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Preface

Unlike the preceding volume of the JARECT series on telecommunication technologies, which placed emphasis on digital and network aspects, this volume covers the state of the art of telecommunications in Japan more broadly. In this manner it complements the preceding volume by providing an overall view of Japanese telecommunication and broadcasting technologies. In the network aspect of these technologies, the Japanese common carrier, i.e., Nippon Telegraph and Telephone Public Corporation (NTT), is mounting a major thrust into integrated digital network services while other institutions are deploying private networks of their own. New technologies are emerging in broadcasting services that offer great flexibility in disseminating information. Technological innovations promising to enhance the infrastructure for communication services and provide sophisticated interfaces for diversifying user needs are also emerging. Due mainly to the rapid progress in digital technologies, telecommunications, information processing, broadcasting and other information services are now merging together to form an integrated whole. With this convergence of service modes, the expanding array of user requirements can be met while preserving economies of scale. However, to fully reap the benefits of this amalgamation, major changes in regulatory measures for telecommunication services must be made.

This volume consists of six chapters, each of which addresses recent developments in Japan in one of the aforementioned areas.

Chapter 1 is devoted to the Information Network System (INS), a system concept for an integrated service digital network formulated, developed and now being deployed by NTT. Dr. Yasusada Kitahara, Executive Vice President of NTT, describes the system philosophy of INS in the first article. This is followed by two articles outlining the new technologies to be employed in INS as well as the pilot model of the system being tested in the Mitaka area, in the Northwestern section of the Tokyo Metropolitan District.

In addition to the public telecommunication network operated by NTT, entities such as the Japanese National Railways (J.N.R.), electric power companies and expressway authorities have extensive telecommunication networks of their own. Of these the J.N.R. network may be the most extensive in scale and the most sophisticated in the services it offers. Its microwaves, coaxial cables and switching centers cover the nation, offering in addition to telecommunications such services as seat reservation, automatic train control, computerized scheduling, and freight inventory. Other organizations, including the National Police Agency, airlines, trade houses, and banks and other financial institutions deploy large-scale networks, mainly utilizing communication lines leased from NTT. Some networks typical of these are described in Chapter 2.

In the area of broadcasting, new systems are emerging which are sometimes referred

to as new broadcasting media. Broadcasting satellites, cable television, teletext and high definition TV are, among others, the most outstanding of these. The Japanese lead in high definition TV technologies has been acknowledged the world over. Japanese satellite broadcasting technologies, including direct receivers with compact roof-top antennas, are also highly regarded. Because of the very large character set inherent in the Japanese language, Japanese teletext technology has been developed specifically to accommodate this complex requirement. In addition, pioneering work in the area of broadband home information systems has been made in Japanese governmental projects. These technologies are described in Chapter 3.

Integrated digital networks will become operational only if the many technologies needed to insure a solid infrastructure as well as a powerful user interface are developed and deployed. The great variety of these technologies may be categorized into two major groups: transparent network technologies that constitute a firm infrastructure, and intelligent communication technologies that provide a powerful and diversified user interface. Japanese technologies for the former are dealt with in Chapter 4 and the latter in Chapter 5. Transmission technologies for trunk lines and subscriber loops, digital signal processing technologies for voice as well as visual signals, network surveillance and control technologies and virtual circuit switching technologies are described in Chapter 4. Japanese technologies for key telephones, electronic mail, facsimile, Kanji recognition, teleconferencing, telewriting and voice recognition and synthesis are presented in Chapter 5.

Reflecting on the one hand the convergence of service modes brought about by the emergence of digital telecommunication technologies, and the diversification of users' needs on the other, Japan's telecommunication policy, as well as its telecommunication services, is now undergoing major changes. The present state of telecommunication administration in Japan is described in Chapter 6.

As it was in editing the preceding volume, the selection of topics as well as the authors for the papers included in this volume has been a very hard task for the Editional Board and its Working Group. As a result, this volume could not include all of the excellent work carried out in this country, despite of the fact that every effort has been expended to make the right choice in the right amount. Again, we wish to express our sincere apologies to the authors whose articles could not be accommodated in this volume because of space limitations.

This volume could not have been materialized without the dedicated efforts of the members of the Editorial Board as well as of those of Working Group whose names are listed in a preceding page. As the Editor-in-Chief of this volume, I wish to express my heartfelt gratitude to all of them, in particular to Professor Hiroaki Terada, who chaired the Working Group and spent considerable time and effort putting all the material together. Last but not least, I wish to thank most sincerely the people of Ohmsha, Ltd. for their attentive editorial assistance.

Hiroshi Inose
Editor-in-Chief

April 1984
Tokyo, Japan

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Introduction

The purpose of this second issue of the Japan Annual Review in Telecommunications is twofold. The first aim is to supplement the first volume by giving an overview of telecommunications system aspects not covered in the preceding issue due to page limitations. Therefore, the first three chapters of this volume are devoted to detailed descriptions of the new ISDN or INS (Information Network System), dedicated networks and new TV broadcasting systems. The second purpose of the issue is to introduce research topics in telecommunications. Thus, the remaining two chapters touch on research currently underway in transparent and intelligent networks, respectively.

Japan has achieved a high degree of maturity with her 41.5 million telephone sets forming a fully automatic switched telephone network that offers complete direct dialing to its subscribers. The natural next step forward is to construct an integrated services digital network covering the entire range of advanced information services throughout the nation. In the first issue of the JARECT Telecommunication Technologies, considerable amount of information on the individual digital techniques being employed in the Japanese telephone network was introduced. This issue revisits the scope of the ISDN network or INS now undergoing initial field trials in the Musashino-Mitaka area in the suburbs of Tokyo. The first paper in Chapter 1 is reproduced from the keynote lecture by Dr. Yasusada Kitahara (Vice-President, Nippon Telegraph and Telephone Public Corporation) at the first INS symposium held in Tokyo last year under the sponsorship of NTT and addresses the basic concept underlying the project. The second paper in this chapter details new technologies being introduced in the INS and discusses future technology trends in an advanced information society. The third paper in the chapter gives an excellent picture of the first field experimental INS system now under construction in the Musashino-Mitaka area.

In addition to the public switched network, there are many dedicated communication networks operated by various organizations to facilitate their internal activities. The Japanese National Railways has its own transmission and switching systems and has been operating one of the largest independent networks outside of NTT. Many other privately owned railway companies in Japan are operating similar but far smaller communications systems independently. The second paper in Chapter 2 gives a good overview of railway communications systems in this country. The National Police Agency is another example of a nationwide system operator independent of NTT. Due to the nature of the agency, it has many mobile communications media along with a dedicated switched network. The third paper outlines the highly efficient police communications system that keeps the crime rate remarkably low for an advanced country such as Japan. The last two papers in this chapter give examples of communications systems based on lines leased from NTT. Besides these examples, there are many nationwide networks operated by large private enterprises. However, these two have the

largest and most typical operations required to keep big business abreast of domestic as well as overseas information activities. It should be noted here that the privately operated networks utilizing NTT's leased lines will be the most interesting field for the application of advanced communications technologies, as the administration authority recently decided to convert NTT into a private company and introduce competition into the common carrier business. At the time of this writing, the details of the new regulations are not yet completely clear. However, the impact of this drastic change on value added networks will be a good subject for review in the volumes that follow.

Japan is also television-saturated with her 40 million home TV receiver sets served by about twelve thousand TV broadcasting and relay stations covering the entire group of island. A survey shows that more than 90 percent of the Japanese population watches televised programs every day in one form or another and that every TV set in this country is on daily for more than 3 hours on the average. Along with the popularity of on-the-air programs, the deep penetration of TV receivers makes them attractive terminals for delivering and originating information to and in home. Thus, a hot debate is raging in Japan on whether or how these TV sets could be used as a new segregated communications media for supplying information other than retransmitted TV programs. Sometimes, the new communications measures anticipated are collectively termed the "new media" in this country. Chapter 3 introduces some recent trends in new broadcasting technologies with particular emphasis on the possible "new media" capabilities of TV sets. Selected for review in this volume from among the various trials being conducted recently are direct reception of satellite broadcasted TV programs, teletext experiments, the development of a high-definition TV system and an experiment on bilateral TV communications.

Research topics in telecommunications are covered in Chapters 4 and 5. Chapter 4 presents current research on transparent networks. A network is said to be transparent, regardless of what communications processing is going on within the network, if the processing is undistinguishable from the network users. The first two papers deal with trunk and subscriber line transmissions, respectively. Optical fiber trunk line technology is being exploited in the first trans-Japanese optical cables from northernmost Sapporo to southern Fukuoka on the island of Kyushu spanning around 2,000 kilometers. The digital subscriber line technology introduced here is nick-named "ping-pong transmission" and is being utilized in the INS experiment in Musashino-Mitaka area. The following two papers outline the status of voice and video coding/processing technologies in Japan. These papers will give the reader an idea of what Japan has achieved in the theoretical aspect of signal processing as well as of progress made in advanced VLSI technology. The third paper in this chapter is a status report on network surveillance and control now in effect in domestic networks. The last paper is a proposal of a new transparent ISDN network architecture applicable to international communications.

Chapter 5 is a collection of reviews on various reserach activities on instilling intelligence in communications networks. The authors of these papers were asked to outline their own research as wll as give an objective survey of the current situation in relevant fields. Thus, the papers in this chapter should serve as an excellent introduction to such research in Japan.

The last chapter is a special contribution from the Japanese PTT exclaiming ad-

ministrative structures and policy on advancing technology in Japan. This paper is intended to show how the Japanese Telecommunications Administration is organized and the role of administrative authority in pushing research forward. This sort of information has rarely been available in technical publications, and the editors believe its inclusion here will serve its intended purpose well.

The chairman of the Editorial Working Group would like to express his deep appreciation to Dr. Toshiharu Aoki (INS), Dr. Hideyoshi Tominaga (Dedicated networks), Dr. Toshihiko Namekawa (New broadcasting), Dr. Michio Fujisaki (Topics in transparent networks) and Dr. Zenya Koono (Topics in intelligent networks) for their contributions in finalizing their respective chapters. He is also indebted to Dr. Yasuo Fukata, Dr. Tadao Saito, Dr. Nobuhiko Shimasaki and Dr. Yoshihiko Yokoyama for their assistance in organizing this volume. Without their effective support, this volume could not have appeared.

Hiroaki TERADA
Chairman of the Editorial Working Group

May 1984
Osaka, Japan

CHAPTER 1

INS

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1.1 INS(Information Network System)
—Telecommunications for the Advanced Information Society—

Yasusada KITAHARA*

Abstract

An Information Network System (INS) as the basis of a new world information order. Maximum advantage is to be made of the marriage between telecommunications and computer technologies in implementing the information network. A bit rate tariff system is also proposed to make INS feasible on both a national and international scale. As the community of man transforms itself, on the shoulders of INS, into an advanced information society, the human and technical weaknesses inherent in such a society must be addressed. By harmonizing the natural and social sciences with the needs of humanity, the technological and information-oriented innovations accompanying INS are expected to greatly enrich the quality of life.

1.1.1 Introduction

In 1974 the United Nations General Assembly proclaimed a New International Economic Order. In addition to economic issues, disparities caused by a widening information gap have also become an issue between developed and developing nations in this new era. At the Nineteenth UNESCO General Assembly held at Nairobi in 1976, many developing countries proposed that basic principles be established which assure creation of a balanced flow of information among all nations. In the proposal, the developing nations emphasized that the state should control the handling of information. Many nations, based on the principle of freedom, claimed that such an emphasis is not acceptable. Heated discussions resulted. The U.S. in particular strongly opposed the proposal, and the meeting closed without any resolution being adopted.

In 1977, UNESCO then established the International Commission for the Study of Communication Problems, headed by S. MacBride of Ireland, to study the proposal on a balanced flow of information. At the beginning of the discussion, Third World countries and international news agencies focused their argument on printed media. Eventually, however, the discussion developed towards how the telecommunications media should be treated, in view of the rapid developments being made in electronics technologies. As a result, the commission concluded that all nations, irrespective of the political problems involved, should

* Executive Vice President, Nippon Telegraph & Telephone Public Corporation, Uchisaiwai-cho, Chiyoda-ku, Tokyo 100.

recognize the rapid progress in communications technology, and should help to establish national and global communications systems that will contribute meaningfully to human society. In 1980, at the 21st UNESCO General Assembly held in Belgrade, Eastern and Western countries, both developed and developing, unanimously agreed to establish a new information order. Subsequently, at the 1981 United Nations General Assembly, it was resolved that 1983 be designated the World Communications Year, with the theme "Development of Communications Infrastructures."

While such lively discussions related to the information gap were under way between developed and developing countries, NTT, since 1977, had been proposing at international meetings the concept of an Information Network System (INS) as a new approach to telecommunications for the 21st century. Although Japan had just finished building a huge telephone society when INS was first proposed, there was considerable criticism of its telephone service and demands for improvement. These demands prodded NTT to tackle a new approach to information. The prospects for technological development that would satisfy these complaints and desires were bright. Times were changing, and it was clear that innovation in telecommunications was mandatory. NTT happened to introduce its concept of INS at the 1978 International Conference on Computer Communication held in Kyoto, which the current ITU Secretary-General, Mr. Richard Butler, also attended. With the strong encouragement of Mr. Butler, NTT once again advanced this idea in 1979 in a presentation at the Third World Telecommunication Forum held in Geneva. Japan's proposal at this forum to establish a bit-based tariff structure, one of the basic conditions for realizing INS, was adopted at the VIIth CCITT Plenary Assembly in 1980. Study group III is now actively studying the proposal.

The INS explained here grew out of the same background that made 1983 the World Communications Year. By developing INS in Asia, then promoting its spread throughout the world, this new order for handling communications could conceivably be the new information order needed.

1.1.2 Information and Telecommunications

Information Innovation in Human Acitivity

In a presentation at the Third World Telecommunications Forum held at Geneva in 1979, NTT presented an approach outlining innovations in information exchange through five distinct stages—a stage-by-stage evolution passing through a series of revolutionary changes in methods of communications occurring along with the development of social activity. First came the era of language, then that in which a writing system was developed; both lasted a long time. Third came the age of printing machines, which greatly spurred the process making information a characteristic element of the social environment. Since the latter half of the nineteenth century, telecommunications and broadcasting have steadily evolved, from the telegraph to the telephone to the radio and finally television. Today, we are living in the fifth stage, characterized by the integration of telecommunications and computer technologies.

There is no doubt that society is undergoing constant, information-oriented change. It has been just recently, however, that people have come to recognize how important this information revolution is to our social lives. The term "information," as we use it today, came into

use around 1948, when Norbert Wiener wrote a book entitled Cybernetics. In the book, he states that information is the third "basic element," along with material and energy, that is essential for people to exist as a society. Developments, especially in the field of electronics, have revolutionarized telecommunications and computer applications. Such developments today are accelerating information-oriented innovation in our society. Data communications accomplished through a combination of telecommunications technology and the computer, and the increasing use of facsimile communications are typical examples of this revolution. Another example is the combination of computer and sensor techniques for use in environment information processing systems and production control systems. With this marriage between telecommunications and computers, it seems certain that the fifth stage of the information revolution will develop fairly fast, and is unlikely to end. Development of this fifth stage will continue, spurred by social needs and technical innovation.

Information Dealt with through Telecommunications and Man's Intelligence

A complete theoretical study on the information dealt with in the field of telecommunications was made in "Mathematical Theory of Communication" by Claude E. Shannon at Bell Telephone Laboratories in 1948. The information referred to here is limited to that transmitted by electric current or electromagnetic waves, including light. Such transmittable waves are the basic requirements for processing information through telecommunications. In other words, the information that people deal with through a telecommunications network must be in a quantitative form or in a form in which its quantity can be measured easily.

This underlines the fact that among the myriad services involved, there is bound to be important information that cannot be dealt with through telecommunications. It is important that this constraint be recognized. This does not mean, however, that telecommunications is underdeveloped. Greater progress is expected in the field of telecommunications, but it is not conceived that telecommunications will ever be able to handle all types of information. On the contrary, this will never happen.

Looked at another way, this fact indicates the depth of man's intelligence. Depending on one's view point, the introduction of machinery way be seen as a major factor in creating the problem of human alienation. Thus, to bring about the kind of INS advocated here, it is particularly important that any society based on INS be created through careful assessment and constant harmonization; that a good balance be struck among the natural sciences, social sciences and humanities.

Qualitative Revolution in Telecommunications

In general, qualitative expansion functions in a direction that destroys the order created in an era of scarcity, and results in raising new issues that never existed before. A look back into society's history shows that increase in disorder has been the cause of war and revolution. As a result, a new order has always had to be established.

As an example of quantitative expansion that took place in telecommunications, there were only about two million telephone sets in Japan when NTT was established in August, 1952. Today, there are 30 times two million—more than 60 million. The telephone, which used to be a status symbol, has become simply one more item on the market. The number of NTT

employees, however, has only doubled during the same period—from 160 thousand to 330 thousand. Thus, this popularization of telephones, the result of various programs geared toward streamlining its operations, resulted in NTT having less and less contact with its customers.

Consequently, as explained earlier, many customers have complained and criticized the telecommunications services provided, and demands have been made for improvement. These demands were collected and consolidated into the five following categories: The first includes demands for expanded non-telephone services. These consist of "needs" type demands, resulting from limitations such as the telephone not being able to record, and "seed" type demands, pressing for expansion towards more diversified telecommunications media to cope with the increasing requirements of an information-based society. The telephone is a means of real-time communication that also permits customers chatting over the line to feel at home; both applications are substantial merits of the telephone. Thus, the direction to proceed in is one that allows customers to use non-telephone services effectively in the face of expanding communication needs.

To meet this challenge, a major effort must be made to spread non-telephone services throughout the country, services that include data, facsimile, and video communications. At the same time, we major changes in technology, rules and regulations must be made to reform the tariff system into one that entails economic rates and is acceptable to customers. Everyday life should also be re-organized so that people are able to enjoy the benefits made available through non-telelphone services.

The second category is demands for rates that are less concerned with distance and as low as possible. More and cheaper information tends to be available in cities, while the increasing urbanization in cities poses potential problems for the living environment. Thus, new technologies must be developed that make it possible to provide information at the same rate regardless of where the customer lives—it must be the same price, whether it is going next door or a thousand kilometers away. Thus, NTT will continue to concentrate its R&D activities, including those for commercializing digital and optical fiber technologies and for developing large-capacity satellite communications technology, toward reducing costs even further.

The third category is the public wish to liberalize the use of data communications circuits and customer on-premise equipment to include the private sector. As society becomes more and more information-oriented, customers will demand more diverse uses of telecommunications network based on their own ideas and creativity. In Japan, the initial liberalization of communications circuits was implemented immediately after the Public Telecommunications Law was partially amended in 1971. Liberalization at that time, however, was limited to authorizing data communications only between enterprises having a specific operational relationship. For an enterprise that desired to conduct data communications with another enterprise, but had no specific relationship, approval, on a case-by-case basis, had to be obtained from the government ministry concerned. Liberalization was still extremely limited. The Public Telecommunications Law was amended again in 1982. The new amendment authorizes the private sector to use communications circuits, without restriction, for data communications that require computer processing.

Customers have traditionally enjoyed a great deal of freedom in Japan regarding such