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Preface

The current volume of JARECT series on Telecommunication Technologies deals with three specific topics, namely, satellite communications, optical local area networks and communications LSI.

In view of the facts that the socio-economic activities in the world are becoming increasingly integrated and the diversifying societal needs urge new means of communication, communication and broadcasting via satellites is no doubt one of the most significant technological areas, and it requires serious attention. For Japan, an island nation remote from the centers of world socio-economic activities, international communication via satellites is an indispensable means of keeping up and promoting its activities in the present age of interdependence. At the same time, domestic communication and broadcasting via satellites is becoming a significant part of Japanese society because, as compared to terrestrial communication, it not only provides broader and more versatile means of access for its users, but it also plays the most crucial role in cases of emergency and disaster.

Satellite technologies are multifold, ranging from systems design to component development. For this reason, the first chapter of this volume is devoted to the description of satellite communication and broadcasting systems currently in operation in Japan. The second chapter, on the other hand, describes research and development activities relative to satellite communications that have been aimed at performance enhancement of systems such as large transmission capacity, multibeam communication and packet communication, as well as of equipment and components such as new antennas, low noise amplifiers, high power transponders, and receivers for home use.

Another area of telecommunication technologies, which has been characterized by a rapid pace of innovation and a keen interest of business users, is the application of optical media for local area networks. Chapter 3 of this volume describes various techniques being developed for use in this area, including time division multiple access, carrier sense multiple access and token passing, along with the application of optical data highway systems for iron and steel plants, railways and electric power industries.

Rapid digitalization in telecommunication networks has made possible by, among other things, the remarkable progress of integrated solid-state circuit technology. Not only logical gates and memories, but also a large variety of functional circuits for digital communications have been produced in the form of large scale integration (LSI) and have contributed significantly to enhance the economy, reliability and performance of telecommunication services. Chapter 4 of the present volume is devoted to describing the progress being made in the LSI technology specific to digital communications. Communication LSIs

are characterized by their great variety of usage, and hence have to be custom made in accordance with specific purposes. In this chapter, LSIs for telephone services such as those for line circuits, coders and decoders, telephone sets, and signaling and time switching are described together with more sophisticated circuitry including that for X. 25 protocols and digital speech processing.

As it was in the preceding volume, the present one could not have been materialized without the dedicated efforts of the members of the Editorial Board as well as those of the Working Group whose names are listed on the preceding page. As the Editor-in-Chief of this volume, I wish to thank all of them most heartily, and in particular Professor Hiroaki Terada, who chaired the Working Group and spent a great deal of personal time and effort to organize the material. Thanks are also due to all the authors of the articles in this volume, who spared their precious time in writing these excellent papers. Last but not least, I wish to acknowledge with thanks the most attentive editorial assistance provided by Mr. Seiji Sato, Mr. Masaki Mori and Mr. Katsuomi Hosoi of Ohmsha, Ltd.

Hiroshi Inose
Editor-in-Chief

June 1985
Tokyo, Japan

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Introduction

The third issue of the Japan Annual Reviews in Telecommunication Technologies is organized to give readers a comprehensive overview of the most rapidly progressing fields in Japanese telecommunications research and development activities.

The first field is public communication systems via geostationary satellites. Several satellite communication systems have recently been put into service in Japan. Geostationary satellite communication systems have been used mainly for long haul links, such as international communications. However, advances in on-board and ground equipments have made it feasible to use geostationary satellite links for domestic services. In Chapter 1, the status of public telecommunication services via geostationary satellites is discussed in detail.

The first topic in this chapter is the successful launching of Communication Satellite 2 (CS-2). The prime role of CS-2 is to provide a back-up link when terrestrial links are interrupted by unforeseeable accidents such as natural disasters. Therefore, channels over the world's first 20/30 GHz links via CS-2 have been shared by different governmental and public organizations to establish various nationwide emergency communication utilities. At the same time, it is routinely used for links connecting remote islands to the mainland network. For example, about 1,500 inhabitants of the Ogasawara islands, (located in the Pacific about 1,000 km south of Tokyo) the last people isolated from the nationwide automatic telephone network, are now enjoying direct subscriber dialing access to the public telephone network.

Chapter 1 also covers other topics such as the inauguration of the new direct reception satellite TV broadcasting system, advances in international communication services and projected mobile communication systems through satellite links. Unfortunately, the direct reception satellite TV broadcasting through BS-2 suffered trouble in two of three transponders. However, using the last working transponder, nationwide TV broadcasting service was started. This service will provide high quality TV program reception in city, mountainous and remote island areas where CATV service has been the only remedy to overcome poor propagation conditions. The basic concept of the BS project was also reviewed in Chapter 3 of JARECT Telecommunication Technologies (Vol. 14). Interested readers are requested to refer to related articles in that chapter.

Undoubtedly, one of the most attractive applications for geostationary satellite links is in mobile communications. The status of mobile communications via satellite is reported at the end of Chapter 1 and some of the coming mobile services for maritime, aeronautical and land vehicles are introduced in detail.

Along with the introduction of public satellite communication services, many research and development activities in satellite communications are being conducted to exploit the broad possibilities in space communications. Several papers reflecting current research and development trends in this country have been collected in Chapter 2. These papers should give readers a good scope of space development activities in Japan as well as information on international cooperation in sharing common space resources.

The third chapter covers the introduction of optical-fiber local-area-network (LAN) technologies in Japan. Japan is probably one of the most advanced countries in practically utilizing fiber-optical LANs. Fiber-optical LANs are more favored in Japan than their coaxial and twisted wire counterparts, since they are superior in expandability of performances and utilitiy. In the first phase of fiber-optical LAN applications, the inherent noise immunity of the optical-fiber media was of utmost concern from a user view point. For example, electric power suppliers, factories with high electromagnetic interference, railroad companies and highway authorities were the early users of optical LANs. Following these forerunners, the rapid and wide introduction of optical communication links into the public communications system began. Now the Japanese public communication network is equipped with various optical links from short haul links of several tens of kilometers connecting the suburban areas and metropolitan centers to long haul links spanning more than 2,000 km across Japanese mainlands. Naturally, widening of the field of application has increased the variety of optical fibers and opto-electrical devices as well reduced the prices of optical LAN systems.

Despite the wide application of optical-fiber LANs, protocol problems still remain unsolved. Many commercially available optical-fiber LANs are using various existing protocols with slight modifications to fit protocols to characteristics of the optical-fiber media. This has made it generally impossible to freely interconnect different optical-fiber LANs supplied different vendors. In spite of the chaos in protocols, however, optical-fiber LANs are considered to be the most promising media for interconnecting information terminals within factories and offices since they are the only feasible solution to the problem of future wideband information exchange within premises.

Along with optical-fiber LANs which rely mainly upon bus, ring or loop topologies, LANs with hierarchical or star topologies are gaining strong attention in connection with recent divestiture policy in public telecommunications in Japan. Many PBX facilities are emerging with data communication capability. Unfortunately, due to page limitations, detailed coverage of this subject has been left for future volumes to come a coming volume of JARECT Telecommunication technologies.

The last chapter covers varieties of communication LSIs. Needless to say, VLSI technology has made a strong impact on traditional communication systems concept. It is also clear that future communications technology must take note of coming ULSI devices. Therefore, the editorial board decided to devote one chapter in the present and forthcoming volumes to communication LSIs. This chapter is actually the first part of the status report on communication LSIs being developed in Japan.

In this chapter, various communication LSIs are outlined to show their effect on changes in design concepts in terminals, central offices and signal processing to be carried

out while the signals are transmitted through the communication system. The single channel CODECs penetrate into the terminals to form integrated voice/data terminals and the MODEMs convert conventional analog transmission media into a data transmission network. Without these LSIs, it would be difficult to conceive of the natural transformation of existing communication networks into the future ISDN.

It is extremely necessary for a large public network to maintain strict compatibility with existing facilities when any new service is introduced into the network. Therefore, it is important that new network architecture have flexibility to be compatible with possible later generation architectures. The key factor in maintaining this principle for an architecture is its affinity to VLSI/ULSI implementation. However, this problem will be left for discussion in forthcoming volumes.

In closing, the chairman of the Editorial Working Group would like to express his deep appreciation to Dr. Hideyoshi Tominaga and Mr. Ryoichi Tanaka (Satellite Communications System in Japan), Dr. Kazuhiro Miyauchi and Dr. Toshiharu Aoki (Research and Development Topics in Satellite Communications), Dr. Tadao Saito (Optical Local Area Network), and Mr. Makoto Watanabe and Dr. Toshiharu Aoki (Communication LSI) for their valuable contributions in finalizing their respective chapters. He is also indebted to Dr. Michio Fujisaki, Dr. Yasuo Fukata, Dr. Zenya Koono, 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

July 1985
Osaka, Japan

Chapter 1

SATELLITE COMMUNICATIONS SYSTEM IN JAPAN

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1.1 Overview

Kenji FUNAKAWA*

Keywords: satellite, space, communication, broadcast, earth station.

During the 14 years since the first Japanese satellite OHSUMI was successfully put into orbit in 1970, 29 satellites have been launched by the National Space Development Agency (NASDA) and the Institute of Space and Astronautical Science (ISAS), and Japanese space development is now considered to be at the matured stage. It enjoys the status of being the world's No. 3, after the U. S. A. and the U. S. S. R., as far as the number of satellites launched by a nation is concerned.

All satellites have been launched in conformity with the "Space Development Program," which the Space Activities Commission decided upon and recommended to the Prime Minister. The program is reviewed and modified annually based upon launch requests from relevant ministries representing user agencies, in accordance with the progress in research and development in space science and technology, domestic as well as overseas.

15 of the 29 satellites are those for application purposes developed and launched by NASDA, and 9 of the NASDA satellites are communication satellites, including engineering test satellites for that purpose.

As Japan is one of the most developed countries in communications, there have always been very strong desires at various governmental and public agencies to launch communication satellites. From the very beginning of the Japanese space development, the Ministry of Post and Telecommunications (MPT) has been very active in space communication. Based upon preliminary experiments by means of NASA's ATS and in conjuction with millimeter wave technology, which was already fully advanced for ground networks, the ECS (Experimental Communication Satellite) was proposed as early as 1970 by the Radio Research Laboratories (RRL) of MPT with the aim of promoting millimeter wave space communication.

Though the test satellite ETS-II, launched in 1977, was completely successful, including the millimeter wave propagation experiments by means of a solid state oscillator on board the satellite, both ECS-a and ECS-b, launched in 1978 and 1979 respectively, were unsuccessful in achieving geostationary orbit. However, continued efforts to develop higher frequency technology in space communication have resulted in the success of the consecutive programs, CS (launched in 1977), CS-2a and CS-2b (both launched in 1983), which were proposed by MPT and Nippon Telegraph and Telephone Public Corporation (now altered as Nippon Telegraph and Telephone Corporation; NTT) and have become the

* Executive Director, National Space Development Agency (NASDA), 2-4-1 Hamamatsu-cho, Minato-ku, Tokyo 105.

world's first space communication system to be operated in the 20/30 GHz band.

The prime objectives of the CS-series are to establish a communication network for natural disasters when terrestrial networks suffer damage, and also to provide communication links to remote islands where microwave links or submarine cables hitherto have not been installed from mainland Japan. In addition, after the successful launches of two CS-2s, new types of communication services, such as multiple access closed network service using digital techniques, are being planned for operation.

As for broadcast satellites, BSE (E stands for Experiment) was proposed by MPT and Nippon Hoso Kyokai (NHK ; Japan Broadcasting Corporation) and was launched in 1978. Through the BSE experiment in 1978-81, the technical basis necessary to develop an operational BS system was established, and BS-2a, which was intended to be an operational broadcast satellite for direct reception, was launched in 1984 as the top contender of DBS's (Direct Broadcast Satellites) in the world. The prime purpose of BS-2 was to provide TV programs to those areas where good quality TV reception is difficult by terrestrial networks due to poor propagation conditions, etc. Unfortunately, due to anomalies which occurred in 2 transponders after station acquisition at 110°E, BS-2 is still under testing status using the only one remaining transponder. Efforts to identify the cause of the anomalies and to find proper means of remedy, if any, are being continued as of August 1984.

On the other hand, an experimental satellite for mobile communication was also proposed by the Radio Research Laboratories and Electronic Navigation Research Institute (ENRI), Ministry of Transportation in 1977. The purpose of the experiment was to develop a maritime communication system for small fishery vessels along with developing traffic control and communication systems for aircraft.

Unfortunately, the plan to launch AMES (Aeronautial Maritime Engineering Satellite) was not authorized due to budgetary limitations. However, the experiment will be materialized by means of ETS-V (Engineering Test Satellite-V ; launch planned for 1987), on board of which AMES mission equipment will be installed.

Turning to foreign and international developments, we notice the number of domestic communication satellites launched is rapidly increasing and a few regional communication satellites have already been launched or planned for launch in the near future, while INTELSAT is steadily deploying new satellites with ever larger capacity.

In the U. S. A., due to the "Open Sky Policy" of the government, many domestic satellites have been launched or planned by various newly established carriers.

In Europe, along with a few national programs to launch their own satellites, there are many bilateral or multilateral programs.

Regional Communication Satellite ECS has already been launched and a newly established organization, EUTELSAT, is operating it.

Arab countries also have a plan to launch ARABSAT for regional communication in that area.

On the other hand, INTELSAT is also providing domestic communication services to some countries by leasing transponders in addition to international communication services.

The outlook of domestic, regional and international space communication is chang-