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COMMITTEE ON THE PEACEFUL USES
OF OUTER SPACE

REPORT ON UNITED NATIONS WORKSHOP ON SPACE COMMUNICATIONS FOR DEVELOPMENT, ORGANIZED IN COOPERATION WITH THE GOVERNMENT OF THE REPUBLIC OF KOREA

(Seoul, 24-28 November 1992)

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INTRODUCTION

A. Background and objectives

1. At its thirty-seventh session, in 1982, the General Assembly adopted resolution 37/90 of 10 December 1982, in which it endorsed the recommendations of the second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82). In that resolution, the Assembly directed, among other things, that the United Nations Programme on Space Applications should promote the dissemination of information on advanced space applications and new system developments among managers and decision-makers, particularly for the benefit of the developing countries.

2. The United Nations Workshop on Space Communications for Development was one activity of the Programme for 1992 which was organized following the decision of the Government of the Republic of Korea to co-sponsor this Workshop. The Workshop was hosted by the Ministry of Communications through the Electronics and Telecommunications Research Institute (ETRI) in Seoul, from 24 to 28 November 1992, for the benefit of participants from the Economic and Social Commission for Asia and the Pacific (ESCAP) region.

3. The objective of the Workshop was to provide the participants with information on the current state and future trends of satellite communication technology and the contribution of this technology to economic and social development. The Workshop was also intended to provide an opportunity for managers and specialists to exchange information on their activities in this field and to discuss possibilities for increasing regional and international cooperation.

4. The present report, which covers the background, objectives and organization of the Workshop, as well as summaries of the discussions and recommendations of the Workshop, has been prepared for the Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee. The participants will report to the appropriate authorities in their respective countries.

B. Organization and programme

5. The Workshop participants were invited in their personal capacity as experts with several years of professional experience in various fields of satellite communications, telecommunications, educational broadcasting centres and in the operation and maintenance of satellite communications systems. Eighty-six participants attended the Workshop from the following countries or territories, international organizations and private companies: American Samoa, Australia, Brunei Darussalam, Canada, China, Fiji, Hong Kong, India, Indonesia, Iran (Islamic Republic of), Italy, Japan, Kiribati, Lao People's Democratic Republic, Malaysia, Marshall Islands, Nepal, Papua New Guinea, Philippines, Republic of Korea, Russian Federation, Sri Lanka, Taiwan Province of China, Thailand, Tonga, Viet Nam, International Maritime Satellite

Organization (INMARSAT), International Telecommunication Union (ITU), the United Nations Office for Outer Space Affairs, Asiasat, Panamsat, Comsat, GE Astro, Globalstar, Iridium and Sovcanstar.

6. Funds allocated by the co-sponsors, the United Nations and the Republic of Korea for the organization of the Workshop were used to cover the cost of international air travel and a daily subsistence allowance for 18 participants to cover board and incidental expenses; room accommodations for participants from developing countries, conference facilities and local transportation were provided by the Ministry of Communications of Korea.

7. Opening addresses were presented by Mr. Adigun A. Abiodun, of the United Nations Office for Outer Space Affairs, on behalf of the United Nations, and Mr. Song Eon-Jong, Minister of Communications of Korea, on behalf of the Government of the Republic of Korea.

8. The programme of the Workshop (see annex III to the present report) was developed by the United Nations in consultation with ETRI. The Workshop was conducted through a series of plenary and round-table sessions. At the latter, the participants discussed the proposal that follows.

I. RECOMMENDATIONS

Proposal on the establishment of an Asia-Pacific Satellite Communications Conference

9. During the Workshop, the Republic of Korea submitted for the consideration of the Workshop's participants a proposal on the establishment of an Asia-Pacific Satellite Communications Conference (APSCC) (see annex I to the present report). The last day of the Workshop witnessed a fruitful dialogue among the participants when they engaged in an intensive discussion on the development and promotion of satellite communications in the Asia and the Pacific region through the establishment of APSCC. At the meeting extensive discussions took place concerning the justification of APSCC as well as modalities for its operation. Annex II is the summary of the discussions at the closing plenary meeting of the Workshop.

II. SUMMARY OF PRESENTATIONS

A. Satellite communications for development

10. Accessible communication services are indispensable elements of global human activities. The mix of terrestrial telecommunication networks and satellite communication systems meets many of the modern demands for communication. Today, practically every country in the world benefits from a variety of communication services through participation in international, regional or domestic satellite communication systems. Indeed, satellite communications technology is now recognized as a critical tool for social and

economic development as advances in the technology continue to lower the costs of its utilization.

11. Satellite communication services continue to find commercial applications in the distribution of space-acquired data, supercomputer networks, mobile services, broadband integrated satellite digital networks and a variety of information services in every practical aspect of human endeavour. The use of such techniques as on-board data processing, efficient network protocols, effective monitor and control procedures, power-efficient devices and system miniaturization would improve the overall cost-competitiveness of future satellite systems.

12. Communications satellites epitomize the reality of two phenomena, i.e., "the global village" and "the information age". Satellites can bring the power of information to virtually everyone on planet Earth and can enable us to instantaneously share experiences. Yet we still have much to learn about the effects of this technology. For example, satellites have the potential to eliminate the barriers of distance that have hampered economic growth, social service delivery and public participation in rural and remote areas of both industrialized and developing countries. We need to learn how satellites can be used to increase rural residents' access to information, to raise agricultural productivity and to promote other rural industries as well as to examine the extent to which the availability of satellite communications for high-quality voice data communications can encourage other industries to decentralize their operations away from major cities.

13. In many developing countries, where terrestrial systems are underdeveloped or even non-existent, satellite communications services, which have witnessed rapid advances in the last three decades, are of particular importance. Internationally, satellites have the power to bring about a "global village". There is much still to be learned about the impact of global television on the knowledge and attitudes of viewers in various countries. Perhaps the most significant contribution of satellites will be to bring basic communications to people in developing countries. Smaller and cheaper Earth stations, many of them solar-powered, coupled with new and improved radio technologies, should make it possible to reach virtually every human settlement. Yet developing countries will still face decisions on how to invest their limited resources to improve basic infrastructure, including communications, transportation, electricity and water supplies.

14. The importance of the impact of satellites on education, not only in the classroom but in the home and workplace as well, cannot be overemphasized. Satellites can bring specialized courses to small schools to help upgrade and enrich their curricula. Engineers, nurses and other employees can study where they work, with instruction delivered by satellite from universities around the country. Physicians, lawyers and other professionals can keep up with advances in their fields by taping specialized programmes delivered by satellites and cable for viewing at their convenience. And adult-education courses delivered to homes offer lifelong learning opportunities to all. On the humanitarian side, the continuous development of satellite communications

and other space systems has provided new capabilities for disaster warning and mitigation, and for search-and-rescue operations. Today, COSPAS/SARSAT, the global operational search-and-rescue programme, has accounted for more than a thousand lives being saved. Satellite broadcasting systems are now in operation or being developed for rural education as well as health-care and safety services.

15. In both industrialized and developing countries, economic and social progress depends on improved telecommunications. Like other means of transport, telephones, computers, satellites and fibre-optic cables are essential for moving commercial goods and services. Until recently, telecommunications was seen as a consequence rather than a course of economic growth. The accepted view has been that telecommunications is an outgrowth of economic development, or is even a luxury which a country could afford when other more important needs have been met. Such perceptions have resulted in significant under-investment in telecommunications, and if this trend continues much of the developing world's rural population will still be waiting for telephone services many years from now.

16. However, recent studies have shed considerable light on the ways and the extent to which telecommunications contributes to development. In other words, while economic growth contributes to investment in telecommunications, it has been convincingly demonstrated that investment in telecommunications contributes to economic growth. Accordingly, planners and policy-makers in developing countries need to recognize the role of adequate information in the social and economic development of their nations, and the indispensable contribution of communications in their policy formulations.

B. Mobile and personal global satellite communications systems

17. Mobile communication is one of the most promising services that can be provided via satellite. Since this service was first offered in 1982, the International Maritime Satellite Organization has played an important role in establishing mobile communication networks for ships and airplanes on a global basis. INMARSAT services in this field have increased by 10 per cent annually.

18. The explosion in the mobile communications market over the past decade vividly demonstrates the enormous demand for communications mobility. There are currently about 15 million cellular users world wide. By 2000, this may increase to more than 400 million, including cellular, paging, private mobile and personal communications network users. This extraordinary growth has led to a fundamental change in expectations. More and more people demand communications services no matter where they are, whether on the move or at rest, and whether for voice or for data.

19. In many parts of the world and for many applications, the demand for communications mobility can only be met effectively through mobile satellite services. Although cellular and personal communications networks are expanding and will continue to do so, economics prevents their spread beyond

populated areas. Rural areas, regions of low population density within industrial countries and large parts of the developing world are destined to be under-served or to remain out of reach of terrestrial mobile services.

20. Global mobile satellite services are particularly suited for extending the reach of cellular services, filling in gaps in terrestrial mobile coverage and providing the means for travellers to remain in contact wherever they are on Earth. Global personal mobile satellite services provide the missing link, overcoming the inherently local or regional nature of terrestrial mobile services.

21. Project 21 is INMARSAT's vision and strategy for the development of a personal mobile satellite communications system from now into the twenty-first century. Using advances in mobile satellite services and technology, it is aimed at introducing a range of affordable, increasingly portable and convenient, global personal mobile satellite communications throughout the decade. Project 21 is an evolutionary programme, and the early stages of its development have already been completed.

22. The four main service elements of the Project 21 programme are: Inmarsat-C, a portable mobile satellite data service introduced in 1991; Inmarsat-M, a briefcase-sized, digital, satellite phone being introduced in 1993; global satellite paging scheduled for service introduction in 1994; and Inmarsat-P, a portable hand-held terminal operating by means of a new generation of more powerful satellites.

23. Inmarsat-P is planned for introduction in the 1998-2000 time-frame. It is envisaged as a dual-mode satellite-cellular terminal that will work with a cellular system or from the satellite when outside the home region cellular coverage, or operating from a region with a different cellular standard or without roaming arrangements. Its basic service objective is telephony to and from a lightweight hand-held terminal with a line-of-sight satellite view, with a voice quality similar to that of digital cellular systems. Calls can be made to or received from any phone on the public switched telecommunications networks or other mobile satellite terminal. The Inmarsat-P design weight is equivalent to that of many full-size cellular hand-held phones currently on the market.

24. Since the beginning of satellite communications, the ultimate service has been one that operates directly with hand-held cordless telephones, the same as those used with cellular systems today. But with satellites in geostationary orbit, a dish is required for voice communications because the satellite is at least 36,000 km away and it is not powerful enough to transmit to, and receive from, a simple aerial at that distance. In addition, the dish cannot be too near the North or South Pole, otherwise the satellite will be below the horizon.

25. If a Low Earth Orbit (LEO) satellite system is used, the antenna gain required is much less because the satellite is only a few hundred kilometres high. Thus a short, low-profile, non-directional antenna can be used.

However, LEO orbits require the satellite to be lower relative to the Earth's surface, so a large number are needed to ensure that all areas are continuously covered.

26. The Iridium system is a digital communications system that operates in a cellular communication architecture. The constellation of LEO satellites covers the Earth with beams turned on and off as necessary to ensure full Earth coverage. The emphasis in the Iridium programme is on the personal communication device, the handset, which can be easily carried in a pocket, runs on rechargeable batteries and operates in environments typical of today's cellular telephones. The Iridium system is composed of four functional components: the space segment, the system control segment, the gateway segment and the subscriber unit segment.

27. The space segment consists of a constellation of 66 small (approximately 700 kg) satellites in LEO. This constellation consists of six orbital planes with each plane containing 11 operational satellites which orbit the Earth at a height of 780 km and circle the Earth once every 100 minutes. Each satellite has three sets of antennas: the main mission antennas, which communicate with the Iridium subscriber units; the cross-link antennas, which communicate with other satellites; and the feeder-link antennas, which communicate with the gateways.

28. The system control segment monitors, manages and controls the Iridium network and the individual satellites comprising the Iridium constellation. It consists of a master control facility, a back-up control facility and the necessary Earth terminals.

29. The gateway segment represents the interconnection point between the Iridium constellation and the Public Switched Telephone Network (PSTN). Each gateway includes a number of Earth terminals, an Earth terminal controller to manage the communications with the constellation, an operations centre to perform network management and the interface electronics to reconfigure Iridium's digital voice capability to connect the gateway to PSTN. Each gateway is expected to include a subscriber database and will be capable of permitting subscriber verification and billing.

30. The subscriber unit segment will design and develop a variety of subscriber products which will provide the means by which the subscriber communicates via the Iridium system. The subscriber products will include hand-held and mobile telephone (single and dual mode), solar-powered phone booths, specialized aeronautical and marine units and a variety of paging products. Each subscriber product will provide one or more of the system user services which include voice, data, facsimile and position location.

31. Globalstar is the world-wide seamless cellular satellite system which will rely on a 48-satellite constellation, with 8 in-orbit spaces, and will combine the use of LEO satellites with existing terrestrial communication systems and spread-spectrum techniques. Globalstar's services will provide communications with unlimited range and access, wireless mobile voice and data

services, radio-determination satellite services, paging and messaging. Services are routed and billed through the communications gateway in the subscriber's home area. Subscribers receive a single monthly bill regardless of location when placing and receiving calls.

32. Like other LEO systems, Globalstar has no intentions of targeting urban areas, focusing instead on under-served suburban and rural areas. Under the assumption that 90 per cent of communication traffic from a given point represents requests for a local call connection, the system configuration has been chosen to link the mobile unit to a terrestrial gateway through a single satellite. This means that the system requires no satellite crosslinks. Globalstar calls will be set up and processed on the ground by a distributed gateway system that is cheaper and includes an architecture that uses, rather than bypasses, existing communications carriers. Because each satellite remains in range for an average of 10 to 12 minutes, a terrestrial gateway implements a "soft handover" to transfer calls to the following satellite, providing a subscriber with seamless, uninterrupted service. The same satellite may be accessed minutes later in another service area.

33. The international satellite COSPAS-SARSAT system, created jointly by Canada, France, the former Soviet Union and the United States of America, is based on the use of low-orbit polar satellites to help vessels and aircraft in distress situations. Since its commissioning in 1982, 10 satellites (four United States Tiros-type and six Russian Cicada- and Nadezhda-types) have been launched. At present, the system consists of three United States and three Russian satellites. Two additional Russian satellites and two additional United States satellites are ready as spares to be launched in case of necessity.

34. The use of polar LEO satellites made it possible to provide for global coverage, efficiency in reception and transmission of emergency signals and distress alerts to rescue teams as well as high accuracy of automatic positioning. With four satellites in orbit, the system's only constraint is about a one-hour delay in the reception of emergency warning for most parts of the world.

35. The high efficiency of the system demonstrated its value and importance for protecting human life. The COSPAS-SARSAT system operates in two modes, regional and global, using two types of emergency radio-beacons, the Emergency Locator Transmitter (ELT), with an operational frequency of 121.5 MHz, and the Emergency Position Indicating Radio-beacon (EPIRB), with an operational frequency of 605 MHz. It is expected that there will be 600,000 ELTs world wide by 1995. During operation in the EPIRB mode, both regional and global modes were envisaged. Such a mode is very valuable because it makes it possible to observe the whole territory of the Earth from system satellites. Further, in this mode, the accuracy of positioning is 3-5 km, which is 5 to 10 times better than when using ELT mode. Moreover, the EPIRB mode allows the identification of vessels or aircraft. At present, more than 40,000 EPIRBs have already been installed. It is expected that by 1995 there will be nearly 120,000 EPIRBs in operation world wide.

36. The International Civil Aviation Organization (ICAO) established the Future Air Navigation Systems (FANS) Committee in 1983 to determine how best to achieve requested improvements in the communications and surveillance systems used for the management of air traffic over oceans and remote land masses. The FANS Committee identified the use of satellite technology as the optimum means of achieving these goals. Satellite communications can provide instantly available, high-quality voice and data communications between the ground and aircraft in flight, no matter where in the world the aircraft are located.

37. The minimum space segment for a world-wide communications system comprises a constellation of three geostationary satellites with transponders operating in the C- and L-bands. The ground Earth segment consists of Earth stations and the supporting terrestrial communications infrastructures. A minimum of one ground station per satellite coverage area will enable voice and data communication services to be delivered to aircraft in flight via satellites. Each ground Earth station acts as a gateway for airborne communication terminals to access terrestrial communication systems such as PSTN and private voice and data networks. The airborne segment of the system consists of the aircraft Earth stations and their supporting systems on board the aircraft.

38. The FANS Committee also identified space technology as the most likely source of enhanced navigation systems for civil aviation. An accurate navigation system will be required on board each aircraft participating in future air traffic management systems in order to permit the pilot to execute his flight plan with the necessary precision. The United States Global Positioning System (GPS) and the Commonwealth of Independent States' Global Navigation Satellite System (GLONASS) are currently the focus of much attention as candidate systems for this purpose.

39. The current configuration of an oceanic airspace surveillance capability makes it impossible for air-traffic controllers to detect unintentional deviations from flight plans. For this and other reasons the FANS Committee adopted Automatic Dependent Surveillance (ADS) as the surveillance technique to be developed for oceanic air-traffic management. ADS uses the data link of the satellite communications system to relay to the ground the three-dimensional position and other operationally significant data derived from aircraft flight-management computers.

40. Economic considerations facing space segment providers dictate that an aeronautical system must share the satellites with others, such as maritime-mobile and land-mobile communications systems. The system designs must therefore be compatible to ensure freedom from mutual interference. INMARSAT has designed and implemented a satellite system which is currently providing aeronautical mobile voice and data communications services world wide. INMARSAT's future plans include enhanced communications capability through the use of geostationary satellites offering full coverage of the allocated spectrum and spot beam antennas as well as additional satellites in non-geostationary orbits.

C. Domestic satellite communications systems

41. OTC International (OTCI) played a significant role in assisting United Nations Advance Mission in Cambodia (UNAMIC) and its successor, the United Nations Transitional Authority in Cambodia (UNTAC), in establishing rudimentary military communications services covering administrative and functional communications needs and subsequently providing a range of services including a comprehensive "commercial" communications network. OTCI provided technical and management advice to the military Force Communications Unit and the United Nations Field Operations Division by assisting in the establishment of telephone connections to PSTN for all UNTAC offices. OTCI also installed a large Private Automatic Branch exchange (PABX) at the UNTAC headquarters building in Phnom Penh and microwave link equipment between UNTAC headquarters and the Force Communications Unit's communications centre.

42. The ground segment of this satellite digital telephony and data communications system comprises a hub station at Phnom Penh, eight sector headquarters stations, 15 provisional stations and 30 district stations. A permanently assigned 64 kbps channel is provided at the central hub site in Phnom Penh to interconnect with the United Nations global message network at the ESCAP office in Bangkok. The space segment is provided by Indonesia's Palapa satellite. Approximately 4,000 telephone terminals are interconnected throughout the UNTAC communications system.

43. The Tibet Autonomous Region of China is an area of 2 million square km which lies at about 4,000 m above sealevel and has a population density of 1.8 persons per square km. In order to solve the problem of county-to-county telephone communications (where the distance between a county and prefecture centre ranges from several hundred to several thousand kilometres), the Government of China began to build a thin-route voice (Voicesat) network, which currently consists of 58 terminal stations. The network will later be extended into other provinces. The application of satellite communications in Tibet began in 1986. At present seven Earth stations with 6m antennas have been set up. A voice very-small-aperture-terminal (VSAT system, developed recently, is using 3-4 m diameter antennas operating in the C-band. However, power supply and software problems must still be solved, together with problems related to the connection of the system to the public-switched telephone network. The telephone service among all 74 counties of the Tibet Autonomous Region of China will be established within two years.

44. The first satellite to be launched by the Republic of Korea, Koreasat, will use advanced digital technology for direct broadcasting and fixed satellite services. It will provide basic communications services in the Ku-band with small, low-cost remote ground stations for rural and remote areas of the country without adequate or telecommunications infrastructure. It will also provide intensive special data and video distribution for commercial television and other programme services such as tele-educational video networks, high-quality colour television, and high-definition TV (HDTV) services, which will be available anywhere in the country.

45. The Koreasat spacecraft is now in the design stage. It is based on the GE series 3000 platform with a dry mass of 1.5 tonnes and is to be launched into geostationary orbit by a Delta II launch vehicle in 1995. Each of the two satellites envisaged by the project will have a capacity of 5,300 voice circuits, 3 television channels and 4 high-throughput channels.

46. The range of Fixed Satellite Services (FSS) covers low/medium speed data transfer by the VSAT; low-speed voice and data circuits by the Demand-Assigned Multiple Access/Single Channel per Carrier (DAMA/SCPC) method and high-speed integrated services by the Time-Division Multiple Access (TDMA) techniques. The utilization of the Koreasat spacecraft may be maximized by new technology and service development such as digital compression, the ultra-small-aperture terminal (USAT) and mobile communications. The demand for new high-speed data transmission services at various rates and direct broadcast service will increase significantly in the Republic of Korea in the next decade.

47. In the Islamic Republic of Iran, natural factors, such as barriers to the formation of an integrated ground communications network throughout the country due to its vastness and geographical particularities, have forced the Telecommunications Company of Iran to decide to implement an independent domestic satellite system that would give the country the benefit of all current social, cultural, industrial, medical, educational, political and economic developments.

48. In the first phase of this project, which has been designated Zohreh, 61 Earth stations of various capacities installed in several provinces are now in operation using the INTELSAT system; some 230 VSAT terminals, with one hub station, are to be installed in the near future. In the second phase of the project, 830 satellite ground stations will be installed as part of a national remote rural-areas telephony communication system, consisting of approximately 1,500 VSAT terminals. All these phases are to be operational before the launch of the Zohreh satellites through INTELSAT and will be switched over from INTELSAT to Zohreh once the first satellite is launched. The ground segment of the system will be fully compatible with both INTELSAT and Zohreh satellites.

49. The space segment of the Zohreh system will consist of two identical geostationary three-axis stabilized spacecraft, each having an expected operational time of 10 years. The payload of the spacecraft operating in the Ku-band will provide all types of services: TV and radio-broadcast throughout the country, reliable communication with remote areas, educational programmes, data transmission and mobile communications.

50. To an archipelago of 7,100 islands with rugged forests and mountainous terrain, satellite communications would be of particular importance. Such is the case with the Philippines, which currently has a very low national telephone density of 1.4 per 100 persons. However, industry and commerce continue to be the biggest users of telecommunication services. At present, there are several domestic satellite carriers in the country which use various strategies in the roll-out of different services.

51. Most domestic industries rely on constant, on-line connectivity at medium or high data rates. VSATs have gained popularity because their cost is predictable compared to that of leased land lines, as locations are added and remote sites become still more remote. While digital voice accounts for a significant percentage of customer usage, VSAT technology today is also being used in on-line computer systems and wide-area systems. On the negative side, the limiting factor in the use of satellite communications remains the cost relative to the short distance and low-volume channel requirements where terrestrial links remain competitive. At present, however, VSATs are gaining preference over microwave-based systems due mainly to critical factors such as the immediate need to distribute information among geographically diverse locations, the declining cost of VSAT technology and the flexibility of VSAT installation.

52. As its communications infrastructure advances, the Philippines' telecommunications activity will continue to rely heavily on more reliable satellite networks. Satellite technology will continue to play a key role in increasing and improving the quality of commercial communications to stimulate the country's economy. Satellite operators will therefore continue to aim to respond vigorously to the growing needs of both business and the Government.

53. The Indonesian Palapa Communications Satellite System was established in 1976 with two satellites, each with 24 transponders and 40 Earth stations. At present, the system has three satellites with 72 transponders and thousands of Earth stations. After many years of operation, it has been demonstrated that satellite technology is the best means of improving the Indonesian telecommunications system. The services have been extended to satisfy the requirements of the countries of the Association of South-East Asian Nations (ASEAN), as well as the region of Asia and the Pacific. Palapa has become a satellite enterprise and soon will be a full regional satellite system.

54. Transponder utilization for public communication and private network purposes in Indonesia itself as well as the ASEAN/Asia and the Pacific region has been increasing very rapidly, and the new Palapa system currently has 35 users from 9 countries within the Asia and the Pacific region. The environment of deregulation and the impact of globalization upon TV distribution and private user groups has encouraged the private sectors in Indonesia to increase their requirements for Palapa transponder use for TV broadcasting, data transmission or for private user groups.

55. The mission of the planned Palapa-C satellites differs from that of the Palapa-B satellites currently in use. The Palapa-C will have 24 transponders in the standard C-band, 6 transponders in extended C-band and 4 transponders in the Ku-band. To satisfy regional requirements, future versions of the Palapa-C will be improved not only in terms of capacity and band frequency, but also in terms of power, operational flexibility and coverage area, which will be much larger than that of the Palapa-B. Therefore, potential interference with other regional satellite systems will have to be taken into consideration.

56. Viet Nam has a diversified topography, 75 per cent of which is mountainous terrain. Scattered throughout the country are major cities which are both economic and industrial centres. This has resulted in great differences in population density and therefore different telecommunications requirements in different geographical areas. International telephone traffic, in particular, has been increasing since 1989 at an annual rate of 48 per cent. Viet Nam now has 600 satellite circuits for international communication and 128 domestic circuits, compared with a total of 30 circuits in 1987.

57. At present, communications in Viet Nam through the INTERSPUTNIK and INTELSAT satellite systems ensures high quality for traditional services such as telephone, telegraph and telex as well as new services such as packet switching, facsimile, lease-line, etc. Since February 1981, domestic television and sound broadcasting via satellite have been in service for four hours daily. More than 200 TV receiving terminals in 53 cities and provinces retransmit central TV programming, which serves 80 per cent of the population.

58. In Viet Nam, many different projects are now under way to consider other transmission methods, such as optical cables and broad-band microwave links. However, its efficiency having been clearly recognized, the development of satellite communications services based on modern technology is a long-term goal which has been given the highest priority of available funding resources from the Directorate General of Posts and Telecommunications of Viet Nam.

59. Thailand covers a land area of 513,115 square km and has a population of approximately 56 million. Even with the increasing industrialization of the economy, the majority of the population still resides in rural villages, with only 28 per cent inhabiting urban areas. Beginning in 1966, a satellite communications service was introduced in Thailand through participation in the INTELSAT system. Provision of domestic satellite communications services began in 1983, and in 1989 the first private operator introduced VSAT services.

60. At present, a licence has been granted to the private sector to launch and operate the first national satellite, Thaicom, by the end of 1993. Government communications authorities in Thailand provide public network, telephone, telegraph, data, TV, etc., services. On the other hand, private satellite communications service providers operate private networks, dedicated circuits, etc., on the basis of 15-to-30-year concessions licensed by the Government.

61. The following are the principal constraints to the privatization of satellite services in Thailand: legislation governing telecommunications is obsolete; policies on competition are not well established; regulatory procedures are complex; existing legislation governing communications provides exclusive rights to government agencies; and inflexible management procedures of the government operators causes delays in launching joint ventures.

62. The following steps towards the privatization of satellite communications services might be implemented: relaxation of monopolistic policies by

allowing private operators to co-invest in terms of joint ventures, concessions, etc.; conducting a review of government operators' roles, focusing on basic services; and reviewing existing telecommunications legislation to facilitate fair competition in this area.

63. Several Japanese government agencies have developed a Pan-Pacific Regional Telecommunications Network Research Satellite (PARTNERS) project. This project represents Japan's first major international experiment in the field of space communications and is one of the country's contributions to International Space Year - 1992 (ISY). Among other experiments, the ground network, established in March 1992, provides communications for medical advice and the transmission of medical databases from Japan to developing nations in the Pacific region and supports educational programmes, radio-propagation studies, real-time conferencing and the transmission of Earth quick-look images.

64. The space segment of the system consists of the Japanese ETS-V satellite, which was launched into geostationary orbit in mid-1987. ETS-V is equipped with C-band (6/5 GHz) and L-band (1.6/1.5 GHz) transponders. The ground segment is primarily composed of low-cost, simple Earth receiving stations operating in the L-band with a 1.2 m diameter antenna and TV conference equipment. Receiving stations have been installed in Fiji, Indonesia, Papua New Guinea and Thailand. Portable Earth station equipment and transponders on ETS-V are made available free of charge to non-Japanese experimenters.

65. The PARTNERS project is a purely experimental one with a design lifetime of about two years, starting in November 1992. Its objective is to promote satellite communications and enhance international collaboration in this field in the ESCAP region.

66. A satellite communications system named Argo has been developed and has been operating since 1990 in Italy to establish voice, fax, data and video links between any disaster area in the national territory and the Department of Civil Protection headquarters in Rome. The Argo network includes: an operational control centre; a master station; 12 transportable, truck-mounted Earth stations, designed to be shipped by a helicopter and powered by their own generator; helicopter-mounted video systems, equipped with a helicopter-to-ground link, used to transmit in real time the images of the disaster area to the operational centre through the transportable Earth stations; a number of carriers on the F-2 satellite of the EUTELSAT space segment; and 100 small fixed Earth stations for environmental data collection.

67. Each transportable station can provide for: two voice channels and one fax or data channel, full duplex; one unidirectional video channel, with associated audio carrying the images shot either by the camera installed on board the transportable Earth stations or by the helicopter-mounted video system. In order to optimize the intervention time of the transportable Earth stations, they were deployed in the areas exhibiting the highest risk, in a position so as to be able to be put into operation near the locations where the operational centres have to be established, within three to four hours from the go-ahead order.

68. By means of medium-scale training, it was possible to test the effectiveness of the Argo system, both in terms of operational readiness and flexibility as well as quality of service rendered. For low traffic volumes, six INMARSAT terminals were added to the system's configuration. The system's operation has also been tested beyond the coverage area of the EUTELSAT satellite. Other future applications of the system are envisaged, such as in telemedicine and combating forest fires.

69. The Indian experience in using satellite communications for rural development has covered a wide variety of fields (agriculture, health, primary and undergraduate education, distance learning, etc.), a number of technologies (TV, telecommunication, messaging and TV with return voice-link) over a large span of time (since 1975).

70. The essence of the Indian experience could be summarized in the following general conclusions: (a) community TV sets in villages are feasible, although their operation is dependent upon the existence of a maintenance system; (b) the activity related to installation of TV sets in remote rural areas requires systematic planning, efficient execution and close monitoring; and (c) while the basic technologies are common, the system configuration must be need-based and therefore specific to the situation and context of the particular country.

71. The INSAT domestic satellite system provides an excellent means of reaching rural areas, either through the extensive TV transmitter network or by direct reception from satellites. The latter is now possible with a parabolic antenna of diameter less than 1.5 m, and for a cost equivalent to about $300. However, despite the dramatic fall in the price of satellite reception equipment, there is only a very limited number of direct reception systems in rural areas.

D. Regional/global satellite systems

72. The Pacific Ocean region is the fastest-growing economic region on Earth, and has been transformed dramatically in the last decade from a low-cost manufacturing region exporting products to the West into a vast and growing producer/consumer region. According to some predictions, the region will produce more than 40 per cent of the economic product of the world by 2020. All this is creating an economic interdependence among far-flung nations (many of which are made up of hundreds of islands) and has given rise to the need for a modern telecommunications infrastructure, including satellite communications. Additionally, the region contains two thirds of the world's population.

73. Today, there are only 23 telephones for every 100 persons region-wide. Nine national and international satellites communication operators in the ESCAP region currently provide domestic, regional and global services. The total existing supply of 150 to 200 transponders in regional and international usage is at full capacity. Current predictions that demand will grow by at

least 20 per cent per annum means that capacity must double every four years. This demand for services in the region may become even more intense by the end of the present century, since even though markets will continue to grow, there are predictions that some scheduled satellite launches by existing and potential satellite operators will not occur due to lack of financial support. This will create an estimated shortfall of satellite service capacity by today's providers of over 100 C-band and 80 K-band transponders by 1996, according to an estimate made by industry experts.

74. Regional systems, as announced recently by the above-mentioned nine operators, will add a total of roughly 558-618 transponders between 1994 and 1997. Television broadcasting will remain the most important category of service via satellite, contributing 25 per cent of the total demand.

75. One of these nine satellite providers, Tongasat, will feature broad regional coverage, usage of the same Earth stations for domestic and international traffic, inexpensive small-community and customer premise stations such as parking-lot rooftops, and driveways, and will provide access to rural areas and bypass terrestrial networks.

International satellite communications operators

76. Sovcanstar is a Canadian/Russian cooperative venture company formed to manufacture, test, launch and operate a Ku-band satellite system. Two geostationary satellites will be equipped with 24 transponders of 54 MHz bandwidth, a nominal-output radio-frequency travelling wave tube amplifier power of 65 W, and 4 steerable antennas each. The design allows the operators to switch individual transponders between the various antenna coverage beams. The first satellite will be commissioned in 1996, offering international service between Canada, the eastern United States, Europe and the Russian Federation. The second satellite will be commissioned one year later and will cover the Western Pacific, eastern Asia and Australia.

77. The system will offer various communications services, including radio and television broadcasting, data transfer between VSATs and 64 Kbps and 1544/2048 Kbps ISDN channels. A wide range of signal formats could be used for these services, such as 32 and 65 Kbps digital telephony; data transmission with standard rates in the range 64-2048 Kbps; analog and digitally compressed television and sound broadcasting. The satellite's communications payload provides high-quality services using small and medium-sized Earth stations (1.5-7.5 m). The spacecraft bus will be designed and tested in the Russian Federation, while the communications payload and antenna subsystems will be designed and tested in Canada. The satellites will be launched by a Proton launch vehicle.

78. The combined technologies of Canada and the Russian Federation, both with many years of satellite and communications experience, has resulted in a very attractive solution which includes the design and optimization of the terrestrial/satellite network interfaces, an area which is often neglected or overlooked. The satellite system will be used both for domestic services in

the Russian Federation and international services. Immediate service can be provided by leasing transponders, allowing deferment of the capital investment until the system has been established and is generating revenue.

79. In the past, domestic satellite communications systems were the most effective means of meeting national requirements when coverage areas were defined and limited by national boundaries. Today, regional trade and governmental agreements have created an intricate web of economic and political ties between countries. Similarly, the wave of world-wide deregulation and privatization of communications is opening up new markets and new opportunities for satellites. A satellite system limited solely to the provision of domestic services simply does not offer as much as regional, let alone global capabilities.

80. The following are some of the advantages for a company to enter into a partnership providing global satellite service rather than building a domestic or regional satellite: (a) the major users of telecommunications, the financial industry and manufacturers, operate on a global scale; (b) data and video services are increasingly reliant on proprietary technologies for various advanced functions related to digital transmission, for which an equipment or software vendor may be attempting to establish a global presence; and (c) as the majority of a satellite system's costs are "fixed" in space, unused capacity must be carried and paid for until customers can be found to pay for it. By participating in a global venture, an operating group can therefore limit the amount of capacity it must carry directly and thereby limit its operating costs.

81. In the near future, the increased capacity and the new competition will have a dramatic effect on the range and price of communication services to the countries of the Pacific Rim. By operating a global satellite system which focuses separately on serving the domestic, regional and international requirements of diverse users, Panamsat's private global satellite communications system ensures the fastest technology access together with shared start-up and carrying costs while minimizing risks. Such an approach, rather than that of a more limited domestic or regional satellite system, will be the most cost-effective and secure avenue to a successful satellite communications system in the coming era.

E. Advanced communications technology

82. Digital technology has already revolutionized telecommunications, multiplied the capabilities of satellites and enabled service providers such as Comsat to offer a wider variety of services at progressively lower costs and affordable to an ever greater number of people. It has allowed improvements in the quality and flexibility of transmissions. With digital equipment built into telecommunications and broadcast networks, it is possible to use the frequency spectrum more efficiently. The unit cost of the satellite resource declines while raising user demand.

83. The first digital voice service, International Digital Remote (IDR), was introduced by Comsat eight years ago. Today, more than 80 per cent of Comsat's voice business is digital. Currently, for example, Integrated Services Digital Networks (ISDN), which combine multiple forms of communications on a single circuit, are proliferating. Comsat Laboratories has developed a product that will enable its customers to provide switched ISDN services via satellite. Known as the ISDN Satellite Switch, it can allocate bandwidth and applications among different users in different locations on demand.

84. Digital technology also contributes to quality. Comsat Laboratories has also developed a new codec to improve the bit error performance of satellite transmissions. This device works with the current IDR equipment and brings the quality of data and fax transmissions to a point where they are indistinguishable from fibre-optic cable transmissions. Tests of this codec between the United States and the United Kingdom produced unprecedented results: no errors for an entire two-week period, with design specifications for a bit error data rate of 10 to minus 11, which typically occurs in cables.

85. The satellite communications industry is striving to deliver affordable high-quality services to its customers, but to do this effectively it requires standards that are compatible across international boundaries and across all transmission media. There is also a need for telecommunication administrations that are flexible towards the adoption of new technology. With the lead of ITU, unified policies and standards must be established to provide for the growth of telecommunications and to ensure that the technologies of today and tomorrow serve all mankind.

86. The Advanced Communications Technology Satellite (ACTS) project is in development under sponsorship of the United States National Aeronautics and Space Administration (NASA), with the objective of developing and demonstrating revolutionary technologies which will permit more cost-effective satellite communications systems. Satellite time to conduct experiments is made available without charge to experimenters in the United States. Foreign participation is permitted under the sponsorship of United States experimenters.

87. Key technologies to be validated as part of the ACTS programme include: multiple spot beam antennas featuring spatial separation and orthogonal polarization, on-board switching using a high-speed digital base-band processor and a dynamic reconfigurable microwave switch matrix. Other features of the system include up-link and down-link transmission in a new portion of the RF spectrum (Ka-band) for United States communications satellite use, adaptable rain-fade compensation and propagation beacons to conduct propagation experiments in the Ka-band under careful controlled conditions.

88. Designed for a four-year life span, the ACTS satellite is a three-axis stabilized spacecraft provided by GE Astro Space to be placed in geostationary orbit in June 1993. ACTS technology will provide capabilities qualitatively

different from those of current satellite and fibre-optic systems, such as on-demand assignment, frequency reuse and flexible targeting of multiple electronically hopping spot-beams directly to VSATs at customer premises. The two-year ACTS experimentation period will provide an opportunity to demonstrate that these technologies can meet commercial telecommunication needs in the near future.

89. United States industry, along with NASA, will conduct a wide range of experiments and demonstrations such as voice and video traffic at throughput rates as high as 1.544 Mbps ISDN, very wide bandwidth applications, educational and research networks, space science applications, mobile services, primary network supplement and back-up, and hybrid systems incorporating complementary fibre-optics communications links.

90. New high-quality digital pulse code modulation audio broadcasting has started recently in Japan via communication satellite in the 126-Hz band. Six stereo audio programmes of compact disc quality are multiplexed in digital form and transmitted by a minimum-shift-keying modulation scheme. The digitalization of broadcasting services may require a new receiver because they are not compatible with the conventional broadcasting system. Since the digitalization of a broadcasting system is more than a mere switchover from an analog to digital system, NHK Science and Technical Research Laboratories of Japan is constructing a new system which will integrate all stages of broadcasting, from programme production to signal transmission and reception.

91. Recently, rapid progress has been made in high-efficiency encoding technology for pictures and sounds, especially in the fields of communications, electronics and broadcasting, thereby making the digital transmission of television effective in frequency utilization. In addition, the evolution of an "information society" has created the need for various data services and the development of data broadcasting systems. In response to this, Integrated Services Digital Broadcasting (ISDB) has been researched as a broadcasting system to integrate digitally such information as television, sound and data to provide services flexibly. As a new broadcasting infrastructure, ISDB offers various possibilities, such as efficient utilization of frequencies, participation of a wide variety of broadcasters and the supply of new services.

92. ISDB can be implemented based on the overall advantages of digitalization in broadcast production, signal transmission and reception. Satellite and terrestrial channels, fibre-optic cable and other means can be used as ISDB transmission channels. By using a picture-encoding technology, some television channels of broadcast quality can be transmitted in the bandwidth of only one satellite broadcasting channel. Furthermore, using compression-encoding of television signals for a transmission channel of 1 Mbps, six newspaper pages can be sent per second.

93. Recently, the Electronics and Telecommunications Research Institute of the Republic of Korea and Alenia Spazio of Italy have begun a cooperative project on satellite networking to integrate public networks for residential

and business subscribers as well as for specialized network layers. An SCPC/DAMA architecture for the system - known as the SESNET system - has been decided upon; this means that any available carriers serve one channel at a time and each channel is assigned to a given call on demand.

94. This technology reflects the consolidated approach, which is aimed at saving bandwidth by limiting the one available to the user, making available the bandwidth required for all quality with no restriction or connections and only for the time required and addressing all the available bandwidths from any site.

95. The SESNET system is an original SCPC/DAMA large-scale VSAT system that integrates long-, medium- and short-distance transmission and transmits and implements local switching for high-quality digital end-to-end links with a single hop connection for domestic and international traffic in multi-network, multi-transponder operation. SESNET is also compatible with existing as well as future networks and features asynchronous transfer mode compatibility, synchronous digital hierarchy entry level, etc.

96. From a financial point of view, SESNET allows gradual investments, with the cost of a transponder being shared by as many as 240,000 users and with a drastic reduction in maintenance costs. It also optimizes antenna diameter and traffic demand, eliminates the high cost of hub entry and allows user-related tariff policies. SESNET is already industrially available from two independent industrial sources in Italy and the Republic of Korea and has been proposed as a European standard for a flexible network layer to allow quick adjustments to traffic changes in volume and flows with a high degree of plant invulnerability to external events.