Invited Paper

Planning for Information Oriented Society in Japan*

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The present paper describes the motivations, potentialities, plans, problems and approaches for the reorganization of Japan's industrial and social structure on the basis of information oriented systems. The problems caused by the rapid industrial growth after the last world war are outlined as the motivation for information oriented society. The accelerated utilization and progress in communications and information proccessing technology are summarized as the potentialities for the realization. The Japanese efforts for the planning of information oriented society are then described and some information oriented systems being planned or under development are outlined. Finally, the author's view is described on the problems to be encountered in the course of the realization of information oriented society together with his proposal on the possible approaches for solution.

1. Introduction

Everywhere in the developed part of the world, such adverse factors as global shortage and uneven distribution of natural resources, environmental disruption and pollution, international trade conflicts, rapid urbanization, etc. are calling for a drastic change in the industrial and social structure. The conventional industrial pattern of mass importation of materials, mass production, mass consumption and mass exportation of products must be slowed down and be replaced by such that produces more sophisticated products in less quantity. The traditional infra structure of our society must be reorganized and sophisticated so as to improve living condition in urban districts and to abolish inconveniences in remote rural districts. The sophistication in industrial and social structure depend among other things, on the art of information transmission and processing. What is implied by the proposition for change is therefore to enhance the use of information technology in a wide variety of aspects of our society. It is clear that we cannot survive without food and that we cannot maintain our living standard without industrial product. The future society therefore would be an information oriented society in which social as well as industrial activities including those that supply primary and secondary products are supported by the information technology.

Although the outlook towards information oriented society may be more or less alike in the developed countries, the motivation may be quite unlike in each other due to the difference in social, industrial and technological background. As an extreme example, the present paper takes Japan as the object of the case study. Being a small but heavily populated country with almost no natural resources, Japan's industrialization and export trade has been an absolute necessity for survival. Rapid industrialization however, brought about worst of all environmental disruption and pollution. Rapid increase of importation of materials and of exportation of industrial products caused serious international conflicts. And rapid urbanization resulted in miserable deterioration of living conditions. Necessity for change in Japan therefore is more than any other country in the world. Being the second largest owner of telephones and computers in the world, Japan also has above-average potentiality for the change. Because of the necessity and the potentiality, Japan's motivation towards the information oriented society may be among the highest in the world.

For these reasons, the subject matter of the present paper is focused on the planning for information oriented society in Japan. For the convenience of readers to get acquainted with the social and information-technological environment of this country, the three sections immediately following are devoted to present some facts and figures on social and industrial backgrounds, on communication services and on computers and data communications. Then some of the projects for information oriented society which are under development or being planned are described together with some future technological trends. And finally the author's view on the problems to be encountered in the course of realization of the information oriented systems is presented with his proposal on the possible approaches for realization.

2. Social and Industrial Background

Japan is a small country with the area of 370,000 km^2 which is about 4% of the area of the United States. It is a heavily inhabitted nation with the population of 110 million which is about one half of the population of the United States. It is also a highly industrialized country

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with the gross national product (GNP) of some 600 billion U.S. dollars which is about one third of the GNP of the United States. Because of the rugged terrain and of accelerated industrialization, the population tends to concentrate in urban district. About three quarters of the inhabitants live in cities with the population over 30,000. No illiteracy exsists and over 90% enter senior high school after finishing compulsory education and some 30% of the high school graduates enter universities and colleges. The country essentially has no natural resources and import all materials and energy from abroad.

The post-war history of Japan over a quarter of a century may be characterized by the rapid growth in economy. GNP has risen at an average rate of 12% per annum until 1973 when the nation was drastically hit by the oil panic. During the period, almost all aspects of industrial activities were heavily invested in pursuit of scale merit in production and of improvement in productivity. In iron and steel industry, the annual output which was 10 million tons in 1955 is now over 100 million tons. Likewise, the output of the oil refineries and petro-chemical industries increased more than ten times. Automobile industry that made only 70,000 cars in 1955 now produces more than 8 million. The output of TV and radio receivers and other electrical appliances industry increased about the same order.

Technological innovation, government policy and motivated labor force may be cited among other things, as the major factors that made possible the rapid industrial expansion. Pre-war technology which had been centered around military purposes, served as the potentialities to quickly follow up the inventions originally made elsewhere and then to add significant improvement to establish international competence. Protective trade policy as well as government oriented financial support provided opportunities for industrial build up and encouraged export thrust. Well educated and relatively cheap labor force worked hard for reconstruction and then for better living.

Another essential factor which supported the industrial expansion and the productivity improvement in this country was the heavier than average investment in communications and information processing. The number of telephone sets increased from 12 million to 43 million during the last ten years. During the same period, the number of computers increased from 2,000 to 35,000. As the result, the diversified social activities were integrated together by the modern telecommunication network and the productivity in business as well as industrial activities were promoted by off-line and then on-line use of computers.

The industrial expansion seemingly brought about affluence to this country as it was intended. At the same time however, as an obvious consequence of the rapid industrialization which took place in a densely populated area, the environmental disruption and pollution reached to such an extent that the installation of iron and steel plants, oil refineries, electric power plants and other large industrial complex encountered serious conflict with the local communities. The industrial pattern of mass production and mass consumption in a resourceless country resulted in a trade pattern of mass importation of raw materials and mass exportation of industrial products which in turn caused conflicts with underdeveloped as well as developed part of the world. Rapid urbanization surpassed relatively poor social investment with the result of absolute shortage of housing and inferior living conditions. Burdened with affluence but with less opportunity for success, the motivation of the traditionally hard working population was gradually lost. Thus towards the end of 25 years of rapid economic expansion, it has been increasingly felt that the industrial investment had to be balanced with the social investment and that the nation's industrial structure had to be switched from the conventional types of heavy industries which caused environmental disruption and international conflicts to something else which consumes less materials and adds more values to the products.

3. Communication Services

Let us first have a look at some of the statistics on communications services in Japan. Table 1 shows the amount of information per capita in some of the developed countries in the world in the year 1971. It is known that an average Japanese makes four times as much telephone calls as he mails, which is the highest ratio among the nations.[1]

Table 2 shows the income of communication services for the same period. It is known that the income of telecommunication services constitutes 65% of the total income.

Table 1 The amount of information per capita in some developed countries in the year 1971.

Country	Number of Mails	Number of Telephone Calls	Number of Newspaper Publi-cations	Number of Book Publi-cations
Japan	115	401	51	2.9
U.S.A.	416	830	30	3.9
U.K.	191	218	46	6.0
West Germany	185	191	32	6.6
France	203	105	24	4.4

Table 2 Income of communication services during the fiscal year 1975 (from April, 1975 to March, 1976).

	Income (million U.S. dollars)
Postal Service	1,649
Domestic Telecommunications Service	7,033
International Telecommunications Service	271
Broadcasting Service	2,267

From these statistics, it may be said that the Japanese are enthusiastic users of telecommunication and that the telecommunication is the major means of communications in this country.

Domestic telecommunication services for the public in Japan are exclusively provided by the Nippon Telegraph and Telephone Public Corporation (NTT) whereas overseas telecommunication services are furnished by Kokusai Denshin Denwa Company, Ltd. (KDD). Besides, some government agencies, Japanese National Railways (JNR), electric power companies etc. have their own private communication networks.

Japan's telecommunication services has a history of a century. The telegraph service was inaugulated in 1869 and the telephone service in 1890. Since then the service had been steadily expanded until 1941 when the Pacific War broke out. The reconstruction of the communications systems after the devastation of war was intense and as shown in Fig. 1, by March 1976 the number of telephone sets reached to 43 million and places Japan second to the largest telephone owner in the world. The nextwork is structured in four hierachical levels with 8 Regional Centers, 81 District Centers, about 560 Toll Centers and about 6800 End Offices. The percentage of dial telephones is 99%.

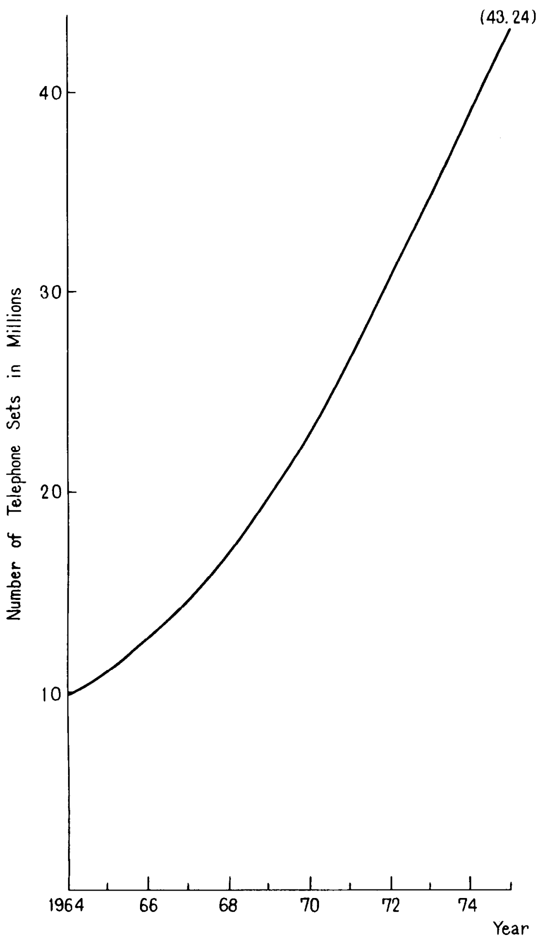

Fig. 1 Growth of number of telephone sets by year.

The switching equipments are mostly crossbar types, namely 790 for toll offices and 4844 for local offices. In 1971, a large-scale stored-program-controlled electronic switching system D–10 was cut over for commercial service. The D–10 system has the traffic handling capacity of 4000 Erlangs and designed as a local switch as well as a toll switch. The switching network consists of 8 stages and employs mechanically latched mini-crossbar switches having 8×8 crosspoints. The D–10 system has been designed to be compatible with CCITT No. 6 common channel signaling system so as to be able to handle international subscriber dialing. Electronic switching systems D–20 for small and medium sized offices having traffic capacity of 500 to 800 Erlangs are also in service. The switching network consists of 6 stages and employs the same mini-crossbar switches to that of D–10. As of March 1977, 56 and 80 D–10 systems were installed for toll and local offices respectively, and 2 D–20 systems were installed for local offices.

The transmission systems in Japan consist of coaxial cable systems, short haul cable carrier systems and microwave systems as shown in Table 3. In addition to these, digital coaxial cable systems with the bit rates of 100 Mb/s (1440 speech channels) and 400 Mb/s (5760 speech channels), digital radio systems employing 2 GHz (200 speech channels), 11 GHz and 15 GHz (960 speech channels) and 20 GHz (5760 speech channels), and submarine cable systems with the bandwidth of 10 MHz (900 speech channels) and 12 MHz (1200 speech channels), have been installed. Research and development efforts are now expended for FDM cable systems with

Table 3 Major transmission systems in Japan (as of March, 1977).

System Types			Voice Frequency Equivalent Channel-Kilometers
Coaxial Cable System	4 MHz,	960 ch	9,576,960
	12 MHz,	2700 ch	137,929,500
	60 MHz,	10800 ch	39,808,800
Short Haul Cable Carrier System	PCM,	24 ch	8,891,160
	FDM,	12 ch	3,410,748
Submarine Cable System	36 MHz,	2700 ch	1,469,880
Microwave System	2 GHz,	600 ch	5,018,000
	4 GHz,	960 ch	7,936,000
	5 GHz,	2700 ch	45,681,000
	6 GHz,	1200 ch	10,135,000
	6 GHz,	1800 ch	125,383,000
	6 GHz,	2700 ch	3,097,000
	11 GHz,	600 ch	2,854,000
	11 GHz,	960 ch	8,625,000
	11 GHz,	1800 ch	10,732,000
	11 GHz,	2700 ch	1,612,000

the bandwidth of up to 600 MHz, and for 800 Mb/s digital systems that employ coaxial cables, radio waves, guided-waves and optical fibres.

Mobile radio communication services in Japan include the costal radio telephone service and radio paging service. The former provides public communications to 5000 ship stations and the latter provides paging service to over 640,000 subscribers. Railway telephone service was opened to the public since 1956 and an improved system was introduced into New Tokaido Superexpress Trains since 1965. The system has such features as the use of leaky coaxial cables for the communication in long tunnels and the use of resonant devices on the railway tracks for automatically swiching radio channels. A land mobile telephone system employing 800 MHz band was developed in 1967 which features automatic switching and control for ground facilities, and automatic selection of radio channels and of base stations for the mobile units.

Majority of international traffic in Japan is carried by satellite communications. The first television transmission across the Pacific was conducted on November 23, 1963 via Relay-1 with the shocking news of the assassination of President Kennedy of the United States. In 1964, television pictures of the Tokyo Olympic Games were sent by Syncom-3 to the world. At present, two KDD earth stations at Ibaraki and Yamaguchi are used for international communications via INTELSAT IV satellites. Development activities for satellite communication in Japan are characterized by various efforts on demand assigned multiple access systems including the following. The Satellite Communication with Automatic Routing (STAR) system developed in 1965 served as the predecessor to the Single-Channel-Per-Carrier PCM Multiple-Access Demand Assingnment Equipment (SPADE) system adopted by INTELSAT networks. The 50 Mb/s PCM-TDMA system with time-preassignment and time-assignment speech interpolation (TASI) features called the TTT system was developed by KDD. The system having 700 speech channels was installed in 1969 and a series of field tests were performed in 1970. Besides, domestic communications satellites as well as broadcasting satellites are being developed.

International semiautomatic telephone service was provided using a crossbar switching system since 1964 when the Transpacific Cable inaugurated service. In 1977, an electronic telephone switching system XE-1 was cut over for commercial service which features processing of operator assisted calls, automatic voice response as well as the recording and retrieval of accounting data. The system can accomodate 7000 domestic and international circuits, 24 No. 6 signaling links and 500 operator positions and is capable of handling 3000 Erlangs of traffic. It employs D-10 mini-crossbar switches for the switching network and a D-10 processor for central control. It also employs plasma displays and keyboards for operator positions to avoid the use of conventional paper tickets.

As for the international telex service, fully automatic crossbar switching system was introduced in 1969, and then an electronic system CT-10 was cut over for commercial service in 1976. In addition, international automatic telegraph exchange has been in service since 1971 which is a store-and-forward switching system employing a commercial computer as the processor and magnetic drums and disk packs for storage. The system accomodates 144 circuits at 50 Bd and 96 circuits at 75 Bd with the telegram handling capacity of 5100 messages per hour.

4. Computers and Data Communications

Ever since the first experimental electronic computer was completed in 1955, the computer installation in this country increased at an average annual rate of 30%. Fig. 2 shows the growth by number and by value for the period of ten years. Japan is now the second largest computer owner in the world. In contrast to the situation in the rest of the world, the Japanese computers have been built by the communication equipment manufacturers. The computer production which was meager in the beginning, now ranks with the communication equipment production. Table 4 shows the amount of production during the Fiscal Year 1975.

Foreign computers have substantial shares in Japanese computer market. Table 5 shows by value the market shares of the five major computer suppliers in Japan. The Japanese manufacturers have larger shares if the

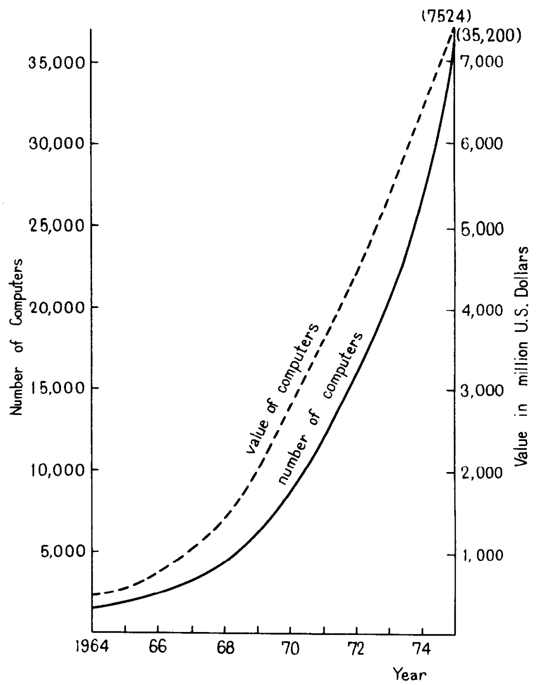

Fig. 2 Number and value of computer installations by year.

Table 4 Production of communication equipments and computers during the fiscal year 1975 (from April, 1975 to March, 1976).

Items	Production (million U.S. dollars)
Wired Communication Equipments including telephone sets and telephone switching equipments	1,632
Wireless Communication Equipments	431
Computers and Peripheral Equipments	1,660

Table 5 Computer market shares by value (1976).

Manufacturers	Shares by Value
IBM	29.0%
Fujitsu	20.0%
Hitachi	15.8%
Nippon Electric	9.8
UNIVAC	9.6%
others	15.8%

comparison is made in terms of the number of computers, since the computers of foreign manufacture are generally large.

In promoting Japanese computer production, the government and government owned public agencies played an important role. The Ministry of International Trade and Industry (MITI) has been the most influential in its protective trade policy, research and development support and reorganization efforts of computer manufacturers. The gradual liberalization policy by which free trade and investment have been introduced step by step until 1975, provided the Japanese manufacturers the opportunities to strengthen their position. A series of contracts paid off a substantial part of the research and development investment made by the manufacturers. The efforts in reorganizing the computer manufacturers into three groups, namely, Fujitsu and Hitachi, Nippon Electric and Toshiba, Mitsubishi and Oki, helped to eliminate duplication in R & D efforts. NTT has also been influential by promoting and coordinating the data communications services and by sponsoring the development of large-scale online computers. Other government agencies including JNR, Ministries of Finance, Post and Telecommunications, Education, Welfare and others also provided wide ranges of support.

Accelerated utilization of telecommunications and of computers naturally leads to the combined use of them, the data communications. In addition to the users' enthusiasm, such facts that NTT has been taking positive attitude in providing data communication services and that all the Japanese computer manufacturers are communication equipment manufacturers as well, have been in favor of the situation. Fig. 3 shows growth of online systems by year which is in an average annual rate of 60%.

As of March 1976, 1479 systems were in service, out

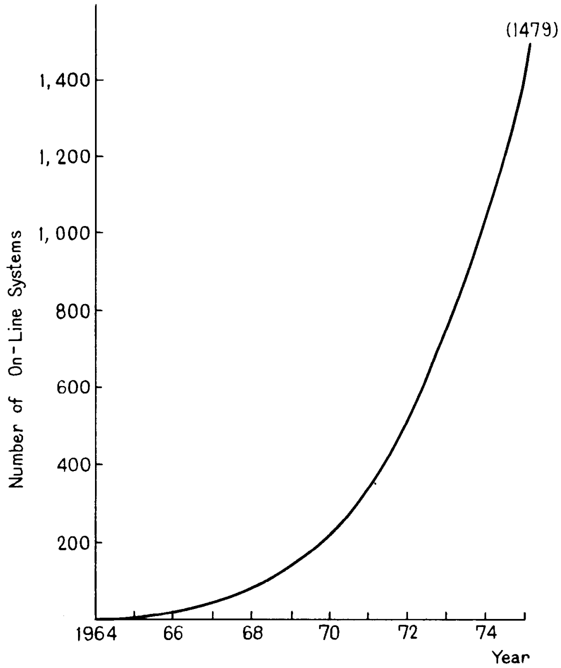

Fig. 3 Number of on-line systems by year.

Table 6 Breakdown of users of user-owned on-line systems as of March, 1976.

Users	No. of Systems	Percentage of Systems
Banking	235	16.4
Manufacturing, Sales and Inventory	694	48.6
Government (Environmental Surveillance, Traffic Control, TSS etc.)	222	15.5
Stock Exchange, Service Bureaus, Transportation, Insurance, etc.	278	19.5

of which 1429 systems were owned by various users and the rest by NTT. Table 6 shows the breakdown of users of user-owned on-line systems.

The first of the on-line systems in Japan emerged in 1964 when JNR introduced the MARS (Magnetic Electronic Automatic Reservation System) for seat reservation service. Since then the system kept expanding, and as shown in Fig. 4, it now consists of three Major subsystems, namely MARS 105, 150 and 202. MARS 105 is for individual or smaller group travellers of up to 14. It can handle some 50 million seats (1 million seats per day for 2 months maximum) through some 1500 terminals distributed all over the country. As is shown in the figure, MARS 105 has the communication control processors and the seat file processors each of which consists of three large computers in two-on-line and one-off-line configuration. MARS 150 is for reservation through NTT's public telephone network. Push-button telephone sets are used in entering data and an audio response equip-

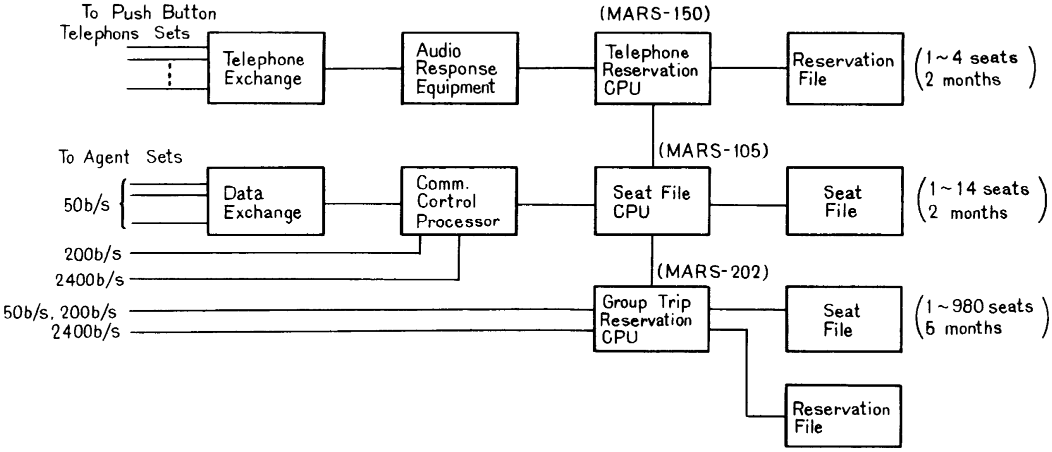

Fig. 4 JNR's total reservation system.

ment is used in providing computer response in the form of synthesized speech. MARS 202 is for large-group travellers of up to 980. It can handle 900.000 seats per day for the period of 5 months maximum. JNR presently has, in addition to MARS, several on-line systems for various purposes including traffic control (COMTRAC), container operation (EPOCS), yard control (YACS), freight information and operation (FIS, FOCS) and data switching (DACS). A computer communication network has been under development to integrate these on-line systems together. Japan Airlines (JAL) and other airline companies as well as some private railway companies also have their own on-line reservation systems. Largest among them is JAL's total system integrating seat reservation, cargo handling, flight control and ground support.

The Japanese banks also play an important role for the promotion of data communication in this country. By 1976, all of the 13 nation-wide banks as well as majority of 63 local banks provided on-line banking service. Some of the smaller banks such as mutual saving and credit associations have their own on-line systems or share a common system. As an example, the Daiichi Kangyo Bank which is one of the largest banks in the world having 300 branches and some 10 million accounts, owns an on-line banking system consists of three large computers, some 2000 terminal equipments and a file with the capacity of 8,000 Megabytes.

Some 50% of the on-line systems in Japan are used for manufacturing, sales and inventory purposes. The iron and steel industry is one of the largest users of on-line systems. Production, inventory, marketing and other activities are performed by a total system consists of a number of process control computers, several larger computers, a large number of visual displays, key-board terminals and sensors. Central and local government agencies are other major users of on-line systems. As an example, the Metropolitan Tokyo Police Department has the world-largest traffic signal control system. By March, 1975, some 2500 intersections were under the control of a hierarchical computer system which consists of seven control computers and a larger computer. The system is still growing to control all the traffic signals in Metropolitan Tokyo.

Except for JNR and others which have their own private communication networks, the communication facilities are provide to the users by NTT. For data transmission purposes, NTT provides the leased circuit service, the specified circuit service and the public network service. The second and the third services were made possible as the result of amendments of Public Communication Law which took place in 1971 and 1972 respectively. The specified circuits are physically the same as the leased circuits but are different in that the connection of user-owned computers is possible and that the circuits can be shared by a plurality of users. The public network service is the use of NTT's switched telephone and telex networks by means of user-owned computers and terminals. To provide this service, charging for local calls which used to be in flat rate, was changed to be timed in three minutes. Fig. 5 shows the growth of NTT's specified circuits by year. By March, 1976, the total number was 45,525 about two thirds of which were voice-grade circuits.

The amendment of the Public Communication Law also gave a formal permission to NTT to provide on-line computer services to the public. The service, legally called the Data Communications Facility Services are devided into two categories, namely, the Public Data Communication Services and the Specific Data Communication Services. The Public Data Communication Services are to provide the public users with the benefit of sharing large computers at a relatively low cost. The services consists of the Calculation Service by Telephone (DIALS), the Scientific and Engineering Calculation Service (DEMOS and DEMOS-E) and the Sales and Inventory Management Service (DRESS). In DIALS, push button telephone sets are used for entering data

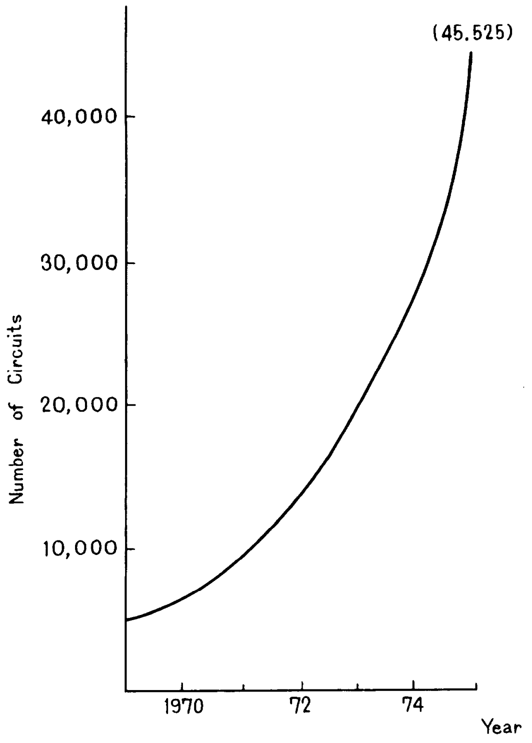

Fig. 5 Growth of NTT's specified circuits.

and an audio response equipment are used to send the results of calculation in the form of synthesized speech to the push button telephone sets. As of March, 1976, two systems were in operation and the majority of 1.5 million push button telephone sets were in the service area. DEMOS is mainly for TSS and RJE services. As of March, 1976, eight systems were providing services to 752 users. DRESS performs file updating and inquiry and provides periodical reports and vouchers. As of March, 1976, eleven systems were serving to 771 users.

The Specific Data Communication Services are for government agencies and nationwide business users. By March, 1976, 30 systems were in operation. One of them is the Motor Vehicle Registration Service for the Ministry of Transportation which was inaugurated in 1970. It connects on-line 68 offices scattered all over the country for the purpose of automobile registration and inspection. Another one is the Inter-Bank Exchange Dealings System for the Federation of Bankers Association of Japan. The system was cut over for commercial service in 1973 and connects 7200 branches belonging to 88 nation-wide banks, local banks, credit banks or others.

To facilitate the rapid expansion of data communications services, NTT started in 1968 a large-scale project, Dendenkosha Information Processing System (DIPS) Project. Computer systems DIPS-I and DIPS-II were developed under the project and cut over for commercial service in 1973. The system assumes multiprocessor configuration in which up to four highspeed CPUs share a large-capacity memory unit having up to 16 Mbytes of memory capacity. A configuration with 3 CPUs can accomodate about 600 simultaneous TSS users with an average response time of 2 seconds. One of the unique features of this system is that it has been constructed individually by three major computer manufactures, Fujitsu, Hitachi and Nippon Electric, under the same software standard.

As for the visual communication service, NTT provides facsimile transmission over the switched telephone network. Transmission service of TV signals for broadcasting stations as well as high speed facsimile signals for newspaper companies have been provided. Video telephone service are still under laboratory experiments and field test except for color TV conference service between Tokyo and Osaka.

Up to this time, data traffic is carried by the telephone network based upon frequency-division-multiplexed hierarchy which has been oriented toward speech communication. The links are plagued with impulsive noise and instantaneous interruptions. Such disturbances cause no appreciable degradation in the quality of speech, but they may result in serious errors in transmitted data if no measures for detecting or correcting them are provided. Quite a few data terminals operate at data speeds ranging from five to 20 kb/s, which is too fast for a speech channel and too slow to make full use of the bandwidth of the basic group of 12 speech channels. The time required to set up a connection by dialing through the switching centers can be as much as 10 seconds, which is too long for data transmission that typically takes a few seconds or less. Above all, a communication network based on frequency-division multiplexing is inefficient for transmitting digital data compared with a network based on time-division multiplexing. For example, a speech channel that is frequency-divided can provide a data speed of only up to 9.6 kb/s, whereas a time-divided speech channel can transmit up to 48 kb/s.

Although the data traffic is much less than the speech traffic at this moment, judging from the very high potential demand for data, visual and other communication services, it is conceivable that new communication network will be built in which the transmission, switching and processing of speech, data and other information are all performed digitally. Progress in large-scale integrated-circuit technology is drastically cutting down the cost of digital hardware. Extremely broad-band (although rather noisy) transmission media such as millimeter-waveguides and optical fibre systems are now becoming available and match the characteristics of digital transmission. Pulse-code-modulation transmission systems are rapidly becoming popular; pulse-code-modulation switching is now ready for service. All these factors support the concept of digital networks. One of the conveniences of a digital time-division-multiplexing system is that it provides a wide variety of transmission speeds by sub-commutation and super-commutation techniques. The new digital network is to handle data ranging from 50 b/s to 48 kb/s on time-division basis by means of digital links and digital switching centers. Envelope interleaving of data with basic clock of 1.544 Mb/s is employed so as to be integrated into speech communication. NTT built a laboratory model DDX-1 for the digital data exchange in 1973 and an improved model DDX-2 for field trial in 1975. The commercial service is scheduled in 1979 in which both packet switched and circuit switched services are to be provided.

5. Projects for the Future and Systems Under Development

In view of the urgent needs for changing the traditional industrial pattern and for filling up the increasing gap between industrial and social investment, and in view of the successful utilization of communications and computer technology over a quarter of a century, it has been felt that the maximum possible use of information technology in social and industrial activities may provide a breakthrough to the problems prevailing in Japan. It has also been expected that if this could successfully be accomplished, the nation's industrial and social structure could be centered around the information technology so that this heavily-populated and resourceless country could have a basis for suvival and hopefully for upgrading living conditions in the coming century. In this context, the government ministries including MITI and the public agencies including NTT have been trying to set up a master plan towards an information oriented society.

The Council for Industrial Structure of MITI, in its interim report issued in September 1974, stresses the importance of promoting the utilization of information technology not only in industries but also in various aspects of social activities and calls for an all out effort to establish a basis for the realization of "an welfare society with vitality". The report analyses the needs for information technology in nine major categories of utilization, namely, government administration, industries, medical service, transportation, environmental protection, caramity and crime protection, education, distribution and community life. As the result of the analysis, the report proposes a number of future projects including data banks and a nation-wide network for government administration, computer-aided manufacture, sales and inventory system, information sharing system for managerial planning, research and development for industries, medical information systems for community medicine, hospital automation and training of medical and paramedical personnel, computerized traffic control, computer-controlled new transportation systems, wide-area surveillance systems and data banks for environment and caramity protection, alarm systems and data banks for crime protection, computer-aided and computer-managed instruction systems, data banks for material and product distribution and computerized community information systems. The report also recommends such government actions as sponsoring the development of proto-type models for feasibility demonstration and assessment, financially supporting and coordinating the research and development effort in the industries, encouraging the future oriented technological innovation in research institutions, minimizing the negative social impacts through technological and legal countermeasures and promoting the development and utilization of data banks and computer networks.[3]

Other government ministries, including the Ministries of Post and Telecommunications, Transportation, Welfare, Education and Agriculture also have information oriented projects by themselves or in colaboration with other ministries or agencies, such as MITI and NTT. In addition to these, the public agencies including NTT have their own guide line for future projects.

Most of the above mentioned projects are just being concepualized or under preliminary planning. Some of them however are under development. MITI, in addition to their financial support to the industries for the development of future computers, has been sponsoring a series of "large-scale projects". Information oriented projects among them are the Large-Scale Computer Project, the Pattern Information System Project and the Integrated Road Traffic Control Project. The first one ended up with a prototype computer the technology of which was utilized in the development of commercial computers HITAC Series 8700 and 8800 and of NTT's data communication processor DIPS-1. The second one is for computer recognition of visual and audio patterns and the third one is for computerized route guidance of individual motor vehicles. Both are now under development. MITI also supports with NTT a project for developing very large scale integrated (VLSI) circuit in collaboration with the major computer manufacturers.

MITI and the Ministry of Post and Telecommunications jointly support the Community Cable Information System Project by which experimental systems have been built in Higashi-Ikoma Model Town near Nara and in Tama New Town near Tokyo. The object of the project is the feasibility demonstration and evaluation of a computerized community information services by means of broad-band coaxial cables to the individual subscribers. The services include rebroadcasting of TV and radio program, broadcasting of community TV, radio and facsimile program, reservation, medical information, utilities' accounting, burglar and fire alarm services. MITI also colaborates with the Ministry of Welfare in supporting the Medical Information System Project by which experimental systems for emergency medical information, rural community medical information, automated multiphasic health screening and medical data bank systems are under development.

The Ministry of Education which has been supporting implementation of computer centers in educational institutions, is now sponsoring the development of interuniversity computer network in which seven larger computer centers are to be connected by the NTT's new data network at the data rate of 48 kb/s. Smaller computer centers, RJE and TSS terminals are to be connected to the larger computer centers by means of voice-grade lines. Data bases for scientific information are also under development and in connection with these projects, a proposal was made in which a master plan for the nation-wide scientific information system was given that include general purpose and special purpose data bases, computer centers, special purpose processors and peripherals which are connected by the public data communication network. The Science and Technology Agency also has a similar project, the National Information System for Science and Technology. The Ministry of Post and Telecommunications has been sponsoring the Government Administration Information Network Project which provides among other things, the facsimile service to the central and local government agencies.

Ministry of Transportation has the Air Traffic Control Project and in cooperation with NTT, is developing a nation-wide system which integrates flight data processing and digitalized radar data processing for air traffic control and surveillance. The National Police Agency has been sponsoring the computer-controlled traffic signal systems for a number of cities. The largest of all is the Metropolitan Tokyo Traffic Control and Surveillance System which when completed, is to control 8000 signalized intersections with a hierarchical computer system including some 20 control computers.[4] The Meteorological Observatory is developing the Meteorological Observation System and the Meteorological Satellite System in colaboration with NTT and the National Space Development Agency respectively. NTT also colaborates with the Environmental Protection Agency for the development of Environmental Pollution Information System and with the Ministry of Agriculture for the development of Agricultural Information Distribution System.

What is common in the above-mentioned and other systems under development is that most of them are the combination of a plurality of computers and of a communication network. The configuration of these systems is different from the data communications systems emerged a decade ago which consists of a number of remote terminals connected star-like to a large computer (with duplex, dual or standby configuration if required). The plurality of computers, either in function-sharing or load-sharing, constitute a computer complex or by means of computer-to-computer communication links compose a computer network. The factors for the change are such that the scale merit for computers is saturating and the Grosch's rule of thumb no longer holds, that the convenience of using communication networks has improved, and that local intelligence has been increasingly required for the improvement of man-to-machine and machine-to-machine interfaces. Such dispersion of intelligence throughout the network may continue considering such advantages of computer communication networks as the resource sharing of general and special purpose data bases, processors and peripherals, the interface improvement by intelligent terminals and local computers, the possibility of dynamic load sharing and emergency back up. The success of computer communication network depends among other things on the realization of data oriented networks with line-switching as well as packet-switching capability and with digital transmission capability including satellite communication, on the establishment of compatibility between the computers of different makes and models, on the reasonable agreement for resource sharing across organizational boundaries and on the progress in reliability technology including automatic diagnosis over communication links.

6. Problems and Possible Approaches[5]

The future projects mentioned above all seem atractive provided that social and technological environment would not undergo drastic changes, that cost for development, implementation and operation of the proposed systems could be afforded and that negative social impacts of these systems would not seriously develop. Unfortunately however, none of these provisions is realistic enough.

As the systems tend to become larger and more complex as is the case for information oriented systems, the period required for their completion and depreciation tends to be longer. On the other hand, it is almost certain that the accelerated and unpredictable changes in social and technological environment would occur in the present age of discontinuity and uncertainty. In other words, the systems face the threat of suddenly becoming obsolete from their very beginning of development until after the investment is sufficiently paid off. We can depend to some extent upon the conventional methods of forecasting either by extrapolation or through concensus. But the extrapolation approach can not cope with discontinuous changes and the concensus approach generally provides nothing but a quantitative expression of common sense. We therefore have to find a novel method of modular system synthesis by which a system or its component can adaptively transfigure at any time in response to the changes in its social and technological environment. We also have to reorient the concept of compatibility towards the future but not towards the past as it used to be so that the implementation of the present system does not totally jeopardize the introduction of future systems.

Larger and more complex systems require more research and development effort in terms of money and man power. In such circumstances as the slower GNP growth and larger social investment however, no substantial increase may be expected in R & D budget which already exceeds 2% of GNP. In the country in which more than 0.2% of the total population has already been mobilized for R & D activities and whose monoracial population structure prevents inflow of talents from abroad, it is also quite unlikely that the human resources capable of R & D activities could be increased substantially. In view of these obvious limitation in R & D resources, it is highly important to optimally allocate the limited resources by avoiding duplicated R & D effort, by critically evaluating the projects to be developed and by promoting international colaboration in R & D activities. Equally important is the promotion of continuing education by which the knowledge of limited number of talented people is refreshed so that they can actively participate in R & D activities over their life time.

Larger and more complex systems also require more money for their implementation and operation. Here again a reasonable policy of optimally allocating finite monetary resources is urgently required. In some of the future systems, the users may be able to pay most or part of the implementation and operation cost so that with little or some financial support, the systems could survive and hopefully could up-grade and expand by themselves. In other future projects which are directed towards the social welfare however, a system could hardly be considered self-supporting or self-proliferating. The beneficiaries may be willing to accept the benefit but not always willing to pay for it, so that the tax payers should make sure whether they could afford to pay not only for the implementation of the system but also for its continuing operation, improvement and expansion.

As for the negative social influence of the information oriented systems, the technology assessment approach extracts to a certain extent a number of negative impacts in terms of the infringement of privacy and security, the centralized and excessive control of information, etc., and provides possible countermeasures in terms of technological and legal action options. Unfortunately however, the action options for reducing the negative impacts generally reduce and in many cases totally jeopadize the positive impacts the original system has had. What is important is therefore to extract the negative impacts, to find out action options and to show the public the result of final impact analysis so that the people are provided with the opportunities to make a choice and through the procedure, to reorganize their own ethical standard. Such procedure for public acceptance seems to be especially necessary in the case of information oriented systems since most of the negative impacts are psychological in nature and therefore intended or unintended over-commitment tends to cause serious distrust in the part of the public.

The information oriented systems, as they become larger and more complex, accelerate the automation in industry, business, medical care, education etc. Automation is good in the sense that machines generally work faster and more accurately than men, that the workers are relieved from monotonous labor and that the administrators are exempted from labor troubles. But at the same time, automation may provide some serious problems. It turns a worker from producing something to merely watching the working machines. He may be bored if everything is normal. He may be flustrated if something goes wrong since the wildly running machine is too complex to be properly controlled by him. It would be worst of all pollutant if a large number of people were turned over to our society who were still employed but were not actively participating the social activities most of their time and thereby almost completely lost their feeling of accomplishment and were unhappy. Automation replaces traditional man-to-man interface with somewhat incomplete man-to-machine interface and thereby reduces the skinship of the people and causes stress and flustration in dealing with not-too-friendly machines. It seems to the author that there should be a conservation law on the feeling of accomplishment so that we must provide something else to make up for the loss of such feeling due to automation. Computer-aided crafts manufacture in which each individual can interactively materialize their creativety may be one of the possible solutions. After all, it may be said that the automation by information oriented systems should be directed from the productivity improvement to the happiness of human mind.

When a system is first introduced for service, the public generally takes its benefit as a bounty. As the system continue to survive in the society and becomes larger in scale however, the social and economic activities develop and transfigure on the premise that the public is deserved to receive the benefit. At this stage, a system failure causes uncontrollable chaos to the social and economic activities which now depend heavily on the availability of the system. People begin to ask for the social responsibility of the system or even ask for compensation which may shatter the existence of the system itself. To guarantee the required social responsibility, a system generally has to have such provisions as failure detection and isolation, parallel or standby redundancy, automatic diagnosis, fall-back capability, etc. Additional investment for these provisions however, tends to upset the economy of the system. It would therefore be advisable to integrate the individual systems together so that systems can substitute or complement each other in case of failure. In this respect, technological standardization, cooperation across organizational boundaries and optimum relocation of activities may be required.

7. Conclusion

So far, the author has described the motivations, potentialities, plans, problems and approaches for the realization of information oriented society in Japan. Although what has been mentioned on the problems and the possible approaches for solution are mostly the author's personal views, it is the author's hope that increasing number of his country men and of those in the rest of the developed part of the world could share his views in coming years. After all, if the plans for information oriented society could be realized successfully, it would bring about to this heavily-populated and resourceless country an opportunity to survive and to contribute to the progress of mankind.

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