management, and root server system management functions[33]. The Internet Engineering Task Force (IETF) is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the internet architecture and the smooth operation of the internet[34].

The outstanding characteristics of these new organizations are that they take individuals as members. No corporations or countries have representation in them. They are not inter-national organizations since they do not act on nations. They are trans-national organizations because they involve concerned individuals across countries and regions. Also, they use a non-traditional approach in which participation and compliance is only voluntary[35].

5.2. Geneva protocol for global information society

In order to secure sustainable development of global information society, we need to see more of the transnational decision-making and surveillance mechanism. We must have a cyberspace protocol tentatively dubbed as Geneva Protocol for Global Information Society in which the basic principles on platform standards, copyright, network security, tax, decency standard, international transaction settlement and other matters are stipulated. The protocol can take the form of an international treaty or a guideline of the ISO style[36]. In it the role of voluntary organizations such as ICANN and IETF will have to be stipulated as partners.

An important element of the protocol will be the guideline for global-USF and its governance board. Together the protocol stipulates all the measures necessary to foster global accessibility and affordability of ICTs pertaining to the infrastructure, platform and applications.

5.3. Cyber Security Council

The last but perhaps the most important question is how a global cyber police can be instituted and operated. Each sovereign country or entities in the global information society lacks the coercive power to enforce any accord or agreement on other sovereign country. Yet it will become increasingly important to make public decisions as global community and give sanctions to the member in case of non-compliance.

It may be advisable to bring serious cases of cyber fraud to the attention of UN Security Council. However, UNSC is already overloaded by international conflicts in the real world. Besides, it takes special scientific knowledge and technical expertise to find solutions to the cyber security problem. It would be better to establish an independent trans-national governance body to oversee the global cyber security issues.

6. Proposal and concluding remarks

In conclusion, we would like to recapitulate our points and proposals to foster globally accessible and affordable ICTs.

First we emphasized the fact that communications infrastructure must be conceived of as a three-layer system consisting of network architecture, platform and applications and contents. As a country moves up the stage of economic development, emphasis shifts from hardware to software. Likewise, the bottleneck in communications infrastructure shifts from the physical network to applications and contents. In order to make the benefit of new technology available to consumers in many countries, we need to pay equal attention to each layer in communications infrastructure.

Second, we pointed out that fostering accessible and affordable ICT infrastructure could not be left for private incentives alone. It ought to be the target of international public policy. However, with the absence of coercive mechanism in international policy implementation it takes a semi-governmental organization to see to it come through.

Third, one of the ideas to promote sustainable global infrastructure deployment is the establishment of the global universal fund for which international telecommunications carriers contribute and through which subsidies are distributed to help build infrastructure in sparsely populated area, for low income groups, and for internet access for schools and libraries. The global-USF will work on the basis of individual company’s participation but need be closely overseen by a legitimate international organization like ITU.

Fourth, the basic idea of global-USF scheme can be justified by the global Ramsey optimal pricing to support the global infrastructure. With some assumptions we were able to show by means of a

two-country model involving network effects that the combination of a heavier contribution by consumers in the advanced country and a lighter contribution or even a subsidy for consumers in the poor country is theoretically justified. This was shown without recourse to equity or entitlement argument.

Fifth, in order to provide the institutional framework and technical standards for platform and applications, we need a new international protocol for global cyber society which addresses the issue of relative roles that must be played by ITU and such open voluntary organizations as ICANN and IETF. A security council for cyber security is also necessitated for the sustainable development of accessible and affordable ICT infrastructure

[1] For various concerns related to the coming advanced information society, see Toshihiko Hayashi, ed., *The governance of advanced information society* (in Japanese), NTT shuppan, March 2003.

[2] These are the five great inventions that were compared with IT revolution in Robert Gordon, "Does the 'New Economy' Measure Up to the Great Inventions of the Past?" Working Paper 7833, National Bureau of Economic Research, August 2002. For the wholesale change that is brought to economic system by the advent of ICT, see Toshihiko Hayashi, ed., *Information-Based Economic System* (in Japanese), NTT shuppan, June 2003.

[3] ITU publishes in depth study for individual countries regarding ICT policies.

[4] This target seems to be meaningful. To set the target at hundred percent penetration is not pragmatic nor necessary for any technology. It is a good rule of thumb to aim for twenty percent of population to be the core of human resource with expert skills.

[5] OECD, *Information Technology Outlook, 2002*.

[6] This is the main concern of the book, *The governance of advanced information society*.

[7] U.S. Department of Commerce, *Falling through the Net: Toward Digital Inclusion*, October 2000.

[8] The tragedy of the commons seems to have not reached the internet yet. However, no physical commons can escape from this tragedy of "over-grazing". With the system of flat usage rate for internet, the traffic demand will soon meet the bottleneck of physical capacity. For the original concept of the tragedy of the commons, see Garett Hardin, "The Tragedy of the Commons," *Science*, 162, 1967.

[9] Two types of business models already in practice is the private broadcasting model in which contents are distributed freely but the cost is recovered from the advertisement patrons, and the club model in which contents are again distributed freely to the members who pay monthly fees. Yet another model is the one where not the receivers but the contents providers pay. This is nothing by the telephone model. This is considered to be one of the most promising markets in Japan where the cellular phone with a camera is becoming extremely popular.

[10] Anuradha Kumar, "Indian Villagers Pedal Wireless," http://www.wired.com/news/wireless/0,1382,56663,00.html. This site was brought to my attention by Lara Srivastava of ITU, for which I am grateful.

[11] Grameen Bank, *Annual Report 2001*.

[12] U.S. Department of Commerce, *Falling through the Net II: New Data o the Digital Divide*, 1996.

[13] "The Okinawa charter on global information society," 2000.

[14] Ministry of Public Management, Home Affairs, Posts and Telecommunications, Japan, *2002 WHITE PAPER Information and Communications in Japan*, 2002.

[15] *Ibid.*

[16] *Ibid.*

[17] DOC, United States, *Falling through the Net: Defining the Digital Divide*, 1997.

[18] We will come back to the universal service question in sections 4.3 through 4.5 below.

[19] See, for example, S. Peltzman and C. Winston, *Deregulation of Network Industries: What's Next?*, AEI-Brookings Joint Center for Regulatory Studies, 2000.

[20] This is the nature of the so-called "stranded cost" argument in the policy debate. For further argument, see Kenta Hayashi, *Theory of Network Pricing*, Ph.D. dissertation submitted to Osaka School of International Public Policy, Osaka University, 2002.

[21] This is becoming increasingly clear in the policy consequences in the advanced countries. For example, competition in telecommunications infrastructure building between ILEC and CATV resulted in the slower pace of investment. As a result of fierce competition between international undersea backbone cables, there is a cutthroat price competition threatening any further deployment of the infrastructure.

[22] In the phase where communications traffic shrinks due to a slower economy, long run incremental cost rises.

[23] For a critical appraisal of TELRIC see Robert G. Harris, "Deployment of Broadband Networks and Advanced Telecommunications" submitted to National Telecommunications and Information Administration on Behalf of BellSouth Corporation, December 19, 2001. Regarding local loop unbundling in Europe, see also Pablo T. Spiller and Svein Ulset, "Why Local Loop Unbundling Fails?" draft, February 27, 2003.

[24] MPHPT, Japan, *op. cit.*

[25] See Kenta Hayashi, *op. cit.*

[26] Claire Milne, "Stages of Universal Service Policy," *Telecommunications Policy*, 22(9), 1998.

[27] ITU, Universal Access Executive Summary, *World Telecommunications Development Report 1998*, March 1998.

[28] Eli M. Noam, *Interconnecting the Network of Networks*, MIT Press, 2001, p.232.

[29] Universal Service Administrative Company, *Annual Report 2002*.

[30] In order to fix our imagination, we can interpret that country 1 is the advanced country and country 2 the developing country.

[31] That is to say, $\varepsilon_i = -\frac{p_i}{q_i}\frac{dq_i}{dp}$, for $i = 1,2.$

[32] This analysis is the first attempt to justify universal service fund rigorously on the basis of the network effect in the literature.

[33] http://www.icann.org.

[34] http://www.ietf.org.

[35] In order to emphasize the voluntary and participatory nature of the rule setting and compliance mechanism, the word "governance" came to be used as contrasted to the formal structure of coercive mechanism called "government". See, for example, Oran R. Young, ed., *Global Governance*, MIT Press, 1997 and D. Loader, ed., *The Governance of Cyberspace: Politics, Technology and Global Restructuring*, Routledge, 1997.

[36] International treaty, convention, protocol or agreement carry with them the same obligations to the participating governments. They are all international treaties in the language of international law. The Vienna Convention on the Law of Treaties stipulates that "treaty" means an international agreement concluded between States in written form and governed by international law, whether embodied in a single instrument or in two or more related instruments and whatever its particular designation.