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REPORT OF THE SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

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Annexes

ACRONYMS AND ABBREVIATIONS

ACC	Administrative Committee on Co-ordination (United Nations)
AFROSAT	African regional communications satellite
APT	automatic picture transmission
ARABSAT	Arab Satellite Communications Organization
ARSC	African Remote Sensing Council
ASEAN	Association of South-East Asian Nations
BSS	Broadcasting Satellite Service
CCIR	International Radio Consultative Committee (ITU)
CCITT	International Telegraph and Telephone Consultative Committee (ITU)
CCT	computer compatible tape
CFC	chlorofluorocarbon
CNES	Centre national d'études spatiales (France)
COPUOS	Committee on the Peaceful Uses of Outer Space (United Nations)
COSPAR	Committee on Space Research (ICSU)
DBS	direct broadcast satellite
DCP	data collection platform
ECS	European Communications Satellite
EIRP	equivalent isotropically radiated power
ELDO	European Space Vehicle Launcher Development Organization
ESA	European Space Agency
ESRO	European Space Research Organization
EUTELSAT	European Telecommunications Satellite Organization
FAO	Food and Agriculture Organization of the United Nations
FES	fluid experiment system (SPACELAB)
FGGE	First GARP Global Experiment (WMO)
FPM	fluid physics module (SPACELAB)
GARP	Global Atmospheric Research Programme
GEMS	Global Environment Monitoring System
GPS	Global Positioning System
GSO	geostationary orbit
HDDT	high density digital tape
IAF	International Astronautical Federation
ICAO	International Civil Aviation Organization
ICSU	International Council of Scientific Unions
IFRB	International Frequency Registration Board (ITU)
IGCP	International Geological Correlation Programme

IGOSS	Integrated Global Ocean Services System
IHP	International Hydrological Programme (WMO)
IMO	International Maritime Organization
IPDC	International Programme for the Development of Communication
INMARSAT	International Maritime Satellite Telecommunications Organization
INTELSAT	International Telecommunications Satellite Organization
INTERCOSMOS	Programme on International Co-operation in the Study and Peaceful Utilization of Outer Space
INTERSPUTNIK	International System and Organization of Space Communications
IOC	Intergovernmental Oceanographic Commission (UNESCO)
ITU	International Telecommunication Union
MAB	Man and the Biosphere
MONEX	Monsoon Experiment (WMO)
NASA	National Aeronautics and Space Administration (United States)
NNSS	Navy Navigation Satellite System (United States)
NPS	nuclear power source
RF	radio frequency
SARSAT	search and rescue satellite aided tracking
SETI	search for extraterrestrial intelligence
SITE	Satellite Instructional Television Experiment (India)
SPS	solar power satellite
SSTO	single stage to orbit
UNDP	United Nations Development Programme
UNDRO	Office of the United Nations Disaster Relief Co-ordinator
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
VLBI	very long baseline interferometry
WARC	World Administrative Radio Conference
WEFAX	weather facsimile
WMO	World Meteorological Organization
WWW	World Weather Watch (WMO-ICSU)

PART ONE

DECISIONS AND RECOMMENDATIONS OF THE CONFERENCE

INTRODUCTION

1. Space has always had a special fascination for man, ever since the first intelligent being looked up into the sky. Man worshipped the sun as the life-giver even before science had shown it to be so, and the moon has had an aura of romance around it for centuries. In our collective psyche, space has always meant freedom, romance, the challenging unknown and - for some - "heaven".

2. Now, after millennia of looking upward and outward from the earth, man has acquired the ability to do the reverse also: to look at our home planet from a vantage point in space. What we see is immensely beautiful and very revealing: a lonely, shimmering sphere, abundant in resources, solid and yet very fragile; a planet whose life processes are inextricably interdependent, where life depends upon the delicate and unique balance between man and nature, between man and man. What is not visible is equally revealing: we cannot discern different countries or separate peoples. Space has given us a new perspective on the universe, our solar system and our own planet. Can it also give us a new perspective on ourselves?

3. We are now also able to look out - to other planets, other stars and other galaxies - without having our vision clouded by the haze of the atmosphere, thus allowing us to see farther out and back almost to the beginning of the observed part of the universe. This has helped to confirm increasingly the theory that the universe evolved from a single fireball of energy some 15 billion years ago and that the material which formed our earth and solar system was synthesized in the evolution and explosion of an earlier star, demonstrating our common ancestry and innate unity - not only with each other, but indeed with all things in the universe.

4. Apart from the philosophical and ethical implications of the view from space, there are also immense immediate and future benefits. Communication satellites have virtually revolutionized telecommunications and broadcasting, while earth-observation spacecraft provide meteorological data of great importance and have considerable potential for contributing to resource management systems through remote sensing. Spacecraft are also replacing celestial bodies in space as means for accurate position-location and for navigation. Long-term benefits of our capability to send objects - and people - into space include not only applications in these fields, but also in biology, medicine, materials and, possibly, energy.

5. The rapid growth of space technology and its potential for important applications was already clear in the 1960s and led to the convening in Vienna in 1968 of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space. The Conference stimulated a great deal of interest - in both developed and developing nations - in space and its applications.

6. It is now almost a decade and a half since the 1968 Vienna Conference and in this period there have been great strides in space science, technology and applications. These revolutionary developments, this new dimension to which man has now acquired access, have been made possible by the very rapid advances in a number of interconnected disciplines. Within the space of one generation, these advances have led from the launch of the first artificial satellite in 1957 to

manned spaceflight, men and robot vehicles on the moon, automatic landers on Mars and Venus, missions past Jupiter and Saturn, to the first partially reusable launch vehicle and space stations in Earth orbit. Of more direct relevance, we have witnessed the establishment and now routine operation of space communication systems, both international and domestic, of space broadcasting systems, of a global observation system for meteorology, of operational navigation and maritime communication systems and of quasi-operational remote-sensing systems. About 150 countries now use space communication and more than 220 stations for the direct reception of image data from meteorological satellites are in operation around the world. It is estimated that over 100 countries have by now used data from remote sensing satellites and almost 40 countries have already joined the only recently formed INMARSAT. While only two satellites were launched in 1957, the beginning of the space era, an average of some 120 satellites are now launched annually. Such a high level of space activity and the many diverse systems clearly require a degree of international co-operation, co-ordination and regulation. While bilateral and multilateral activities have promoted this, an important role has been played by the United Nations and its specialized agencies. The progressive development and codification of the law of outer space including, in particular, the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies and the work done by ITU in the field of radio regulations concerning outer space, have created conditions conducive to the smooth and orderly growth of space activities. However, improvements can be made in the United Nations system in these regards.

7. At the same time, the increasing use of space - for scientific purposes, experimentation and applications - and the growth of space technology, necessitate a fresh look at possibilities, potentials and implications, including possible new legal procedures and institutions. In particular, while the first outer space Conference did a great deal to promote awareness of the immense promise of space, it is now time to proceed further and take appropriate measures for the wider and fuller utilization of space technology. In doing this, there is a special need to examine how the United Nations system can play a more effective role in stimulating the peaceful uses of outer space so as to benefit all countries - including especially the developing ones - and how the United Nations can promote and co-ordinate international efforts to this end. The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space was convened to allow wider participation of Member States in the activities of the United Nations in outer space matters and to assess the new developments, to exchange information and experiences on their present and potential impact, and to assess the adequacy and effectiveness of institutional and co-operative means of realizing the benefits of space technology.

8. Space science and technology cannot be considered in isolation, but must be seen as an integral part of the totality of science and technology, which in turn form part of the social, industrial, educational and cultural context of human society. The role of science and technology in society and in the process of economic and social development was the subject of the United Nations Conference on Science and Technology for Development held in Vienna in August 1979. The conclusions of that Conference are, in general, applicable to the field of space science and technology. It might be useful to recall here the Preamble of the Vienna Programme of Action on Science and Technology for Development adopted by the Conference:

"1. The United Nations Conference on Science and Technology for Development comes at a critical point in the evolution of the world economic situation and international economic relations characterized by crises in the world economy leading in particular to a further deterioration in the situation of developing countries. Developed countries continue to dominate the field of science and technology to the extent that around 95 per cent of all research and development is executed by them, while developing countries, which represent 70 per cent of the population of the world, have only about 5 per cent of the world's research and development capacity. These figures demonstrate the magnitude of the problem and the task facing the international community. The experience of the last few decades makes evident the need for determined measures on the national and international planes to redress this situation, for without such action the present inequitable situation will be aggravated further and the gap between developing and developed countries will continue to widen.

"2. The necessary resources and technological potentials exist for eliminating the under-development of the developing countries and for improving the well-being of humanity as a whole. The achievement of this goal presupposes that developing countries exercise full control over their own resources. It also presupposes an equitable distribution and creation of scientific and technological capabilities of the world.

"3. The Conference is an integral part of the efforts of the international community for the establishment of the New International Economic Order through the adoption of decisions and the provision of concrete and action-oriented recommendations aimed at the use of science and technology for the development of all countries, and particularly of the developing countries.

"4. The industrialized countries have, through their control of science and technology, provided themselves with an immense power to enhance the human environment, increase production and improve the standard of living of their population. However, their production and consumption patterns have led to a waste of resources and often carried with them negative social and environmental consequences. To avoid such undesirable effects, developing countries should carefully analyse the options in connexion with the choice, development and transfer of technology.

"5. The ultimate goal of science and technology is to serve national development and to improve the well-being of humanity as a whole. Men and women in all groups of society can contribute positively to enhance the impact of science and technology on the development process. However, modern technological developments do not automatically benefit all groups of society equally. Such developments, depending on the given economic, social and cultural context in which they take place, are often seen to affect various groups in society differently. They may have a negative impact on the conditions of women and their bases for economic, social and cultural contributions to the development process. This is seen to happen in industrialized as well as in developing countries. Therefore, steps should be taken to ensure that all members of society be given real and equal access to and influence upon the choice of technology.

"6. Developing countries have long recognized the need to pursue policies of creating the necessary structures at the national level in order to maximize their capacities to develop, absorb and use science and technology as well as to distribute the results of those important tools of development among all sectors of their population. It must however be recognized by the international community at large that there are, and will continue to be, limits to the ability of developing countries to realize their full potential as long as there is no restructuring of existing international economic relations on a just and equitable basis.

"7. International development co-operation in the field of science and technology must assist developing countries in strengthening their creative and innovative capacity and thereby promote their autonomous scientific and technological development. This requires fundamental changes in the present pattern of international relations in this field so as to enlarge substantially international co-operation and thus enhance the opportunities for developing countries in the development and strengthening of their scientific and technological capacities, reflecting the requirements of each country in accordance with its realities and its vision of the future, as well as in the international process of the transfer of technology so as to substantially increase and facilitate such transfers, in particular to developing countries, and to enable them to have significantly improved access to the technology they require, including advanced technology." 1/

9. These observations and the more detailed considerations and conclusions that are contained in the report of the Conference served as an important backdrop for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82).

10. The present report, reflecting the considerations and conclusions of UNISPACE 82, is divided into three chapters. Following the introduction, the next part (chap. I) assesses the present and likely future state of space science and technology. The following part (chap. II) discusses present and potential applications of space science and technology, their implications and the means of ensuring that all countries derive benefits from space. It also examines the choices for countries with regard to space technologies and the difficulties faced in using them. The important issues about the use of the geostationary orbit and access to space technology are discussed, as are matters connected with the compatibility and complementarity of systems and the protection of the environment. Chapter III deals with international co-operation and the role of the United Nations, including especially co-operation between developing countries. It makes recommendations with regard to the future role of the United Nations and financing. In accordance with the agenda, the Conference was not limited to discussions on science and technology, but also considered their relevance to man and his environment. The Conference discussed scientific, technological, social, economic, organizational and other relevant aspects and their interrelationship.

11. The growing range of space applications has brought benefits to many countries. While any developing countries use space technology, they have not yet fully exploited its considerable potential. In fact, only the developed countries with advanced technology can fully exploit these benefits. The international community, and in particular the developed countries with more advanced technology, should intensify their efforts to promote the wider exploitation of space technology by developing countries. Space technology can be a powerful tool to

accelerate national development: it provides a way of leap-frogging over obsolete technologies and getting away from percolation and trickle-down models of development for which developing countries do not have the time. It could effectively deal with the problems of illiteracy, isolation and lack of information afflicting the development process. Depending upon each country's unique social, economic, cultural and resource context, and taking account of other alternative technologies, space could play an important role in specific areas of development.

12. Space technology offers the potential to spur economic and social development of all countries. It is by no means the complete solution to a country's problems neither can there be any generalized prescriptions for the use of space technology. However, it is often a more effective alternative for achieving a given goal and can sometimes bring about a qualitative change by doing things not possible through more conventional means. In this connexion, international co-operation should be seen and conceived as a major instrument in assisting all countries, especially developing countries, to derive the optimum benefits from the application of space technology. However, the future of each country should rest primarily upon itself.

13. The extension of an arms race into outer space is a matter of grave concern to the international community. It is detrimental to humanity as a whole and therefore should be prevented. All nations, in particular those with major space capabilities, are urged to contribute actively to the goal of preventing an arms race in outer space and to refrain from any action contrary to that aim.

14. The maintenance of peace and security in outer space is of great importance for international peace and security. The prevention of an arms race and hostilities in outer space is an essential condition for the promotion and continuation of international co-operation in the exploration and use of outer space for peaceful purposes. In this regard, the Conference urges all States to adhere to the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies and strictly to observe its letter and spirit.

15. Space technology has made dramatic progress in our own lifetime. It has changed our concept of distance, made each person the neighbour of all others and given us a new measure of ourselves in relation to the cosmos. Can we now rid ourselves of our obsolescent biases and concepts, and move forward to the more equitable, humane and co-operative society that the image from space conjurs up?

CHAPTER I

STATE OF SPACE SCIENCE AND TECHNOLOGY

16. Since the launch of the first artificial earth satellite (1957), and in particular since the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space (1968), space science and technology have developed extremely rapidly. Satellites, first used for space research, were soon used for experimental applications as well. Within a decade of the launch of the first satellite, operational space systems were established for telecommunications and meteorology. Today, telecommunications, television broadcasting, meteorology, maritime communication, navigation, global positioning, geodesy and remote sensing routinely make use of satellites.

17. This extensive use of space for a variety of applications has been brought about by the immense progress in space technology. Today, it is possible to launch a payload weighing tens of tons into low earth orbit - compared with the tens or hundreds of kilograms that the early rockets could launch. Many developments, particularly improvements in reliability, in micro-electronics, in materials, in solar cell technology and deployment mechanisms, have revolutionized space technology. Man has not only gone into space, he has also stepped on the moon. Equally impressive missions have been carried out by completely automated spacecraft, responding to commands and relaying data from billions of kilometres away.

18. Space science has made equally astounding progress and in many cases has been the cause of technological developments. It has brought new understanding about the solar system and indeed about the whole universe. Unexpected discoveries have shed new light on the origin of the solar system and of the universe itself. Closer to earth, space science has vastly improved the understanding of the atmosphere and climate, has led to better weather predictions and has aided mankind's efforts to keep the atmosphere within agreeable conditions. Space biology and medicine are completely new fields that may help solve medical problems. Materials science experiments in space should result in the production of better, possibly cheaper and new materials.

19. The present chapter briefly reviews some of the exciting and promising developments in these fields of space science and technology and makes a few suggestions for future action.

A. Space science

20. The oldest field of space science is, of course, astronomy. Its birth probably dates back to the time when the first intelligent being looked up at the beauty of the star-studded sky. The arrival of the space age allowed man the possibility of observing the universe from outside the earth's atmosphere. For looking at the planets, the sun, the stars, our galaxy and other objects extending into the deep depths of space (and billions of years backwards in time), this was like removing blinkers from his eyes. The maximum emission of the sun's energy occurs in the same narrow band of wavelengths in the optical region of the electromagnetic spectrum to which the earth's atmosphere is transparent; it is no accident that the range of sensitivity of our eyes is also confined to precisely

these wavelengths. Even in this narrow band of wavelengths, our ability to distinguish between various objects is greatly enhanced because we have the faculty of separating different colours (i.e. by different responses to different wavelengths). Outside the atmosphere the extraterrestrial signals cover a wavelength range millions of times larger than the optical band. An ability to detect those signals and analyse them can, therefore, provide an enormous amount of new information about the nature of astrophysical phenomena. Indeed, every time a new window for astrophysical observations is opened, we find things which had never been expected by the most imaginative of scientists, even though practically everything we do find can be ultimately understood in terms of the physics we learn here on Earth. One such window was opened by the discovery of radio astronomy in the 1930s. This did not have to await the arrival of the space era, since radio waves at wavelengths between a few centimetres and several tens of metres are not significantly attenuated by the earth's atmosphere or by the ionosphere. It was soon found that not only does our Sun emit radio waves, but there are a large number of sources - compact and diffuse - in the universe which emit a significant fraction of their energy in the form of radio waves. By building larger and more sensitive instruments and inventing auxiliary observational techniques, man's radio-visibility was extended to much further distances than was possible through observations with optical telescopes.

21. But for the techniques of radio astronomy, we would still be ignorant about a great many phenomena in the universe. Amongst them are the cosmic background of black-body radiation representing, most probably, the cooled down remnant of the hot fireball associated with the very early phase of the universe some 15 billion years ago, and the existence of a host of organic molecules in interstellar space. Different happenings and things in the universe can manifest themselves at different frequencies and unless we tune in, we will not be able to put the pieces of the picture together.

22. Observations in the ultraviolet, X-ray and gamma ray wavelengths are possible only from the top of the atmosphere, using balloons, rockets and especially satellites. These observations have led to some of the most remarkable advances in astronomy in the last 20 years. Some of the new understanding relates to the high temperature and dynamical phenomena on the Sun. That the Sun has a high temperature corona was directly verified through the observation of soft X-rays. X-ray and ultraviolet observations have shown similar and more extensive coronal features around other stars. Like the sun, most stars have stellar winds, and a great deal of the stellar surface material is continuously cast out into space, ften in great bursts.

23. About a thousand X-ray sources have been observed since the almost accidental discovery of X-ray sources during a rocket flight. X-rays are emitted from galaxies, quasars, diffuse envelopes and remnants of supernova explosions, compact objects such as neutron stars - alone or in close-binary systems - and by hot intergalactic matter. Some of the objects emit 10,000 times as much energy in X-rays as the total energy output of the sun. A picture begins to emerge, with crucial support from X-ray observations from space, that compact objects and close binary systems are fairly abundant in the universe. The discovery and analysis of the X-ray pulsar phenomena form one of the most exciting chapters in modern astronomical history.

24. Gamma rays are simply X-rays of much shorter wavelength or higher energy per quantum. Gamma ray emission has been observed from supernova remnants, some

pulsars, and from the disc of the galaxy. Since high energy (most probable energy about 100 MeV) gamma rays can be produced in interactions of high energy cosmic-ray particles with matter, they provide a powerful tool for surveying matter density and cosmic rays in interstellar space. Positive and negative electrons can annihilate each other in slow collisions, resulting in gamma rays of energy close to 0.5 MeV. Such a gamma ray line has been observed towards the centre of our galaxy. Intense bursts of X-rays and gamma rays from some objects (so called "bursters") have challenged the understanding of astrophysicists.

25. Observational evidence for the existence of compact, dense objects like neutron stars on the one hand and possible existence of an early hot dense state of the universe on the other, is beginning to provide new insights and constraints on our ideas about the basic structure of matter and the relation between fundamental forces of nature. In this sense many of the observations in astronomy simultaneously impact our understanding of sub-nuclear physics and cosmology.

26. Immediately on the longer wavelength side of the visible spectrum lies a long band of infra-red wavelength extending from 1 micrometre (um) to about 100 um. The earth's atmosphere allows specific narrow parts of the near infra-red spectrum to pass through without significant attenuation. During the last couple of decades many surprising discoveries have been made with ground-based telescopes. Many objects are found to emit significantly large amounts of energy in the infra-red wavelengths. Longer wavelengths ($>$ 20 um) have been accessible only through balloon and rocket observations. Many cool stars and clouds have been discovered and studied. When infra-red telescopes are deployed in space, many new aspects of the galaxy and the universe will reveal themselves for the first time. Particularly interesting is the possibility of observing the slowly contracting clouds of material on their way to becoming stars like our Sun.

27. Balloon and ground-based observations during the last 30 years or more have already established that cosmic rays consist primarily of atomic nuclei, extending from hydrogen to uranium, accelerated to extremely high energies. The energy spectrum ranges over many orders of magnitude and the highest energies are far beyond any values we can hope to achieve in our accelerator laboratories. The relative abundance of different elements and the spectrum at low energies have been established by many clever experiments aboard satellites. Lower down in the atmosphere the cosmic ray nuclei break up in nuclear interactions with air nuclei and many new species of short-lived and stable particles are produced, some of which propagate deep into the earth. Precise elemental and isotopic composition of cosmic rays, as also their energy spectrum, carries very significant information about the sources, the acceleration mechanism and the propagation of this radiation. Some of the most important parts of this information can be obtained only through space observations. This cosmic ray signal is valuable because it is the only form of particulate matter which comes to us from the depths of space, carrying with it the signature of rather unique cataclysmic events in which it is produced and accelerated, as also the scars of its encounters wih intervening matter and radiation.

28. Space astronomy, as discussed in the previous paragraphs, is but a form of very remote "remote sensing". Space capabilities also allow us the possibility of going close to some of the objects and phenomena and studying these at near range or <u>in situ</u>. This is at present possible only for the region of the galaxy confined to our own solar system, since a return voyage to even the nearest star seems at present impractical in terms of both cost and elapsed time.

29. The study of the solar system, particularly the motions of the planets, was perhaps the first "science" that preoccupied man. The order and predictability of the planetary motions pointed strongly to the existence of a natural law and finally resulted in the founding, by Kepler, Galileo and Newton, of the first and most basic branch of physics, namely, dynamics and universal gravitation. It is no wonder, therefore, that soon after the dawn of the space age, a visit to the moon and the near planets of the solar system was put high on the agenda. Modern space observations have been used to study - besides the sun - Mercury, Venus, Earth, Moon, Mars, Jupiter, Saturn and the four Jovian satellites. For obvious reasons, the most intensive studies have been concentrated on the earth and its environment.

30. Man has landed on the moon and several hundred kilograms of lunar material have been brought back to the earth, both by manned missions of the United States and unmanned robots of the Soviet Union. A study of this material by hundreds of scientists around the world has provided new and valuable information about the chemical composition, structure, and evolution of the moon: the history of the cratering process, size distribution of micro-meteorites and the prehistory of low energy cosmic rays and the solar wind. The instruments left on the moon have continued to give data on the heat outflow and moon-quakes, rare though they are. There is no evidence of current volcanic activity. By now we know more about the moon than about any other planet in the solar system, except Earth.

31. Besides the moon, man has been able to land instruments only on two other planets, namely, Venus and Mars. Several landers on Venus provided atmospheric and soil analyses and transmission of panoramic pictures of the surface. Venus was and remains very interesting because, in terms of size and distance from the sun, it is the planet most similar to Earth. On the other hand, its atmosphere is principally carbon dioxide with considerable traces of noble gases, with a pressure 100 times greater than the atmospheric pressure on the earth. The surface temperature is about 470°C. There is indication of fairly active geological history, with volcanoes and craters still discernible. Direct determination of the elemental composition of Venusian soil and analysis of panoramic pictures from Venera landers confirm volcanic activity on Venus. One of the most interesting findings is that Venus and Mars both lack any measurable intrinsic magnetic fields. This places severe constraints on any theories to account for the intrinsic magnetic field of the earth.

32. Planetary bodies similar to the earth in composition, size and orbit are compatible with atmospheres which may or may not be able to support life. It follows that a thorough scientific understanding of the limits of stability of the terrestrial atmosphere under the impact of man-made modifications is one of the most urgent tasks of space science.

33. Mars has always been an intriguing planet because of early speculation about the possible existence of life on it. It has been studied by several space missions, including landers, which provided spectacular photographs of the surface and analysed the soil for its chemical composition and evidence of biological activity. The atmosphere of Mars is rather thin (about 0.6 per cent of the earth's atmospheric pressure) and, as on Venus, consists mainly of carbon dioxide with 1 to 2 per cent of nitrogen and argon. There is no indication of any biological activity, though surface features suggest running water and catastrophic floods some time in the past.

34. Mercury has not been studied very intensively, though a most significant discovery by the very first fly-past mission was that of a weak intrinsic magnetic field. Mercury is very hot on the sunlit side and very cold on the other. The surface is heavily cratered like the moon, and the planet is too small and close to the sun to have an atmosphere.

35. Of the giant planets (Jupiter, Saturn and Uranus), Jupiter and Saturn have already been observed by planetary probes. Jupiter is the largest planet in the solar system, with a mass greater than that of all the others put together. Like the other two giants, Jupiter is really a proto-planet, in the sense that it is in the same state as it was when formed 4.6 thousand million years ago and has not lost its lighter elements or noble gases. Thus the most abundant elements are hydrogen and helium and there is no solid crust like the one on the terrestrial planets. Its atmosphere is about 1,000 kilometres thick and, besides the above two gases, contains methane and ammonia. The atmospheric phenomena are grand and have been observed in some detail by visiting spacecraft. Winds up to 400 km/h have been observed. The atmosphere has a large scale banded structure caused by the effect of rapid rotation of the planet (about 10 hours) on convection currents. In addition, there is an endless variety of eddies or turbulences, the most prominent of which is the famous Great Red Spot, which has varied somewhat during the 300 years it has been observed. The formation and persistence of this phenomenon is still not properly understood.

36. Jupiter emits about twice as much energy as it receives from the sun, and, indeed, can be considered a micro-star. It has a strong magnetic field, about 10 times the earth's value, at its surface. Jovian magnetospheric phenomena have been studied in great detail by various fly-by missions. Particles are accelerated and produce radio waves in interaction with the magnetic field. In fact Jupiter is the strongest radio source in the sky.

37. The largest four satellites of Jupiter were discovered by Galileo, in the earliest observation of the heavens by a telescope. Of these, two are about the size of the planet Mercury, and the other two the same size as the moon. By now the number discovered has increased to 16, including those seen by spacecraft. Thus Jupiter as a minor solar system represents an excellent astronomical laboratory. Some of the satellites have been studied by the Voyager spacecraft and have revealed interesting and differing features. One of these, Io, though only the size of the moon, has been found to be the most volcanic object in the solar system. It is believed that Io is an important source of the plasma that populates the magnetosphere of Jupiter, and of the radio-emission therefrom. It is probably because of the influence of Io that the radio emission of the planet shows a 10-hour variation, a period which is the same as the rotation period of the planet. In this sense Jupiter is also a "pulsar", the nearest one to home.

38. Saturn has many properties in common with Jupiter as one of the giant planets. A most interesting feature of this planet is its spectacular rings. These have been studied in fair detail by the two Voyager spacecraft and have revealed many new features. The role of small moons in the evolution of the ring structure is beginning to be understood. Many of the newly discovered radial features are yet to be explained properly.

39. The discovery of radiation belts by Explorer-I and the detection of the solar wind by Lunik-2 initiated a new and active field of research in solar terrestrial relationships. Radiation belts are produced by a large population of low-energy

charged particles trapped in the earth's magnetic field. Most of the particles in the belt are captured from the solar wind, though some are accelerated within the belt.

40. The sun interacts with the earth not only through its light and heat, but also through emission of some of its material in the form of ions and electrons, which impinge on top of the magnetosphere of the earth. This stream of plasma, called the solar wind, varies in temperature, intensity and speed. The plasma also carries along a magnetic field, essentially stretched out from the sun to fill the interplanetary space. The solar wind is the source of the bulk of the particles in the radiation belts. Interaction of the solar wind with the magnetosphere produces a magneto-pause on the sunlit side, preceded by a bow shock, and stretches out the earth's magnetic field into a long tail on the opposite side. The solar wind is also the cause of the formation of the magnetospheres of some other planets. The earth's magnetosphere contains a population of charged particles, mainly electrons and protons, of solar wind origin. These are found to cause geomagnetic disturbances and provide the excitation mechanisms for auroral emissions at high latitude. Particles precipitating in the auroral regions are also the source of strong radio emissions from the earth.

41. Space observations have unravelled many of the features of this complicated interaction, though several aspects are still not well understood. In situ measurements of the solar wind and magnetic fields have been made by several space missions, but all these are confined to regions of interplanetary space close to the ecliptic. The out-of-ecliptic mission planned for the near future will add significantly to our understanding of interplanetary phenomena.

42. Study of solar-terrestrial phenomena is important in its own right because a great deal of distant and inaccessible astrophysical phenomena must be of a similar nature. A wide range of solar-terrestrial variations can also produce effects on a number of practically significant areas such as communication, transport, power and energy, space systems, navigation and, perhaps, weather and climate. Winds and storms that rage in the plasmas and magnetic fields existing from the top of our atmosphere to the solar surface have effects on man which in their own right can be as potentially hazardous as the atmospheric storms which sweep across the earth's surface.

43. Space science and space scientists have provided the cutting edge of developments in space technology. Discoveries in science are not made only through design of instruments or observation. Equally important is the work of the theoretical scientists who work at producing coherent systems out of the mass of data and suggest further experiments. But without the capability to observe, there is no stimulation and no proof. And very seldom does man have an imagination as rich as nature itself displays. Observations are, therefore, essential.

44. In a short span of 25 years, our picture of the universe has been transformed because of the new observations made in the space era. However, what has been done so far is mere reconnaissance, and the real observational phase is yet to begin. Many surprises and many discoveries lie ahead awaiting the time when more or less permanent space observatories are established. In addition there will be a continuous need to have autonomous experiments for following specific leads. Space science should, therefore, continue to have a high priority; in fact, in view of its promising future, it is desirable that support be substantially increased.

45. In the case of space science missions a healthy tradition of co-operation has been established over the years, allowing experimental payloads from scientists in different countries to be put on spacecraft launched by other countries. Many co-operative experiments have been done by scientists of various countries using balloons, rockets and satellites. In more recent years, international crews - from both the developed and developing countries - have been provided opportunities for participating in experiments on orbital space stations. It is desirable that such co-operation continue and be further encouraged. Major space observatories to be set up in the future should also be open to scientists and experimenters from all countries, continuing the tradition of scientific co-operation and "guest observers" in many existing earth-based observatories. Scientists from all countries should be encouraged to use these facilities.

46. It is sometimes argued that basic science in general, and space science in particular, are not important in a world pressed by practical problems. This is not correct. Besides the fundamental argument that an understanding of the universe we live in is important in its own right, it is also true that initiatives in space applications have most often been taken by people who were earlier motivated by their interest in space science. The encouragement of space science and space astronomy in the universities and institutions of developing countries could, therefore, provide an important stimulus and strong support to the development and practical applications of space technology.

47. This brief survey obviously cannot cover adequately the vast and growing field of space science. While aspects related to space biology and medicine and to materials science in space are discussed in the following section, a slightly more detailed exposition can be found in Conference background paper A/CONF.101/BP/1.

B. Experiments in space environment

48. Space provides an environment that cannot easily be reproduced on Earth: a virtual absence of gravity (micro-gravity), access to that part of the cosmic spectrum of radiations which cannot be sampled and studied on Earth and a virtually infinite source of near-vacuum. On Earth, all materials and organisms are subject to the force of gravity. The flow of liquids, the convection of fluids, the growth of plants and animals and the physiology of people are all determined or strongly influenced by gravity. Therefore, space provides a unique opportunity for studying the effects of micro-gravity and/or vacuum on life processes, man and materials.

49. There are many well-known effects of gravity in fluid systems including buoyancy, convection, sedimentation and segregation. One important phenomenon is gravity-driven convection currents in fluids, which are, in most cases, oscillatory or turbulent. In a micro-gravity environment, the relative importance of convection, diffusion and surface forces may be changed drastically. In space, crucible-free zone-melting of single crystalline materials or metals is possible without restriction by gravity effects.

50. Materials science experiments in a space environment, coupled with ground-based research, should lead to a new understanding of the basic processes. Fluid physics, chemistry, metallurgy (including composite materials and glasses), single crystals and pharmaceuticals represent specific areas of activity.

51. Single crystal growth studies require furnaces with precision temperature measurements. Such monocrystals, which are very important semi-conductor material, have been grown in numerous experiments both aboard the United States Skylab as well as under the USSR and the INTERCOSMOS manned space programmes aboard Salyut-6. Study of melting and solidification processes and tests of electron-beam welding in space were carried out by the USSR as early as 1969 using the "VULKAN" unit on Soyuz-6. Apollo 14, 16 and 17 carried several small micro-gravity experiments including composite casting, electrophoresis and fluid transfer in preparation for similar larger experiments aboard Skylab. Micro-gravity experiments were also carried out during the joint Apollo-Soyuz Test Project. A few countries have also flown miniature space processing laboratories on board high-altitude rockets, which can provide a few minutes of micro-gravity conditions. Limited experiments have been conducted using aircraft trajectories and drop towers, providing respectively up to one minute and a few seconds of simulated micro-gravity conditions. It is likely that not too far in the future, semi-conductor materials which are difficult and expensive to produce on earth with the degree of purity and perfection required by modern electronic and micro-electronic industry will be manufactured in space. Likewise, the possibility of producing specialty glasses and products and advanced alloys is being considered. Over-all cost-benefit assessments, however, are still rather controversial.

52. Space-processing also seems very promising for the production of pharmaceuticals such as erythropoietin to stimulate red-cell production in fighting kidney and blood diseases, anti-haemophilic factors to clot blood in haemophiliacs, urokinase to reduce clotting in stroke and phlebitis victims, and beta cells which might provide a single-injection cure for diabetes. Electrophoretic chambers for the experimental processing of such biological products will be flown aboard the Space Shuttle.

53. A number of materials science experiments will also be carried out by European countries and the United States, using the SPACELAB. Facilities for these include the special fluid physics module (FPM), developed in Italy, to be flown on the first SPACELAB mission, and a fluid experiment system (FES), under development in the United States, to be flown during future SPACELAB flights. The FPM will investigate fundamental fluid physics problems such as natural and enhanced column stability, convection, drop coalescence, liquid/vapour interfacial forces, etc. The FES allows fluid phenomena investigations using optical observation techniques. Its data capability includes holographic photographs and a flow visualization video system.

54. Much work remains to be done in material sciences to develop a better understanding of the various processes involved. In order that rapid progress be made in this field, it is essential that the results of experimentation continue to be widely disseminated and readily available to scientists all over the world. There is now an increasing probability of economically viable production in space of new materials in the near future. It is desirable that the benefits of these developments be made available on reasonable terms to all nations and all mankind (see also chap. II, paras. 306 and 307).

55. Early experiments with animals in space were quickly followed by manned missions of gradually increasing duration. Man demonstrated his ability to function in space and was given increasingly complex tasks. In a number of cases astronauts and cosmonauts solved problems that would have crippled unmanned vehicles. There were, however, physiological effects of micro-gravity, both during

and after spaceflight, that at first appeared to limit the effectiveness and the duration of manned missions. "Motion sickness" limited effectiveness in some cases but was found to disappear after a week or two. Loss of calcium from the bones, muscular atrophy and redistribution of body fluids caused problems, but these were eventually largely overcome by physiological adaptation, rigorous exercise and devices to simulate the effects of gravity. Cosmic radiation also poses a hazard, particularly in the radiation belts, but space vehicles can be shielded to the extent that long duration missions in low earth orbit and short missions through and outside the belts can be reasonably safe.

56. Manned space missions and general scientific interest stimulated work in the field of space biology and medicine. Neither the microgravity environment nor the complex spectrum of space radiation can be produced or effectively simulated in ground-based laboratories. Consequently, studies of the influence of these factors on living matter will only be possible to the extent that experimental facilities in space become available. Both factors have at least two characteristics of exceptional biological interest: they have not been encountered by living organisms throughout the entire history of their terrestrial existence and evolution, and living organisms display varying degrees of tolerance of each factor, permitting varied and systematic quantitative experiments to determine the nature and extent of their effects. For biology and medicine, space therefore represents a new and powerful research environment: it makes possible experimental investigations into problem areas in which theory is in no position to make trustworthy predictions.

57. Our current state of knowledge in this field derives from experiments carried out in space over the last two decades, notably those conducted during recent years in the United States Skylab and the USSR Cosmos Biosatellite and Salyut series. Of the problems that have so far aroused interest, and continue to do so, many involve fundamental issues in the biosciences. Cardinal questions concern the biological significance of earth's gravity. Gravity strongly affects the behaviour of the liquid and semi-solid phases which comprise living matter. It always existed as it does today, and the evolution of all organisms has therefore taken place under its constant and pervasive influence.

58. Important experimental facilities already exist or are being developed in many countries for research in the following areas:

(a) Basic physiological phenomena with respect to the three main sensing systems (vestibular, somatosensory and visual) related to spatial orientation, control posture and locomotion;

(b) Cardiovascular phenomena and conditioning of the cardiovascular system during prolonged exposure to weightlessness;

(c) The possible effect of micro-gravity on cell proliferation kinetics;

(d) Cell and molecular biology.

It is desirable that opportunities to use these and other facilities continue to be made available to scientists of all countries - especially of those that do not now have the capability of setting up their own experimental facilities for such work - in a co-operative and co-ordinated manner. The results thus obtained would also be useful for clinical medicine and public health care. Techniques resulting from medical studies in space could be used on Earth for health care and clinical medicine, as has been mentioned in other bodies of the United Nations.

59. The USSR has conducted a number of long-duration space flights, resulting in a great deal of important medical data. A major conclusion has been that there is no indication of the impossibility - or of hazard - to future extended manned space flights. This is especially important in view of the likely need for human intervention for fabrication or erection of large structures in space, for which concepts and designs already exist. A significant part of the scientific research programme of Soviet manned flights has been concerned with biological experiments. Fundamental vital activities - heredity, cell division, embryonic evolution processes, structure formation, etc. - were studied. Important data on gravitational biology, cytophysiology, comparative and evolutionary biology have been obtained.

60. While most biological experiments in space have focused on the practical problems of manned space flight, some missions have studied the fundamental biological effects of micro-gravity. Effects of stimulated growth of micro-organism, muscular and skeletal abnormalities in rats and multidirectional growth in plants have been noted as preliminary observations. Data from planetary landing missions have been analysed with regard to the possibility of life. In the case of Mars, which seemed promising for the existence of life as we know it, a number of experiments conducted by the US Viking spacecraft on the planet's surface were specifically designed to detect biological activity, and yielded generally inconclusive results. While there is yet no reason to believe that life should be unique to Earth, there is as yet no observed evidence of life elsewhere. However, the implications of life elsewhere in the universe would be profound for science as a whole.

61. Experimental research in the micro-gravity environment is a rapidly growing space discipline which will lead to advanced scientific knowledge and new applications. The research will develop through utilization of existing and planned manned space systems. There is also a clear trend to utilize fully automated orbital platforms which will provide microgravity conditions, energy, power, control mechanisms, etc., and will guarantee the recovery of samples and test objects. Examples of fully automated systems are biosatellites of the COSMOS series, the proposed Space Shuttle long-duration experiment facility, the unmanned modules of the Salyut system, and the projected materials experiment carrier (NASA) and MINOS (CNES). In view of the long-term implications of this work and its interest to humanity as a whole, it is desirable that research in this field be supported and carried out in a co-operative and co-ordinated manner.

C. Telecommunications

62. Telecommunications was one of the first applications of space technology and, beginning with the passive relay of voice and video by a satellite in 1960, it progressed very rapidly to operational international service in 1965, using active geostationary satellites and satellites in high elliptical orbits. Communication satellites have now become a routine and vital element of the international telecommunications network. They have also become an integral part of the domestic network in several countries. As on 31 December 1981, a total of about 220 satellites for various telecommunications purposes (including broadcasting, meteorology and other services, as well as experimental) were already in operation

or notified to the ITU as planned for operation in the geostationary orbit. Of these, about 63 satellites are for international public telecommunications services (INTELSAT, INTERSPUTNIK and INMARSAT). Of the approximately 157 remaining satellites, about 128 stand notified by developed countries and about 29 by developing countries.*

63. The rapid advances in this field have been made possible by the tremendous technological progress in related fields, especially micro-electronics (large and very large-scale integration), transmitters (travelling wave tubes and solid-state devices), antenna design, high-frequency techniques, communication techniques, micro-processors and the field of electronics in general. While these fields have contributed to space, there has been a corresponding positive feedback and space technology itself has accelerated - even caused - some of these developments.

64. These and other advances led to the development of large, high-power spacecraft which could be kept relatively fixed on-station in the geostationary orbit, making possible a technology inversion by which the complexity was shifted from the ground to the spacecraft. Further progress especially in the field of deployable antennas and solar arrays on spacecraft, led to the development of the direct-broadcast satellite. The first of these was the United States ATS-6, launched in 1974 and used extensively by the United States, India and other countries for experiments in direct broadcasting to augmented community television receivers. Similar experimental satellites have been developed by the USSR and Japan and jointly by Canada and the United States. The USSR, in fact, has had an operational satellite broadcasting service (EKRAN) since 1976, and Canada operates an experimental television broadcast service using its ANIK-B spacecraft. Much current activity in this field is directed towards the development of larger, more complex, more powerful and capable satellites.

65. The technology-inversion mentioned above inevitably results in significant cost increases for the satellite. While the economic attractiveness of this depends upon an over-all system cost analysis of alternative configurations, complex and large satellites are often economical because of the substantial savings in ground segment that they make possible. Such satellites could perhaps contribute to a desirable reduction of pressure on the geostationary orbit. The use of such satellites - with the large investments involved - also implies a very extensive ground segment, so as to fully utilize them. In fact, in many such systems the ground segment (especially when maintenance and operation are taken into consideration) accounts for a large proportion of the total system cost. There is, therefore, a great need for reductions in the cost of ground hardware, and all work aimed at doing this is worthy of encouragement and support by all countries and international organizations. This is also important in the case of international or regional systems, where the space segment may be rented or its

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* These figures are based on notifications made to ITU under the procedures of the Radio Regulations and must be interpreted with caution for purposes not connected with the applications of these regulations. It should be noted, for example, that within the INTELSAT system, about 24 countries lease or plan to lease capacity for domestic purposes (including about 18 developing countries) and that some satellites notified by a single country (e.g., for meteorological services) may be of benefit to many countries.

cost shared between many countries, but the cost of each ground installation is borne fully by the country concerned. It can be expected that the technical development and the greater production due to higher demand will lead to a substantial reduction in cost for, inter alia, ground segment hardware.

66. Most communication satellites are in the geostationary orbit. Since these satellites operate within limited designated frequency bands and therefore need to be sufficiently separated to avoid interference with one another and also possible collisions, there is a limit to the total number of satellites that can operate in the geostationary orbit in the different frequency bands and also in any given frequency band. There is real concern that some parts of the orbit are approaching saturation in certain frequency bands. Technological advances are under way, however, which will probably permit among other changes, the closer spacing of satellites and their satisfactory coexistence. It is therefore imperative that studies and research to achieve this objective be intensified, including a closer examination of techno-economic implications, particularly for developing countries in order to ensure the most effective utilization of this orbit in the interest of all countries. Besides those efforts, and bearing in mind that the geostationary orbit is a limited natural resource, thus it is imperative that its use be properly and justly regulated. These aspects are discussed in greater detail in chapter II G.

67. Advancing technology and increasing traffic have led to decreasing cost per circuit for satellite communication (e.g., the INTELSAT satellite utilization charge per circuit has been reduced by a factor of six since 1965). Traffic has also increased from 150 half circuits in 1965 to 50,244 half circuits in 1981. The share of the developing countries in this traffic was nil in 1965 and about 35 per cent in 1981. Another major factor in the decreasing cost of satellite circuits has been the increased lifetime of satellites. Reliability and quality assurance have helped to do this and, at the same time, have spread the culture of reliability engineering and failure analysis to other sectors of industrial effort, with very beneficial results. Launch vehicles capable of carrying larger payloads have also contributed to the economics of satellite communication.

68. The possibility of launching, deploying or even fabricating large structures in space (see chap. II I) could lead to another revolution in space communication. Such structures could have large antennas and high power outputs making possible communication between extremely small terminals. The possibility of "repairing" satellites in orbit would also make possible the use of more sophisticated systems, thereby permitting simpler ground equipment for reception. Advanced concepts like on-board (spacecraft) switching and signal processing combined with new communication techniques (spacecraft switched TDMA, code-division multiple access, etc.) could even make possible pocket size, individual "earth stations". There are however constraints on the realization of small terminals in particular frequency bands due to the power flux density limitations necessitated by the fact that these bands are shared by ground and space services. Given the large investment in existing ground (conventional) systems and their importance, regulatory provisions have been specified by WARCs and regional radio conferences. In view of the immense possibilities opened up by advancing satellite communication technology, it is desirable that ITU continue to study the optimum allocation of bands for various services, the criteria for sharing and the use of the geostationary orbit with a view to adopting appropriate changes at future WARCs or regional radio conferences.

69. While greater radiated power from the satellite enables reception by simpler ground equipment, the use of smaller antennas on the ground requires wider spacing of satellites in the geostationary orbit in order to reduce interference to acceptable limits. And because greater radiated power by satellites and the use of small antennas on the ground increase possibilities of interference in terrestrial and satellite services, we have a paradox that is common to other sectors of activity also: the intensive application of an innovation often degrades some of its most desirable features. Careful studies of various trade-offs are therefore needed to arrive at an optimum solution.

70. However, partly because of the existing constraints, exciting new developments have been taking place in higher frequency bands. The 14/11 GHz band is already being used for operational purposes by INTELSAT and some countries have carried out experiments in the 20 and 30 GHz bands. Satellite television broadcast systems in the 12 GHz bands will soon be operational as well. Other techniques such as polarization diversity and spot beams may also help to reduce intersatellite interference. Satellite-to-satellite links will avoid multiple hops and may increase the efficiency of global communication. All these developments may also contribute to a lessening of the pressure on the use of GSO in certain frequency bands and orbital arc-segments, mentioned earlier, and deserve active support.

71. Large "space telephone exhanges" have been proposed, which would be electronic exchanges in space, receiving, processing and transmitting signals to appropriate locations through large, narrow beam antennas. Such structures are now feasible and most of the technology for implementing such a system is already at hand, although its launch and assembly may at the moment be difficult and uneconomical. Nevertheless, it is possible that such a system may one day become economically attractive; in this case the development of a large communications platform could be undertaken to satisfy, in the most economical way, the needs that would appear at the international or regional level. The expected impact of such (and other) large platforms, on GSO must be thoroughly studied in order to avoid any unnecessary congestion in GSO, taking into account the equal rights of all countries to this particularly important international resource.

72. An alternative to such single large platforms, and one that may be immediately feasible, is clusters of (electronically) interconnected satellites. Since these could basically serve the same purpose as single large platforms, and both will also be more efficient from a GSO-usage point of view, its development too should be encouraged. Unnecessary congestion in GSO should be avoided taking into consideration the equal rights of all countries to GSO which is one of the most important international resources.

73. A recent development of great promise is the rapid progress in the field of fibre-optic technology. It is desirable to take maximum advantage of this to accommodate international and trans-oceanic traffic so as to lessen the pressure on the geostationary orbit and the frequency spectrum.

74. Satellite broadcasting is an increasingly important application of space technology. Satellite sound broadcasting to portable and automobile receivers is likely to be possible in the future and CCIR has only recently completed a study on this. The use of satellite broadcasting - especially for education - is discussed in greater detail in chapter II E.

75. The increasing power that enables satellites to broadcast directly to small home or community receivers and high gain receiving systems on satellites makes possible communication with small receivers and transmitters on ships, aircraft or ground vehicles. The system of INMARSAT for global maritime communications is now operational, and it is desirable that technologies and systems be developed that will enable smaller ships as well to use satellites for maritime communication (see also chap. II, para. 157). Currently, joint studies and developments have been undertaken by INMARSAT and IMO in close co-operation with CCIR aimed at the establishment of a future global maritime distress and safety system. In this new system Morse radiotelegraphy will be replaced by digital selective calling, radiotelephone and narrow band direct printing using terrestrial or satellite communication facilities. It is intended that distress alerting via satellite will primarily use small low-power distress transmitters that can be carried both on ship and survival craft or be fitted into floating buoys and be activated should a ship sink. The implementation of this future system is envisaged around 1990. This system together with the availability of low-power distress transmitters could be of great value, especially for those developing countries that constitute archipelagos with extensive small ship traffic between their numerous islands or countries with considerable fleets of small coastal or fishing boats. Satellite systems for aeronautical and land-mobile communications are also likely to be developed in this decade. The International Conference on the establishment of an international maritime satellite system, 1975-1976, recommended the study of multipurpose satellites providing both a maritime mobile and an aeronautical mobile capacity. There may be economic advantages to be gained from multipurpose satellites serving both the maritime and aeronautical communities, although the operational and institutional consequences of such an arrangement need to be studied. In an attempt to encourage studies on purely technical aspects, the INMARSAT Council has indicated that the INMARSAT space segment could be used for test and demonstration purposes for a wide range of mobile satellite terminals. ICAO, in 1981, completed a comprehensive study which assesses on the basis of extensive computer simulation the potential and economic viability of an aeronautical satellite system as compared to existing and possible alternative aeronautical communication systems. The early implementation of a suitable system should be encouraged (see also chap. II, para. 159).

76. Lightweight transceivers which operate using appropriate satellite links are especially attractive for use in disaster relief operations and in the dissemination of warnings of impending disasters. Such a system, providing ready and reliable communication with disaster sites, could be defined through an analysis of detailed operational requirements and should be implemented operationally. International organizations which operate commercial components of such a system should make these components available at minimal or no cost during disaster operations. An appropriate body of the United Nations system should be mandated to govern the over-all operations of the disaster operations communications system. The INMARSAT system is already available for disaster relief communications on land through the use of transportable ship terminals.

77. Satellite communication is being put to wider and newer uses. These include video conferencing and various types of interactive use, computer interconnection, data communication, electronic mail, etc. While these basically use the technology of "conventional" satellite communication, they depend on new interface equipment, special software and new communication techniques like packet switching in its various forms. Techniques such as spread spectrum, demand assignment, multiple access, digital speech interpolation, etc. have by themselves created major

advances in the field of communication. Much of this depends upon very basic, fundamental work in such fields as communication theory. Similarly, the use of higher frequencies depends upon extensive scientific investigation of propagation phenomena. It is therefore necessary that all possible encouragement and assistance be provided - especially to developing countries - to undertake such basic science pursuits.

D. Meteorology

78. Both meteorological as well as earth resources and environmental satellites use remote sensing techniques. They can be considered as complementary and partially overlapping subsystems of a global earth-observation system. This is the reason why certain "remote sensing" applications such as large-scale air and water pollution monitoring are also referred to in this section.

79. Despite the impressive developments in technology, man is yet dependent on the weather for a large proportion of his sustenance and wealth. In fact, a better understanding of the environment has further emphasized his dependence on weather and on the climate. All countries are - to a greater or lesser extent - affected by adverse weather phenomena and climate changes. Developing countries are particularly dependent upon the weather and its vagaries - not just for food, but also for agriculture-dependent industries (e.g., textiles), cash crops like coffee and tobacco, and also for hydroelectric power. Forecasts that are even slightly more accurate or can be made a little more in advance would mean a great deal, both economically and in terms of advance action to prevent human misery caused by storms, floods and droughts.

80. In the few years since the transmission of the first visible cloud images from space in 1959, much progress has been made through space meteorology in trying to tackle some of these problems. Rapid technological progress has permitted the extension of observations from the visible to the infra-red, ultra-violet and microwave regions of the electromagnetic spectrum and the development of a global system making complementary use of polar orbiting and geostationary satellites. The first satellites used television cameras to provide pictures of cloud patterns. The introduction of thermal infra-red scanning systems made possible the measurement of cloud data that could be used in the computer models of the atmosphere that are the basis of weather forecasting. The first operational system, based on these techniques, included the APT system which made satellite imagery freely available in real-time anywhere in the world to anyone who could build or buy a simple low-cost ground receiving system.

81. As higher resolution sensors were developed, it became possible to make meteorological observations from geostationary orbit, where the constant field of view permitted frequent observations and also enabled satellites to relay ground measurements and processed satellite data between ground stations. In particular, the raw digital image data are received by primary receiving and processing facilities which retransmit corrected and processed data in simpler formats to less expensive secondary user stations. Sequential images from geostationary satellites, acquired at intervals of typically 30 minutes, can be compared to determine wind speeds at cloud level. During FGGE (1978-1979), five geostationary meteorological satellites were in orbit to provide continuous coverage around the world. The Global Observing System within WWW now includes geostationary meteorological satellites launched by the United States (GOES) (3); Japan, GMS (2);

the ESA METEOSAT (2); and a system of polar-orbiting meteorological satellites operated by the USSR (the METEOR series) and the United States (the NIMBUS and TIROS-N series). These polar-orbiting satellites operate in the sun-synchronous orbits at altitudes of 800 to 1,500 kilometres. In the near future the Global Observing System could be augmented with the Indian and the USSR geostationary satellites. India has already launched a multi-purpose geostationary satellite which provides meteorological imagery over the Indian Ocean.

82. The use of high resolution Fourier spectrometers and multifrequency radiometers for atmospheric and mesospheric sounding in absorption bands in the infra-red and microwave regions has introduced the third dimension into satellite observations previously limited to cloud levels. These profiling sensors provide measurements of air temperature and humidity as a function of altitude, for use in computer models of the atmosphere or weather forecasting.

83. Air and water pollution monitoring is another activity made possible by new sensors. Radiometric and spectrometric measuresments with better spatial resolution or through point sounding may be able to identify specific pollutants, their concentration, drift and dispersion. Source location will be improved by high resolution remote sensing satellites. There are plans to use laser radar (Lidar) systems aboard the SPACELAB for atmospheric studies. Development of technologies and techniques of pollution monitoring should be encouraged.

84. An important direction of experimental and future operational meteorology will be the monitoring of slowly changing atmospheric variables and the implications of these changes for long-term weather patterns. Satellite sensors are being developed to measure global albedo and the amount and distribution of carbon dioxide, chlorofluorocarbons, ozone and dust. These factors are affected by man's activities and long-term changes may give rise to changes in weather patterns with harmful environmental and economic effects. Satellite sensors provide the best means of accurately monitoring such global phenomena, and the further development of such sensors should be continued.

85. Observations over the oceans, particularly of such parameters as sea-state, sea-surface temperature and precipitation, are important for meteorologists. While DCPs (see para. 87 below) can collect such data in situ, microwave radiometers, microwave scatterometers and radar altimeters on-board satellites can provide this data over large contiguous areas or long profiles. Since these techniques are yet at an experimental stage, their further development must be encouraged and scientific studies in these fields need to be intensified.

86. Many problems of environmental monitoring can only be solved by combining high temporal resolution with (selectively) high spatial resolution. To cope with these requirements within reasonable data rates, future satellite systems will emphasize flexibility of sensor parameters. Long and variable focal length optics may be used in order to get, by ground command, either "wide angle" or "high resolution" imagery; a selection of filters and sensors may provide optimum spectrometric sensitivity for different tasks. The geostationary orbit will provide a synoptic view and the possibility of frequent observations. Development of such systems that provide frequent observations and transmit the data at low bit rates should be encouraged.

87. Data from meteorological satellite sensors need to be combined with ground, air and sea-based in situ measurements if their potential for improving weather

forecasts and monitoring environmental parameters is to be fully exploited. Therefore, both geostationary and polar-orbiting meteorological satellites are increasingly being used for relaying data from manned or unmanned DCPs to central ground receiving stations which automatically decode, process and retransmit the data to specific users. DCPs consist of small automatic collectors and transmitters of data that can work without maintenance for long periods of time. They are normally installed in remote or inaccessible land areas, attached to moored or drifting buoys or ships for monitoring sea conditions and currents, or flown on balloons to measure air movements and other parameters. Geostationary GOES satellites can relay the data of up to 10,000 DCPs every 6 hours. Polar-orbiting satellites can additionally be used for determining the position of drifting buoys by means of Doppler measurements. The use of DCPs with satellite relay is restricted to low-data rate transmissions (typically 100 bits per second). Therefore, DCPs are normally used in connexion with sensors for the measurement of slowly changing parameters such as temperature, humidity, atmospheric pressure, wind speed and direction, sea state, rainfall, snow height, etc.

88. Before the advent of satellites, balloons were used for gathering meteorological data from the upper atmosphere. Today, balloons and sounding rockets continue to play an important role in collecting meteorological data. Rockets are also used for dissipation of hailstorms that could otherwise cause damage to crops. Systems for such hailstorm control are operational in some countries, including the USSR, China and Argentina. The use of such systems for other countries should be studied.

89. As data becomes available from more sophisticated meteorological satellites and as the science of meteorology advances, more accurate and longer range forecasts will be possible, although the original goal of GARP to extend the reliability of weather forecasts to two weeks seems difficult. However, the full potential of current and future meteorological satellites beyond the stage of APT and WEFAX data reception can only be exploited by means of more sophisticated (S-band) direct receiving stations and the use of large, expensive computers for data pre-processing, analysis and modelling. Few developing countries are likely to be able to afford such investments on their own. Close regional co-operation or the establishment of regional or international centres is an attractive way for developing countries to derive the benefits of these technological advances without exorbitant investments or duplication of national efforts. The feasibility of setting up such regional or international centres for meteorological data reception and analysis is being examined by WMO, and should be encouraged. On the other hand, the centralization of such facilities is a viable solution only if there exists a well developed regional communications infrastructure which allows the minimization of the data turn-around time. Otherwise the near real-time availability of this data - an indispensible precondition for its usefulness - is lost. Before embarking on the establishment of such regional centres, it should therefore be examined whether already existing telecommunication links are sufficient to transmit the analysed data to national centres or could be expanded at reasonable cost. Otherwise the local establishment of smaller and simpler, cost-effective data reception and processing stations might be the only viable solution. Another important precondition for the successful long-term use of meteorological satellites for operational weather forecasts and monitoring of climate changes is that data are acquired over extended periods of time with at least part of the basic and well proven sensor and orbit parameters fixed in order to allow statistically valid evaluations. Thus all possible efforts must be made

to maintain continuity in programmes of operational meteorological satellites, particularly with regard to their financing or any other modification that may be introduced.

90. Since forecasting or understanding of local weather requires integration of relevant data collected in many countries and over large regions, progress in this field is possible only through close co-operation between nations. The whole field of meteorology has a history of such co-operation and space meteorology has continued this tradition. The world-wide free availability of data from meteorological satellites through decentralized direct reception, and rapid world-wide data exchange is crucial for the effective use and rapid integration of satellite data with data from ground-based networks. It is desirable that such co-operation - exemplified by co-ordination of efforts and exchange of data - be not only continued, but further intensified.

E. Remote sensing

91. Remote sensing technology with its various components can be considered as a technical imitation, modification and extension of the natural eye-brain system. Using remote sensing techniques from a high vantage point, man can extensively and systematically derive environmental information over a wider range of the electro-magnetic spectrum and with a higher, quantifiable and thus objectively reproducible, spectral and radiometric resolution.

92. Though satellite remote sensing systems are - in the formal sense - still at the experimental or pre-operational stage, many countries have made considerable investments in ground stations, processing and analysis facilities and the data is being used on a near-operational basis. This indicates a clear recognition of the importance of satellite remote sensing and its potential contribution to economic develoment; it also implies an understanding or hope that data will continue to be available. Definite indications in this regard from satellite operators are important, so that countries can continue to invest in ground equipment or devise alternative means of obtaining the data.

93. With respect to sensors used, a principal distinction has to be made between passive and active remote sensing systems. The first requires a natural supply of reflected (solar) or emitted (earth) radiation, while the latter provides the initial signal itself and records the object's response (reflection, scattering, fluorescence emission, etc.). Remote sensors can be mounted on a large variety of air or space-based platforms operating at different altitudes and for different periods of time. Consequently, satellite remote sensing should be recognized as being just one component in a complex multistage integrated systems approach, which also includes extensive sampling of ground information. The technology as well as the methodology developed for satellite remote sensing has therefore a significant bearing also on the efficiency of a purely aircraft-supported remote sensing system and vice versa.

94. From the early manned satellites with short duration missions, astronauts and cosmonauts used conventional hand-held photographic cameras to take pictures of the earth from various altitudes and at various angles. While these pictures had very limited applications, they were dramatic and showed some unexpected features, exciting speculation as to what might be done. As satellites became larger and missions longer, systematic surveys could be undertaken and special camera systems

were designed for remote sensing from space. Multispectral cameras were designed to use a variety of films and filters, allowing more flexibility in image processing for different applications.

95. A major advance was the development of automated satellites for weather and earth observations using multiband electronic sensors and real-time data transmission to the ground. These satellites made possible regular, repetitive surveys of the earth's environment and resources on a global scale. Within a few years, cheaper and more reliable linear arrays of electronically scanned detectors (charge coupled devices) are likely to replace the currently dominant electromechanical scanners. While electronic sensors tend to have poorer resolution than photographic systems and are thus less suitable for large-scale mapping, the advantage of regular coverage over many years offsets the resolution disadvantage in the case of monitoring changing phenomena. Furthermore, electronic sensors can make observations at infra-red and microwave wavelengths, beyond the sensitivity of photographic film.

96. The advantage of real-time data transmission can only fully be exploited by users if decentralized direct data reception and rapid, efficient data dissemination is guaranteed. Therefore, a growing number of countries are establishing remote sensing ground stations which generally provide data to all countries within the zone of coverge. In order to take full advantage of the real-time data transmission and to manage the vast amount of data that will inevitably flow from future remote sensing satellites, further decentralization of ground data reception and processing facilities down to national and provincial scale may be desirable. The availability of cheap and versatile technology for the ground segment as well as the ability of user countries to develop an indigenous capability for designing, establishing, maintaining, running and adapting the components of the ground segment to advances in sensor technology are important pre-conditions in this respect. At present the scarcity of foreign exchange, as well as difficulties and delays in procuring spare parts or getting maintenance services not only hamper indigenous developments but also occasionally render existing facilities inoperative for long periods. Additionally, a number of users particularly feel the need for assurances from countries operating remote sensing space segments of continuing services with direct and unrestricted access to data of their territories at reasonable prices before embarking on extensive investments in ground facilities (see also chap. II, paras. 204 and 225). A number of operators of space segments feel, however, that, if continuity is to be assured, the prices that users pay will reflect a sharing of the cost of these expensive systems.

97. In the last two decades, over 30 earth observation satellites have been launched, mostly from the United States and the USSR. Since 1972, remote sensing has become increasingly "quasi-operational" through the LANDSAT satellites of the United States. Four have been launched including LANDSAT-D which was launched in 1982. The Soyuz, Salyut, Meteor and Meteor-Priroda spacecraft of the USSR have also collected extensive remote sensing data.

98. By the end of the decade there are likely to be six or more remote sensing satellite systems operated by national or regional agencies. Apart from those of the United States and the USSR, remote sensing satellite systems are likely to be set up by Brazil, Canada, China, France, Japan, India, and possibly other countries. In addition, a remote sensing satellite system will be established by ESA. While discussions are under way to make some of these systems compatible with

existing ground stations and complementary to each other, the design of each system will correspond primarily to the requirements and capabilities of the agency concerned. The sensors on these satellites will operate at visible, infra-red and microwave wavelengths with a variety of resolutions and fields of view, thereby allowing the user to select the system or combination of systems that best meets his needs. By the end of the decade a number of satellite systems will be operational and prices for data are likely to rise to cover the costs of developing and operating the systems. A number of users have expressed the need to institute arrangements to enable them to have continued access to data at reasonable costs (see chap. II, para. 209).

99. Future satellites with data direct transmission will have higher spatial resolution and some will have pointable sensors and stereo-viewing capabilities (e.g., the SPOT system of France). Other new satellite sensors such as the thematic mapper of LANDSAT-D (United States) or the Soviet Union's FRAGMENT-2 have significantly improved spectral capabilities. All weather active sensors have already been flown - e.g., the microwave radar on SEASAT of the United States - and some future systems also include similar sensors (the United States Space Shuttle flew an imaging radar and both ESA and Canada are considering synthetic aperture radar satellites).

100. The currently dominating trend in the development of electronic satellite remote sensing systems is towards multipurpose and multichannel (up to eight) high-resolution sensor packages, sometimes including an all-weather capability (radiometer, scatterometer, altimeter and imaging radar). This results in extremely high data rates (up to about 200 megabits per second) and the use of microwave (around 8 GHz) technology for data transmission and reception. The latter requires costly augmentation of existing (2 GHz band) data reception facilities and poses significant problems with respect to data pre-processing and handling.

101. This tendency has spurred studies into possibilities of on-board data processing aimed at data compression and reduction of redundant information. However, at present no technologically viable and generally accepted solution is in sight. The optimal data compression algorithms would change from scene to scene and would depend upon the specific application area, thus reducing the usefulness (or even being detrimental) for other applications. A retransformation of compressed data into its original form would be very expensive and would entail some loss of information. Nevertheless, further research in this field is desirable.

102. On the other hand, various studies of current as well as potential applications of earth observations from space seem to indicate that satellite systems based on a total systems concept incorporating both space and ground segment and taking into account special needs and conditions of major application areas and user communities could be a viable alternative or at least a cost-effective complement to highly sophisticated, multipurpose remote sensing satellites with their immensely high data streams. Data rates between 5 and 15 Mbit have been proposed for such dedicated remote sensing satellites. One such concept for an agricultural application would allow for flexible selection of both spatial and radiometric spectral sensor parameters depending on actual user requirements. Other application areas for dedicated remote sensing satellites are geological surveys, mapping or remote sensing in tropical areas. The latter could

be achieved by, for example, launching the satellite into a high or near-equatorial orbit providing high temporal resolution in order to cope with prevailing cloud cover.

103. Besides these developments in the field of electronic sensors, high resolution panchromatic and multispectral photographic sensors with high geometric fidelity will continue to be flown on automatic as well as manned space missions. Their use will not require sophisticated technology or the establishment of costly ground segments. It will probably remain superior for large-scale mapping (down to 1:50,000 as demonstrated by the USSR Soyuz-22) of quasi-stationary or slowly changing phenomena observable in the visible and near infra-red part of the spectrum. Space photography, therefore, constitutes a valuable complement to the frequent direct reception at low data-rates of medium resolution remote sensing imagery. It is a low-cost approach with respect to data analysis and therefore is particularly attractive for developing countries which cannot afford large investments in ground hardware.

104. While this section has dealt primarily with the satellite component of a remote sensing system, it is clear that other elements on earth are equally - or even more - important. These include not only the data reception facilities, but also the data processing and analysis hardware, the computer software, equipment and techniques for "ground-truth" collection and, of course, the organizational and utilization aspects. Data processing and analysis facilities may range from large, sophisticated and expensive computers to simple, inexpensive photo-processing and visual interpretation equipment. The choice of technology and equipment depends upon a country's needs, resources and specific characteristics. However, it needs to be emphasized that a great deal can be done through simple, inexpensive equipment and appropriate techniques.

105. The systematic collection of ground truth is indispensable for the proper interpretation of remote sensing data. The creation of a data bank of representative examples of radiometric-spectral and/or structural-textural appearance of typical ground objects and feature associations in the respective types of remote sensing data ("signature bank") would be a desirable activity requiring comparatively little investment. Of course, even here there is a wide range of possibilities and costs - from ground truth radiometers to more expensive mobile platforms (e.g., "cherry pickers") that carry a wide array of equipment like spectrophotometers, scatterometers, etc. It is important to note that signatures and ground truth are area-specific and therefore countries involved in remote sensing have to carry out this work for themselves and/or on a regional basis. These aspects of ground truth, data processing and analysis need greater emphasis and it is desirable that countries devote special effort to work in these fields.

106. With the advent of operational remote sensing satellite systems and with more and more countries already establishing ground segments for data direct reception and/or data processing and analysis, great attention has to be paid by countries developing and operating space segments as to the complementarity and compatibility of their data systems with those of other satellite systems. This will help to avoid redundant experiments, to minimize costly changes of existing ground equipment, to guarantee a long-term availability of satellite data and to enable their broadest possible use with existing facilities (see also chap. II F). In this connexion, the importance of a complementary future use of geostationary orbit

for environmental remote sensing using satellites with selectively adaptable sensor parameters becomes obvious, particularly for tackling problems of monitoring and mitigating disasters.

107. Likely future developments include the continuing use, with great benefit, of photo-interpretation techniques by a large number of users, particularly in developing countries. At the same time the use of computer processing, interactive and automatic analysis and integration of interpreted information into computer data banks is likely to grow very rapidly. Data from a variety of remote sensing systems, along with meteorological, climatological and hydrological data and economic, social and demographic statistics, may be formatted to a common geographic framework. A network of terminals could allow users to obtain specialized maps compiled from these data bases according to any combination of parameters specified by the user. In general, systems are likely to become more user-oriented.

F. Navigation, global positioning and geodesy

108. Position determination - in real time for navigation and with an acceptable delay for geosciences - is an increasingly important requirement in a wide range of human activity. It has become essential in civil engineering, environmental planning, resources exploration and management, transportation and traffic control, search and rescue operations, etc. It is also a vital tool for a deeper understanding of the internal structure and dynamics of our planet and for studying crustal movements in relation to earthquakes. These applications require accurate position determination and monitoring of position changes in space and time.

109. Before the advent of satellite technology, the classical task of geodesy, i.e., the determination of the figure and size of the earth and of the geometry of its surface, had to be solved by precise determination of the geometric connexions between single points at the earth surface as well as of the parameters of the terrestrial gravity field and by finding a suitable mathematical model which fitted these measurements best. Position measurements by means of satellites provide instead geocentric co-ordinates of surface points and thus data on the physical earth's surface without assumptions and hypotheses on the figure and the internal structure of the earth. Besides this, satellite technology has demonstrated its unique capability for high-precision geodetic measurements and navigation on a world-wide scale, covering also with the same accuracy the vast ocean areas. The synoptic view and frequent repetitive coverage of the earth surface are major advantages offered by satellites. Particularly in the case of frequently repeated precise vertical position measurements along long traverses, the costs are considerably less than those incurred using conventional methods. This, and the fact that many developing countries are not well mapped, makes geodesy an especiallly relevant and important application for developing countries. The low investment on ground equipment and the high pay-offs in terms of new information would be attractive and suitable for most countries.

110. Other important tasks of geodynamics, in particular direct measurement over large distances of plate-tectonic movements with sufficient accuracy, monitoring variations of polar motion with very high accuracy, the study of terrestrial tides and monitoring the earth's rotational period with an accuracy down to 100 micro-seconds, can only be solved by means of modern satellite and space technology.

111. Principally, observations of an orbiting satellite can be used to determine the relative positions of the observer and the satellite. If the position of the observer is known, the position of the satellite can be calculated and vice versa. Once the satellite orbit is accurately determined, an observer anywhere in the world can determine his position. For navigation, the observer wants to use simple equipment to make a quick determination of his position which may be changing quite rapidly, while for geodesy precise position determination - with fewer restrictions as to time and complexity of equipment - is required. The technologies of navigation, global positioning and geodesy are therefore very closely related and have developed in parallel.

112. Early satellite tracking was based on radio interferometry using radio beacons on the satellites. More accurate observations for checking the radio determinations and for correlating ground geodetic networks were obtained by photographing simultaneously the satellite track against the star background from several ground stations. Already these early tracking data showed that the figure of the earth is pear-shaped, departing from the theoretical assumption of a rotation ellipsoide by up to 10 or 20 metres. But these methods were not yet sufficiently accurate for geodynamic applications. To meet these precision requirements, new space geodetic techniques such as laser ranging to and from satellites, microwave interferometry using distant extraterrestrial radio sources (e.g., quasars) and satellite radar altimetry have been developed.

113. Laser ranging to satellites was originally developed to improve the precision of satellite orbit determination. Now it has become also an invaluable geodetic tool to determine station positions with an accuracy ranging from several decimetres down to 1 to 2 centimetres. The latter is currently achieved only by a few fixed stations but design goals for mobile laser stations under development are also aiming at this precision, which is required for regional crustal deformation studies and actual measuring of plate-tectonic movements. In order to achieve this high precision, special geodetic satellites have to be compact, heavy and placed in high altitude orbits in order to minimize the effects of air-drag and of gravity anomalies. Also, a very high level of technical sophistication in hardware is required which includes accurate time and frequency standards, high-power short-pulse duration lasers and wide-band recording systems. The hardware required to achieve 1 to 2 centimetres positioning accuracy over distances of hundreds and thousands of kilometres is as yet available in only a few countries and the world-wide distribution of fixed laser ranging stations is rather uneven. It is therefore desirable that wider deployment of both fixed and mobile high-performance stations take place, so that internationally co-ordinated measuring campaigns can help develop a better scientific understanding of the earth and its dynamic features.

114. Studies have shown that space-based laser ranging equipment with the passive retroflectors attached to the ground targets might be useful and cost-effective alternative system for rapidly surveying the relative positions of sites with a few tens of kilometres' spacing but spread over fairly large areas such as tectonically active regions. The development of such equipment therefore deserves to be encouraged.

115. Highly advanced computer modelling is needed in order to interpret the results of high precision laser measurements in the centimetre range taking into account the earth's gravity field, earth tides, ocean loading and the effects of earth's

precession, nutation, diurnal rotation and relativistic effects. International co-operation in this, through a pooling of data and knowledge, could greatly accelerate progress in this field.

116. Satellite laser ranging and radar altimetry have also greatly contributed to a much more detailed presentation of the earth's gravity potential up to harmonic order 36. Recently launched dedicated gravity field mapping satellites will soon allow determination of the gravity field with an accuracy of several milligals and with a spatial resolution of about 100 kilometres. This is roughly equivalent to obtaining the geoid at this resolution to an accuracy of a few decimetres. These missions have recently been supplemented by detailed mapping of the earth's magnetic field from satellite to an accuracy of a few nT (nanotesla). Besides geodetic satellites, laser ranging of the moon has also been used for studying terrestrial geodynamics, providing information on long-term changes in polar motion and the earth's rotation rate.

117. The second basic method of space geodynamics involves radio interferometry by simultaneously receiving and later cross-correlating the radio noise from distant radio sources at widely spaced antennas. Accuracies of about 4 centimetres have recently been reached over distances of several thousand kilometres. The results are obtained in an inertial reference frame. Systems planned to be operational in the next few years will provide daily estimates of polar motion and earth rotation with expected errors of about 5 to 10 centimetres in pole position and only 100 micro-seconds in time. These stations will also serve as base stations for crustal deformation measurements and plate-tectonic studies by means of mobile VLBI stations.

118. Accurate VLBI measurements require extremely precise timing. Hydrogen maser clocks have been used as the frequency standard in the most successful VLBI programmes. These clocks are expensive and not yet commercially available. Also the tape recorder requirements are very stringent. Data rates in excess of 100 megabits per second have to be recorded, which is equivalent to recording 20 television channels simultaneously. These technological difficulties in VLBI are offset by the advantage that VLBI stations can be made small and highly mobile. In order to check the validity of high precision laser ranging and VLBI measurements, both systems should be used in parallel with considerable overlap of the network of observation sites of the two types.

119. The use of satellites for navigation began early in the space age with the use of Doppler analysis of signals received from continuously radiating space-based radio beacons of high frequency stability which also regularly broadcast the satellites' orbital data. The equipment and the calculation techniques have been refined since, but the basic system is still current today. If a large number of measurements are taken over an extended period of time using more complex data processing, the results can even be sufficienty accurate for use in geodesy and geodynamics. It is therefore desirable that the computation techniques, equipment and necessary information be widely disseminated.

120. The same method - of measuring the Doppler shift - is also used for locating the position of fixed as well as mobile platforms on land and in the sea or air. These could be data collection platforms or equipment on board ships, aircraft, etc. Based on this, search and rescue systems have been devised for locating

ships, aircraft or land vehicles in distress. Demonstrations of such search and rescue systems are being planned by the USSR and co-operatively by Canada, France and the United States.

121. Both the United States and the USSR have navigation satellite systems in operation. The Tsikada low-altitude satellites of the USSR serve several hundred ships, off-shore drilling rigs and floating bases. The United States NNSS has satellites in 1,000-kilometre circular polar orbits and serves a wide variety of users from many countries. Improvements in computational techniques have reduced the position-fixing error to less than 1 metre.

122. A proposed advanced navigation satellite system, being set up by the United States and called GPS or NAVSTAR, is scheduled to be fully operational by 1986. It will comprise 18 satellites in circular 20,000-kilometre orbits, six each in three equally spaced orbital planes. This would ensure that a minimum of four satellites would always be in view of any given station, thus allowing immediate and extremely accurate three-dimensional position fixes by means of independent range and Doppler calculations. Ground receivers can be made very small and easily portable because of high signal strength.

123. Further processing of the data is expected to provide absolute positions in the 1 metre accuracy range, and considerable advances have been made towards the adopted goal of positioning by Doppler satellite to an accuracy of 10 centimetres or better.

124. Using VLBI techniques and GPS, a number of investigations have demonstrated subdecimetre three-dimensional accuracy on baselines of several hundred kilometres. These results have encouraged the development of transportable VLBI stations for possible monitoring of the small (1 to 10 cm per year) plate-tectonic movements for earthquake studies.

125. In view of the considerable scientific and practical utility for both rapid and high accuracy position location, it is desirable that world-wide access be provided to such systems.

126. Apart from navigation, space techniques provide an efficient way to improve the precision of geodetic measurements for position determination. The practical value of the extraordinary technological progress may not be immediately obvious, but what may be of interest today to geodesists alone may well, tomorrow, end up serving the needs of other disciplines, in particular those that are concerned with the management of the planet's resources and its environment.

G. Space transportation and space platform technologies

127. It was the first launching of an artificial satellite into earth orbit by the USSR in 1957 that marked the beginning of the space age, and even today the criterion that defines a "space power" is the capability of carrying out a complete space mission, including the launch into orbit. At the same time, with the increasing importance and utility of space-based platforms, technologies related to space structures have also assumed significance.

128. As we progress to larger and larger systems in space, the demand for economy becomes paramount. If space systems using large space structures are to be

economically competitive with terrestrial systems, their costs and the costs of transporting them to low earth or geosynchronous orbits must be minimized. Specified performance at minimum cost will dictate the way in which large space systems are designed and made.

129. With respect to space transportation systems, there has been a continual increase in payload capability, improvements in the precision of propulsion and orbit control systems and an increase in the reliability of systems. The efforts to improve the performance of space vehicles have been accompanied by persistent efforts to reduce the costs of launching. The large number of missions, and the growing proportion of these missions with a more or less "commercial" character, have made economic factors increasingly important. The future development of space transportation systems will depend largely on cost considerations. These considerations do not, however, imply a standardization of space transport technology. They have, rather, produced two fundamentally different options.

130. One technology is that of reusable vehicles. The costs of such partially reusable vehicles can be spread over a large number of missions. The increased complexity, and therefore cost, of making these systems wholly or largely reusable will be offset if they can be used a sufficient number of times. The other option is expendable vehicles whose cost can be reduced through the production of a relatively large number of vehicles. It is likely that these two options will remain in competition for some time, and perhaps indefinitely, since the wide range of requirements for space missions may best be satisfied by different transportation systems.

131. Cost reduction is also sought to be achieved by the simultaneous launching by one rocket of more than one satellite. China, ESA, the USSR and the United States have demonstrated the capacity of their launch vehicles to make such multiple launches. For the launch of geostationary satellites, the geographical location of the launch pad is also an economic consideration: payload capacities are significantly greater for a launch from near the equator than for one from a high latitude.

132. The technical resources for designing, building and operating the rocket-related technologies exist in a number of countries. With the systems that are now in use, those that are about to become operational and those that are under development, users are assured of having a variety of systems available to meet their needs. This variety is important since it will contribute to unrestricted availability of space transportation services and will keep prices within a reasonable range. It also helps the user to optimize his satellite without being constrained to a single set of size, weight and launch environment limits.

133. The primary future demands will be to reduce specific transportation cost. This reduction of specific transportation cost will be achieved either through vehicle reusability, a technique which will certainly be further developed in the future, or by means of multiple launches carried out with expendable vehicles.

134. The United States Space Shuttle is the first of the reusable vehicles. Its launch mass is 2,000 tons and the payload it can carry to low earth orbit (LEO) about 30 tons. It is partially reusable: the winged "orbiter" vehicle is expected to be flown into orbit and back to earth more than 100 times, while the large propellant tank is expended each time. The solid-propellant boosters are recovered and are proposed to be reused for ten or more flights. The reduction in launch

cost is expected to be substantial. The vehicle return capability has also another important advantage: expensive payloads which are compatible with the space shuttle, such as the Space Telescope, can be returned from space back to earth, refurbished, re-equipped and launched again, thereby offering considerable potential cost savings.

135. New and ambitious space projects - made possible by advancing technology and decreased launch costs - may require very frequent launches. As applications of space technology become operational and more widespread, there is also need to provide on an assured basis, launch facilities to all countries for peaceful applications or research. It is therefore desirable that:

(a) Launching services should be provided through bilateral or multilateral arrangements, on equitable terms, to all countries wishing to use them for peaceful purposes;

(b) Development of more economical space transporation systems should be encouraged in every possible way;

(c) The long-term consequences of the increasing number of launchings should be studied; if there are harmful consequences, corrective measures should be taken.

The increased frequency of launchings might also require a certain degree of co-ordination to avoid interference between launching operations at different sites. Consideration might also have to be given in the future to regulations to minimize the environmental effects of exhaust gases or of the re-entry of burned-out lower stages. (See also chap. II H and I.)

136. While launch costs per kilogram of payload have been decreasing, future fully reusable large launch vehicles are likely to allow further reductions. These vehicles with 100-ton payload capability are technically feasible with present technology, but require a large development investment. Systems reliability and the consequent vehicle complexity require considerations of simpler vehicles with fewer stages, which also reduce operational costs. Hence SSTO vehicles have gained increased interest in recent years. Thus, future launch vehicles are likely to be distinctly different from the multistage expendable launchers which are widely used today.

137. Orbit-to-orbit or orbital transfer vehicles are of particular importance for satellites or stations to be set up in geostationary orbits. In the past, transfers from low earth to geostationary orbit have been carried out by using liquid and solid fuel rockets. While cryogenics (liquid hydrogen and liquid oxygen) would allow an increase in capabilities, other propulsion systems are also being investigated. These include high-energy, storable propellants, solar-electric, and nuclear-electric propulsion. Each has specific advantages, and the choice must depend on the particular needs.

138. With advances in space technology, it has become possible to launch large spacecraft into orbit; simultaneously, new applications have been suggested which require even larger space structures. Space operations centres, space satellite power systems, manufacturing in space: these and other concepts have arisen from the rapid development of space technology. This includes improvement in systems for tracking, telemetry and command, increasing automation, a more precise understanding of the dynamics of structures in space, increasing efficiency and

power in electrical generation systems as well as remarkable developments in the reliability of electronic and mechanical systems. These advances have been made possible by the technical advances in other fields, particularly in micro-processors. It is equally true, however, that the development of space technology has contributed to the development of these other fields through an extremely productive process of cross-fertilization. This implies that, if it is essential for a country wishing to make even a modest contribution to the development of a space system to have a minimum of industrial infrastructure, this same infrastructure will benefit from new capabilities and spin-offs resulting from participation in the space system.

139. The technical resources for designing and building space research and applications systems are developing in an even larger range of countries than is the case with space transportation systems, and this trend should be encouraged. In this field as well, economic factors are becoming more and more important. A reduction in the cost of space operations will require a reduction in the price of space systems through the development of more highly organized space industries. Economies can also be achieved by increasing the operational lifetime of space systems, thereby effectively spreading the cost over a longer period. Extended lifetimes will also serve the valuable purpose of helping to ensure continuity of operational service.

140. For large space platforms, structural aspects assume great importance - in terms of weight, size and ease of fabrication. Deployable structures have already been used for various space applications - especially for solar panels and antennas. Erectable structures permit high packaging density and are mass-limited rather than volume-limited at launch. However, erectable structures are likely to require human intervention through extra-vehicular activity in space. Automated assembly is also being studied, though, and may become possible in the future. Structures fabricated and assembled in orbit seem to hold the greatest promise for achieving low-cost structures for large systems. The development of automatic beam builder machines - capable of building structures as large as 1 kilometre or greater - for use in space is currently under way in the United States.

141. Materials for space structures are of obvious importance in terms of optimizing performance at a given cost. The basic requirements are high stiffness, low density, long life and low thermal distortion. While considerable experience exists in the use of aluminium and aluminium alloys for aerospace purposes, it does not satisfy all the requirements. Titanium, steel, magnesium, beryllium and graphite/resin composites are alternatives being considered at present.

142. Large space systems would inevitably require considerable amounts of power. The present technology of solar-cell arrays is rapidly advancing through the use of low-density honeycomb cores and low-mass face sheets that provide greater power per square metre with lower mass. Future developments may include the use of gallium-arsenide or gallium-aluminium-arsenide materials with efficiencies above 20 per cent and multiband cells (which use a larger fraction of the solar spectrum) with efficiencies around 30 per cent. High performance batteries (possibly using nickel-hydrogen) long-life fuel cells, radio-isotope generators and nuclear reactors for high power are in various stages of consideration, design and development.

143. As mentioned earlier, some possible future space systems which will require large-scale operations in space, such as assembly of large multimission space

platforms, or operation of permanent space stations, will demand new analyses of the appropriate role for man in space operations. It will probably not be possible to give a definitive or universal answer to the question of whether it will be more desirable, efficient and economical to give an important role to manned operations in space, to completely automate these activities, or to utilize some optimum combination of manned and automated subsystems.

144. The realization of programmes of great magnitude will also require renewed consideration of wide participation by the international community in these activities. The enormous complexity, size and cost of these activities must not retard the progress that has been made - even if it is still modest - in disseminating space technology to a greater number of countries. Studies should therefore be made of the implications for international co-operation of these new concepts of large-scale space systems.

CHAPTER II

APPLICATIONS OF SPACE SCIENCE AND TECHNOLOGY

A. Current and potential applications of space technology

145. As is clear from the previous chapter, space technology has been developing very rapidly and its practical applications began within a few years of the launching of the first satellite - the USSR SPUTNIK - in 1957. Few other technologies have witnessed such a rapid transition from experiment to routine operation and almost no other advanced technology is as widely used. Space technology is now used in a wide variety of fields and its current applications include communications, navigation, remote sensing, meteorology, and other geo-sciences. Space manufacturing and space biology are fields in which some experimentation is already under way; space power systems have been studied and analysed in depth, and even space settlements have been discussed. Given the rate at which space technology has been advancing, there will soon be no technological constraint to the realization of these concepts. The actual application of space technology, however, has to be constrained by other considerations, such as economic, socio-economic and environmental considerations. This chapter discusses space applications from this perspective of beneficial use.

1. Telecommunications*

146. Of all the applications of space technology, the most widely used - and the one that has become the most routinely operational - is satellite communication. While its first uses in 1960 were for intercontinental communication, satellites are being used by a growing number of countries for domestic communication also. Satellites for international communication are operated since 1964 by INTELSAT and since 1971 by INTERSPUTNIK. (For a brief discussion see chap. III A). INTELSAT also leases capacity on its satellites for domestic services. Some countries have their own operational domestic satellite communications systems (Canada, India, Indonesia, USSR and United States), while many others have plans to set up such systems soon.

147. Thus, for some developing countries with limited investment in conventional terrestrial systems, with difficult terrain, geographical isolation or vast geographical areas, and therefore, with poor communication infrastructure and/or other difficulties against using conventional terrestrial systems, satellite communication would be a big boon: therefore, developing countries must pay particular attention to these needs.

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* The use of the expression "telecommunication" in the present report refers to communications in a general way and need not be construed to be strictly in accordance with the definition of the term as given by the International Telecommunication Union Convention of ITU.

148. Communication plays a key role in development, to the extent that it transfers information, data and ideas. It is one of the key infrastructure lements for social and economic development. While broadcasting does have greater reach and often more impact, the two-way nature of telephone and telex services engenders participation and involvement. For historical reasons, telephone and telex services are, almost everywhere, organized as a self-supporting and/or revenue-earning activity. As a result, even when rapid expansion of telephone and telex services has taken place, it has been inevitably in the heavy traffic areas. Thus, in many developing countries it is easier to make an international call rather than an intercity one, and easier to call another city in the country than a small town only a few miles away. In part, this is due to satellite communication and its distance-insensitivity, but mainly it is due to a lack of adequate resources, technical expertise and capital to establish an extensive and reliable infrastructure. It is therefore desirable that developing countries examine in detail the importance of communications, especially to and from rural areas, as an integral element of development and that studies to this end be undertaken by appropriate agencies of the United Nations system - especially ITU, which has already initiated work in this field, and UNESCO which has recently established IPDC. Due to the important role of communication, it is necessary that funding institutions recognize communication as an essential infrastructure for development and provide adequate funding for systems (national and regional) that aim at strengthening this infrastructure.

149. Despite the many advantages and the tremendous possibilities offered by satellites, their use is not necessarily always advantageous or beneficial. There are situations in which space communication may not be the best solution and may, in fact, be needlessly expensive. Even where space communication is used, an optimum mix and an integration of various systems is necessary. All countries - and developing countries in particular - should therefore undertake careful studies to determine the best approach to their communication needs. Where necessary, the United Nations system should provide assistance in the conduct of such studies.

150. Even when the use of a satellite seems optimal, it is necessary that the matching infrastructure be in place on the ground. Experience indicates that satellite capacity is often under-utilized due to poor co-ordination and planning on the ground, especially with regard to interfaces - both equipment and organizational - between the space element (including the earth stations) and the rest of the system. This aspect - equipment interfaces, appropriate modems, organizational co-ordination, etc. - therefore needs special attention.

151. Technological advances have made it possible to use small and inexpensive earth terminals. These are especially important for rural communication, where the need is generally for only a small number of circuits. The ANIK system and the design for AUSSAT provide such communication to widely separated users in areas far removed from conventional communication or power services. CCIR of ITU has for many years been studying low capacity earth stations and associated satellite systems. An ITU study financed by the Federal Republic of Germany has revealed the potential value for Africa of a satellite system specially designed for rural telecommunication and capable of using small earth stations. This is especially important when one remembers that current satellite systems are basically designed for high density traffic.

152. The African countries are at the moment exploring within the Pan-African Telecommunication Union (PATU) and the African Union for Post and

Telecommunications the possibility of establishing a regional "multi-function" satellite telecommunications system. Such a system should make it possible to:

(a) Use small earth stations;

(b) Use satellites with high EIRP concentrated in the intended receiving areas and capable of ensuring allocation on request and should also be capable of operating in the demand-access mode;

(c) On-board use of regeneration and switching systems; and

(d) Use ground terminals that are as inexpensive as possible and capable of operating from renewable power sources or standard batteries.

153. For a vast number of purposes, instantaneous two-way communication is far from essential. What is required - especially in rural areas - is a way of sending and receiving messages and data quickly, reliably, easily and economically between a number of different points. Existing systems - both conventional and space - do not cater to these needs and requirements; where they do, it is only in an inefficient, slow and/or expensive manner. It now seems feasible that fairly simple satellite-based systems may meet these needs. It is even possible that in some cases a low-orbit satellite system (involving an inexpensive launch and relatively inexpensive satellite) combined with microprocessor/computer technology could adequately satisfy these needs by serving as a "travelling electronic postman". It is therefore recommended that the United Nations, in association with appropriate specialized agencies, e.g., ITU through CCIR, and UNESCO, should make a study of the economic aspects of the use of satellites in low orbit by the developing countries.

2. Mobile communications

154. Mobile telecommunications are used for different purposes and new services are being considered. There is a possibility of applying space technology for land mobile and aeronautical communication, in addition to existing and future maritime communications. An integrated system might, in the long term, lead to a reduction of costs for terminals used on ships, aircraft or on land.

3. Land-mobile communications

155. Mobile communications systems for use on land are now being planned in some countries and are being considered by INMARSAT as well. Such systems would not only be of use for normal mobile communications, but would also be especially useful for disaster relief and emergency operations. Being basically designed for use with simple terminals which need only a few channels each, such systems could clearly be modified to serve rural communications - where the needs are somewhat similar. This possibility merits examination, and countries and agencies planning mobile communications systems using satellites should be encouraged to look at the feasibility of using the same system for rural communication in developing countries.

156. The INMARSAT Council has decided that, in the context of its research and development programme, space segment capacity would be made available for general

mobile experiments and pre-operational trials on a pre-emptible basis. Such use of the INMARSAT space segment would be without prejudice to any institutional arrangements and without commitment to provide operational services. The INMARSAT space segment can also be used for emergency relief operations on land with transportable earth stations approved and commissioned in accordance with the appropriate INMARSAT standards and procedures.

4. Maritime communication

157. Maritime communication is now an established space application and INMARSAT is the international agency that operates the system for international maritime communication. Maritime communication via satellite will not only result in quicker and more reliable communication, but will also lead to greater safety at sea and quicker response to emergencies. The proposed Future Global Maritime Distress and Safety System being evolved by IMO and INMARSAT would be an important contribution to safety at sea and deserves the continuing support of all nations. WMO and INMARSAT have recently initiated co-operation to find means of improving the collection and dissemination of meteorological data to and from ships using the INMARSAT system. While the present importance of maritime satellite communication is necessarily limited in most developing countries, its role is bound to grow with time as maritime developing nations expand their trading and shipping fleet and - later - their marine resources exploitation activities. However, in order to derive the full benefits of space technology for maritime communication, the efforts of INMARSAT (with ITU and IMO) to develop smaller and quite inexpensive ship terminals for a broad range of communications, distress and safety applications should be continued. Necessary changes in the over-all system design should be examined by INMARSAT, particularly from the point of view of enabling greater usage by developing countries. In this context, appropriate United Nations agencies should provide assistance, on request, for the conduct of studies aimed at assessing the communication requirements.

158. In certain circumstances, the primary requirement is for one-way communication - transmission of storm warnings or other messages - and for reception of a beacon to facilitate search and rescue missions, if required. These are vital for maritime safety, and INMARSAT is actively studying possible methods for early implementation of one-way (broadcast) transmissions of weather forecasts, storm warnings, navigational warnings and other safety messages, for reception by means of simple and inexpensive broadcast receivers suitable for all classes of ships. INMARSAT is also co-operating with ITU and IMO in an experimental programme where emergency position-indicating radio beacons (EPIRB) capable of immediate distress alerts to shore will be tested. Experiments and demonstrations will be conducted in 1982-1983 by the Federal Republic of Germany, Japan, Norway, the USSR, the United Kingdom, and the United States using INMARSAT satellites and in conjunction with shore stations operated by INMARSAT member States and ESA. In addition, Canada, France, Norway, the USSR, the United Kingdom and the United States are involved in an evaluation of the use of polar-orbiting satellites for distress alert, identification and position determination of EPIRBs transmitting from ships or survival craft, and crashed aircraft in distress using the SARSAT and COSPAS systems.

5. Aeronautical communication

159. While aeronautical mobile communication via satellites has been experimented with, there is as yet no operational system in this field. INMARSAT is examining the possibility of providing this service on its future spacecraft. It is possible that such a service could be operational by the end of the decade. ICAO is also engaged in studying the needs and possibilities of such a service. In view of the potential importance of improved mobile and fixed aeronautical communication - for both routine operations and safety - it is important that such studies be continued.

6. Satellite-to-satellite links

160. Another important emerging application in the communications field is satellite-to-satellite links. The United States Tracking and Data Relay Satellite System is the first such system that will be used, among other things, for relay of remote sensing data (from LANDSAT-D) to receiving stations. Such a system reduces the minimum number of stations required for receiving world-wide data from orbiting satellites. Such satellites could also be used for linking one communication satellite to another, thus enabling a signal to be sent around the globe without having to go through multiple earth-satellite hops. Satellite-to-satellite links would also assist in the exchange of television broadcast programmes between countries having broadcast satellite services.

7. Future communications applications

161. The advanced technologies mentioned above, in addition to others like beam shaping, multibeam antennas, frequency reuse, on-board satellite switching, use of higher frequencies and use of new communication techniques, will result in a continuing revolution in the field of satellite communications. Concepts like satellite clusters and large, very high-power communication satellites may be seen in the near future. Like most technological possibilities, these developments in space communication could be used in a wasteful manner of little benefit to most nations, or they could be directed so as to provide very substantial benefit to all nations. They could have considerable social and economic implications, and their beneficial uses would need appropriate organizational arrangements. It is therefore recommended that the United Nations system examine the implications and potentials of these developments, especially for developing countries.

8. Satellite broadcasting

162. Reception of satellite-relayed television programmes using specially augmented devices which supplement television receivers is now a well-proven application. The USSR and India have such operational systems. Other countries - including Australia, Canada, Japan, the United States and, in a joint venture, the Federal Republic of Germany and France - have carried out experiments and many are now planning operational domestic systems. This is obviously an application with tremendous possibilities, especially for education - in the broadest sense of the term - and as a means of accelerating development.

163. Operational use of the broadcasting satellite service in the 12 GHz band is likely to be introduced soon. This, together with the future utilization of the 22

GHz band (allocated in ITU Regions 2 and 3) and the 40 GHz band (world-wide) will make it possible to use receivers having parabolic antennas of the order of one meter diameter and smaller. In addition, advances in low-noise receivers have also made possible comparatively small (2.5 to 4 meter diameter antennas), low-cost systems for reception of television emissions in the 4 GHz band allocated to the fixed-satellite service. This band is widely used for the intended purpose of television networking in North America and the USSR.

164. The issues connected with the use of satellites for education are discussed in greater detail in section E below.

9. Remote sensing

165. Remote sensing has become an increasingly important application of space technology even though there is as yet no formally "operational" system. Many countries - including some developing countries - have been involved in either data analysis and/or data reception and analysis. While the LANDSAT satellites of the United States have been the most widely used, other countries - including the USSR, India and jointly by the USSR and Bulgaria - have also used their own and other remote sensing satellites. Data has been collected in various bands of the electro-magnetic spectrum, including visible, infra-red, and microwave; and both active and passive sensors have been used.

166. Remote sensing applications are most effective when data acquisition and analysis are carried out in a problem-oriented manner. Ideally, remote sensing data should be collected at different altitudes with varying degree of detail and, if possible, at different times and at different angles, in particular for stereoscopic purposes (multistage and multitemporal data acquisition). Satellite remote sensing data are generally no substitute for more detailed data from aerial remote sensing missions. But they are extremely useful for small-scale reconnaissance mapping of large areas for updating landuse, monitoring of changes, etc. even in medium scales. One satellite image typically covers an area that would require a photo-mosaic composed of several thousand aerial photos. The synoptic nature and frequent homogeneity of satellite remote sensing imagery is also very suitable for the delineation of large-scale homogeneous associations of features representing, e.g., certain types of land use, ground cover, drainage patterns, morphology, etc. This eases the incorporation of details recognizable in aerial remote sensing data into the regional context and allows, among other things, the cost and time-saving expansion of detailed local information from ground and aerial surveys to much larger areas.

167. With regard to analysis and interpretation of remote sensing data, one has to note that these images are instantaneous representations of the surface appearance of a vast number of different objects in their complex unity and relatedness. Discipline-specific information has to be filtered out, requiring an interdisciplinary understanding of the mutual relationship of these different forms and patterns and their radiometric-spectral appearance. Therefore, visual image analysis by an experienced photo-interpreter who is a specialist in a given field is generally superior to automatic image analysis in instances where the thrust of the interpretation effort lies in the recognition and complex evaluation of geometric-structural features and patterns. Much of this can be done by using very simple and inexpensive equipment and techniques (see chap. I, para. 104). On the other hand, the full resolution of radiometric-spectral feature contrasts, their

quantitative evaluation, statistical analysis and automatic classification require the application of digital methods of image data analysis. Digital image pre-processing aimed at feature enhancement can also be extremely useful for subsequent visual interpretation. Therefore, the use of interactive hybrid image analysis systems permits optimal man-computer "co-operation" and - depending on the specific task - fully exploits the specific advantages of both analog-visual and digital image analysis and interpretation. However, before embarking on major investments in expensive equipment - requiring also specially-trained personnel for effective utilization and maintenance - the need-condition context should be carefully analysed.

168. Satellite remote sensing has, a priori, planetary dimensions. The synoptic view and the possibility of frequent repetitive coverage of large and even inaccessible areas make, for the first time, regional and global monitoring of renewable natural resources and changing environmental phenomena technically feasible and economically attractive. The long-term future of satellite remote sensing lies, therefore, in its operational utilization for effective management of renewable resources and the monitoring of man's environment. This potential is still far from being fully exploited, partly due to the large time lag between the acquisition of data and their availability to the user. Effective application requires rapid, and preferably direct, access by countries to data of their territories. "User-friendly" satellites that can work with simple, inexpensive ground equipment would greatly facilitate this and their development needs encouragement. At the same time, sophisticated sensor systems transmitting very high data rates may need large, expensive ground reception and data processing facilities. Since most countries may not be able to afford such investments, the alternative of a network of close co-operation between the national agencies and regional facilities might be considered, possibly in conjunction with a system of distribution of the processed data to simple, low-cost user terminals.

169. High resolution satellite radars used for microwave remote sensing provide qualitatively different information from that obtained by visible and infra-red sensors. They have the additional advantage of all weather operation. This is important since one of the major obstacles for remote sensing in the optical part of the spectrum (visible and infra-red) is that cloud cover cannot be penetrated. Since about 50 per cent cloud cover is typical for most countries, developed and developing countries alike, a need for high-resolution all-weather satellite radar has repeatedly been expressed and a few countries are pursuing programmes aimed at establishing such systems within this decade. From an applications point of view, it must, however, be mentioned that both data acquisition and processing from such systems as well as the proper analysis of radar data for topographic and thematic interpretation pose significant problems. Currently planned systems will - for numerous technical and economic reasons - use only a single-frequency synthetic aperture radar. In the case of vegetation studies, however, good results would require multifrequency radar. Generally, much research is still needed in order to make efficient use of imaging radar data for thematic interpretation. Their main potential is currently still in the field of geologic-geomorphologic investigations, in particular in regions with heavy cloud cover.

170. Remote sensing has the potential to improve, rationalize, intensify and/or supplement conventional survey and resource management systems. Although much needs still to be done to fully exploit this potential, data obtained by remote sensing satellites and often unobtainable by any other means, complemented with

other collateral data and "ground truth" have already been widely applied with great success and significant benefits in many countries. While developed countries use this data mainly for change detection and updating of existing information, many developing countries still use it, in the first instance, to derive primary basic information on land cover and land use, hydrology, topography, geological structures, etc.

171. Remote sensing applications aimed at topographic and first order thematic mapping using methods of visual photo-interpretation are relatively simple to accomplish by trained interpreters and do not require major research efforts and investments in ground hardware. Their results are in most cases self-evident and can easily be combined with conventional data and integrated into existing traditional information systems or data banks. This type of application is, therefore, still dominant, in particular in developing countries.

172. New potentials of remote sensing lie in applications aimed at the solution of complex survey and monitoring tasks such as agro-meteorological crop-yield prediction, early detection of potential breeding sites of desert locust, detailed classification of land cover and land use, water and air quality monitoring, identification, classification and quantification of hydrothermally altered rock formations, reliable prediction of snow-melt run-off for a given water shed area, etc. A successful solution of such complex tasks necessitates the use of satellite remote sensing data in conjunction with extensive "ground truth" and other complementary data and information. It also requires major research efforts and, frequently, extensive use of sophisticated computer hardware and software for data analysis and quantitative modelling of the phenomena and processes. Such applications are - initial promising results notwithstanding - still in an experimental stage. This is the more so since operational data availability with the required sensor parameters and repetitivity of data collection is not yet assured by current systems. The same applies for all-weather remote sensing and marine observations. Oceanographic satellites have been so far purely experimental. Operational applications in this field are likely to take a few more years.

173. Recent analyses indicate that the largest benefits of satellite remote sensing might be expected in the areas of agriculture and forestry followed by applications for land-use planning and water resources management. But it should be kept in mind that the relative benefits which one can derive from different types of applications depend both on the technical parameters of available remote sensing systems and alternative systems as well as on the actual status of knowledge about one's country's resources, their relative abundance or economic relevance as well as on environmental and other conditions. Cost-benefit assessments of satellite remote sensing, too, make sense only with respect to the specific problems to be solved paying due regard to local conditions, needs, systems specifications, cost and timeliness of data acquisition, and available alternatives and recognizing that only part of these benefits may be quantifiable in economic terms. Each country, therefore, has to make its own unique cost-benefit assessment and decisions before embarking on large-scale remote sensing applications and major investments. In this respect, it is likely that many developing countries may have similar needs; those countries should jointly take necessary steps to study these needs and assess appropriate remote sensing systems to meet them. In this context, the United Nations system (FAO, UNESCO, UNDP and UNEP) should strengthen their programmes and encourage dialogues among member States so that interested countries could:

(a) Take steps to study these needs and assess appropriate remote sensing systems to meet them; and

(b) Engage in dialogues between users/potential users and designers/producers of satellite systems in order to determine user needs and the extent to which those needs can be met.

Furthermore, the regional commissions, with the assistance of the United Nations system, should carry out the necessary studies on the most efficient and practical ways of co-operation among the countries in their respective regions, on space activities; and, as appropriate, on mechanisms for their implementation.

174. Satellite-acquired data combined with ground observations may in future make possible accurate crop predictions, better management of forests and other renewable resources, location of mineral and hydrocarbon resources, etc., through better resolution, use of all-weather sensors and a better understanding of the science of remote sensing. A possible situation in which data are not available to the sensed State but are available for commercial and other forms of exploitation by another country has been a cause for concern to a number of countries. The sensed State shall have timely and non-discriminatory access under reasonable conditions to the primary data obtained by remote sensing from outer space which relate to its territory. It is therefore important to reach agreement on principles governing satellite remote sensing. Accordingly, the current discussions on this in COPUOS should be completed expeditiously.

10. Meteorology

175. Meteorology has been a major field of space application. Various international programmes organized by WMO (see chap. III) have met with considerable success and observations from space are now an integral and important part of weather reporting and forecasting. Satellites are used for the dissemination of processed meteorological data to users all over the world, and also for the collection of data from remote places or mobile platforms through data collection systems. Cloud cover pictures, vertical temperature profiles, sea surface temperatures, sea state, sea-ice, precipitation, snow-cover and a wide variety of other data are collected by a number of meteorological satellites operated by a number of countries. Data is received directly from satellites by many countries - mainly through the APT system - and indirectly through communication links by many others.

176. The present world-wide system is largely operational and includes close co-operation and co-ordination between satellite operators as well as national meteorological services. Problems of utilization of national space and ground segments, of standardization, acquisition, archiving as well as world-wide exchange of data and their application both for actual weather forecasts as well as in connexion with world-wide or regional research projects are discussed in WMO and the respective activities of States are co-ordinated in the framework of the WMO, WWW and GARP. Access to data from operational meteorological satellites is free, and because many countries have become dependent upon this system, it is necessary to ensure continuation and intensification of such services. This is especially important for developing countries which do not have independent or alternative sources for much of this data and for whom weather forecasting is directly linked to national prosperity because of their dependence upon, among other things, agriculture.

177. Until now, data from meteorological satellites have mainly been used in synoptic weather forecasting. For numerical forecasting, satellite data collected up to three hours preceding the starting point of the prediction are generally included without time correction. The large and well-equipped forecasting centres apply the so-called four-dimensional assimilation of satellite data. Satellite derived vertical temperature profiles are still - because of limitations in accuracy as compared to in situ measurements - useful only over areas where such in situ data are lacking. The methodology for operational determination of atmospheric humidity and wind fields from satellite measurements as well as the world-wide availability, quantity and quality of data on humidity cannot yet fully satisfy practical requirements for advanced numerical weather forecasts. More research and operational efforts in this direction are still required.

178. Geostationary meteorological satellites with their capability of virtually continuous observation of cloud patterns over major parts of the globe have proved to be extremely useful for early detection and tracking of severe tropical storms. The maximum wind speed and intensity of hurricanes and cyclones can be derived from a study of wind speed, the phenomenological type of the cloud spiral and its diameter as inferred from the satellite imagery. It is hoped that in the future satellite-based prediction of the severity and path of these storms might be possible up to 48 hours in advance with sufficient accuracy to facilitate preventive actions. WMO runs a special Tropical Cyclone Programme (TCP) in which the use of meteorological satellites is a key element. WMO reports regularly on the progress made in implementing the programme to the United Nations Committee on the Peaceful Uses of Outer Space.

179. Meteorological satellite imagery has also been used in experimental applications for flood prediction caused by snow melt run-off. Although the spatial resolution of meteorological satellites is relatively coarse as compared to resource satellite sensors, the estimates of snow cover, if the area is large enough, are still sufficiently good, and the advantage of much more frequent repetitive coverage offsets by far the resolution disadvantage. This is particularly important because the greatest danger of flooding exists in periods of rapid melting - and consequently snow cover change - in connexion with high insulation and surface temperature or rainfall. Both factors can be measured or at least inferred from satellite data.

180. Estimation of rainfall through monitoring of cloud patterns in both the visible and thermal infra-red range and the use of correlations between rainfall, brightness and radiation temperature of cloud tops in satellite imagery seem to hold promise for evaluating regional crop productivity, particularly for areas in which water availability is the controlling factor. During the NASA Large Area Crop Inventory Experiment (LACIE), rather good early wheat production estimates were achieved by combined use of LANDSAT remote sensing data (for acreage estimates) and data from meteorological satellites (for estimates of average monthly soil temperatures, precipitation and - in some instances - also potential evapotranspiration as a measure of plant stress). However, this was done only over areas with large fields and low crop variety. Also, other countries, such as Argentina and Brazil, are carrying out projects on crop production estimates, by using remote sensing and meteorological satellites as major source of data. FAO has carried out several regional studies using both data from meteorological and remote sensing satellites for early detection of potential breeding sites of migratory desert locust. Meteorological as well as remote sensing satellites also hold promise for monitoring desertification phenomena and both have been used in

joint regional studies by FAO, UNEP, UNESCO and WMO and as part of GEMS. In the Soviet Union, data from Meteor satellites are operationally used in conjunction with aerial surveys and ground truth collection for regular spring and fall estimates of biomass productivity and carrying capacity of large rangeland areas in Central Asia.

181. New experimental sensors of high radiometric and spectral resolution are also used in studies for large-scale air and water pollution monitoring and in experiments to determine the concentration of chlorophyll from quantitative measurements of "ocean color" in several spectral bands, but a good deal of basic research remains to be done before these applications can be used operationally. In any event, it seems clear that satellite systems will not be a substitute but rather a complement to in situ measurement of environmental pollutants in water and air. The main potential of satellites lies in monitoring the extent, movement and dispersion of large pollution plumes. For accurate detection and identification of sources and sinks, the spatial resolution of meteorological satellites is normally not sufficient. On the other hand, high resolution satellites do not generally meet the repetitivity requirements for pollution monitoring.

182. As already mentioned in chapter I, paragraph 87, meteorological satellites are also widely used in order to collect and distribute a great variety of environmental data acquired by remotely located, manned or unmanned data collection platforms (DCPs) on land, at sea or in the atmosphere. DCPs can, amongst other things, provide part of the independent meteorological in situ ground data needed for calibration/interpretation of remotely sensed data. The two types of data are complementary and should, therefore, be used jointly wherever possible. DCPs are also used to observe changes in seismic activity (event counters), to make river gauge and flow measurements and to monitor sea level changes that might be connected with earthquake-generated tsunami waves. The DCP data relay capability of meteorological satellites is playing an ever-increasing role in the establishment of satellite-based early warning systems for natural disasters. Requests for medical or other kind of help could also be relayed using DCP transmitters.

11. Navigation, global positioning and geodesy

183. Navigation and geodesy are important applications of space technology. Methodologies, major satellite systems, and the more scientifically oriented concepts and results of geoscientific applications have been dealt with in chapter I, section F. In the following paragraphs, emphasis will be laid on applications of navigation satellites.

184. Navigation has always been of great importance to man, and while navigational errors have sometimes led to unexpected discoveries, they have more frequently led to disaster. In the modern world, accurate navigation is becoming increasingly important not only for safety, but also for optimizing steadily growing traffic flows and minimizing fuel consumption through appropriate routing. Reliable position determination is also needed for a variety of other economic activities - e.g., off-shore oil drilling and sea-bed mining - or scientific studies related to geodesy, plate-tectonics, geodynamics, etc. While some of the scientific studies require very accurate geodetic measurements using satellite laser radar or very long baseline interferometry, almost all safety and economic activities can effectively be carried out by using satellite navigation based on Doppler measurements.

185. One proposed safety application is the experimental SARSAT (jointly by Canada, France, Norway, Sweden, the United Kingdom and the United States) and the Space System Searching for Vessels and Aircraft in Distress (COSPAS) (USSR) systems for search and rescue, which is already being used experimentally. Both use radio beacons transmitting distress signals to orbiting satellites which relay the signals to a ground station for processing. The two systems are compatible, enabling quicker and better response to distress signals. The Argos system, designed by France and the United States provides, on an operational basis, a positioning service. Other experiments will be carried out by member-administrations of ITU using the INMARSAT space segment (see para. 158). EPIRB equipment used for these tests will be capable of providing an immediate distress alert with transmission of the vessel's position to shore-based SAR authorities. In view of the importance and the humanitarian nature of these systems, it is desirable that the present co-operation be continued and efforts be made to evolve a world-wide operational search and rescue system as soon as possible.

186. Navigation satellite systems are operated by both the USSR and the United States. The Tsikada satellites of the USSR serve several hundred ships, off-shore drilling rigs and floating bases. The United States NNSS has been used by many countries for many years for both navigation and geodesy. This is now to be phased out and to be replaced by GPS (see chap. I, para. 122). This will have the capability of far greater accuracy for both position location and navigation on the ground, at sea and in the air. The system will operate at two different levels of accuracy. It is not yet clear to what extent the United States will permit access by other countries, but it is recommended that GPS be made available to users. However, a long-term answer to the needs of the many actual and potential user countries needs to be devised. A single world-wide system seems very attractive since it would ensure compatibility and yet require a much lower investment from interested countries because the space segment costs could be shared (see also section C below). In this connexion, it is noted that navigation and position determination was foreseen in the INMARSAT Convention and that INMARSAT has initiated studies to determine the technical and economic feasibility of providing an international navigation and position determination system through INMARSAT satellites.

187. Position location of "ground control points" is also useful for processing of remote sensing data. These are prominent features whose exact location is known (possibly by satellite geodesy) and which are then used for "correcting" the image to obtain high precision data products.

188. The immediate economic relevance - and overall importance - of satellite navigation and geodesy highlight the need for providing continuity and assured access to such systems by all countries. In its basic form, the ground equipment required for position-location (a georeceiver and a computer for data processing) is not very expensive or sophisticated and is within the reach of most countries. Thus, this is an application which can be taken up without great difficulty by all countries which have need for such uses. This is another reason to move ahead quickly and establish a mechanism and/or arrangements for an ongoing international satellite geodesy/navigation system.

12. Future applications

189. With further advances in space technology, new applications seem feasible. Among the major ones being studied at present are manufacturing or processing in space, and space power systems. The operational applications of these are probably many years away, but it is already time to examine their relevance and their implications. Their possible biological, ecological and radio-frequency interference impacts must therefore be studied and identified by ITU and other United Nations agencies with the necessary information to decide on them. Some of these issues are examined in greater depth in section I below.

B. Choices and difficulties in the use of space technology

1. Choices

190. Space technology now spans a vast range of complexity from fairly common and comparatively simple APT receiving stations to extremely complicated fully-automated space probes. It also encompasses equipment whose costs range from a few hundred dollars - for a television direct reception system, for example - to many millions of dollars. The investments required to develop and produce such equipment differ by many orders of magnitude, as do the infrastructure and technical skills involved. The variety of space applications now feasible, though not as wide-ranging, is also quite substantial. It is within this almost bewildering array of possibilities that a country must make choices about what applications and which technologies it wishes to pursue. Clearly, the choices must be determined by:

(a) The needs of the country;

(b) Its priorities;

(c) The feasibility of meeting these needs and priorities through the use of space technology with due regard to other countries' needs;

(d) The financial resources, the industrial infrastructure and the technological capabilities of the country;

(e) The availability of matching scientific and application-oriented as well as managerial and decision-making infrastructure and human resources required for effective utilization of data and of the information derived therefrom;

(f) Recognition of the rights of other countries to utilize space technology at a later stage.

191. It is therefore obvious that there can be no fixed formulae of universal validity. It is equally evident that costs and benefits of space applications also will vary from situation to situation and from country to country. Thus, each choice of a space application by a country has to be unique: a decision based upon the parameters of its particular context. This requires that each country carry out studies regarding costs and benefits before deciding upon the adoption of a particular application. Such studies should take into account not merely the economic aspects, but also technical, environmental and social effects that may result from the use of space technology. Many of the developing countries may not

themselves have all the expertise necessary for such interdisciplinary studies. In this case it would be advisable to consult with other developing or developed countries which have worked on these problems and have relevant expertise, or to seek advice from appropriate United Nations bodies and agencies through established mechanisms.

192. In many cases, assistance may not be required for basic decisions regarding whether to get into a specific application; rather, it may be required for choices of systems, type of equipment and selection of the most suitable methodological approach to tackle the problem in question. The latter is a particularly important element, because it has a significant bearing on the choice of the most appropriate system or instrumentation and thus also determines other parameters such as cost, organizational set-up, degree of self-reliance, extent of indigenous participation possible, etc. The United Nations system should - on request and where possible - provide such assistance to help countries make appropriate choices.

193. In deciding upon and implementing a space application, there is a whole hierarchy of possibilities ranging from problem analysis and systems studies through fabrication of ground hardware to the development and launch of spacecraft and setting up and running an effective user-oriented ground segment with all its ramifications. The level and extent of indigenous effort undertaken by a country clearly depends on the criteria outlined in paragraph 190 above. Thus, countries at different levels of development would be in a position to undertake different magnitudes of indigenous efforts. All possibilities for mutually beneficial co-operation between different countries by undertaking complementary efforts in this respect should be fully exploited (see chap. III D for an elaboration on this).

194. Other important aspects with regard to the choices for utilizing space technology include:

(a) While the most sophisticated technology is frequently tailored for multipurpose utilization, it is not necessarily the most suitable for a given application;

(b) Practical application of space technology requires a great deal more than the mere hardware. These non-hardware elements need to be given much more attention than they usually get;

(c) The "end-links" in any application are of crucial importance and due care must be taken to set these up in good time;

(d) The existence - or use elsewhere - of space technology for a particular application does not automatically imply or prove its universal utility: in a given situation, it is quite possible that a non-space technology may be more suitable;

(e) While considering present applications of space technology, due attention should be paid to combining it with medium and long-term needs.

2. Difficulties

195. Most countries - and developing ones in particular - face a number of difficulties with regard to space technology and its efficient utilization. Some of the major problems are identified in the following paragraphs. On the other

hand, these very difficulties might spur innovative approaches, press for needed indigenous educational, scientific-technical, industrial and managerial efforts and thus finally contribute to increased self-reliance and socio-economic advancement. Suggestions on how to overcome some of these major difficulties will be dealt with in sections C and D.

(a) Financial and industrial resources

196. Development, fabrication and operation of space hardware - i.e. launch vehicles and/or satellites - are large-scale ventures requiring a well-developed industrial and scientific-technical infrastructure and substantial investment in facilities and equipment that most developing countries do not have or cannot afford purely on their own. Also, most space applications include the use of fairly sophisticated equipment which - if not manufactured in the country itself - would need to be acquired from abroad. The investment proportions in ground and space hardware would very much depend on the type of application and on whether the space segment would have to be bought (inclusive of launch cost) or leased, in full or on a cost-sharing basis, or whether access to it or its data is granted free or at nominal cost.

197. Decisions to use space technology should be based on a proper "needs-conditions-alternatives" assessment, and, if possible, also be backed up by positive results of a pilot or demonstration project, thus assuring that there will be a return on this investment in terms of a significant contribution to socio-economic advancement and to the development of indigenous industrial as well as scientific-technical capabilities. However, space applications do have the potential to make significant economic contributions, and expenditures in this field should be looked upon as capital investments on which there will be a return. Thus, while financial support for such projects through bilateral or multilateral financing agencies is important, countries should themselves strive to raise internally at least part of the finances required.

(b) Human resources

198. Development of space technology, as for any other new technology, requires a strong base of high-calibre manpower: scientists, technologists and technicians familiar either with space technology itself or with related technologies - especially electronics, computers, etc. But space technology is only a tool to a higher end. Its effective use also requires a large number of adequately trained personnel in the respective application areas and a fair number of knowledgeable people at the decision-making level who are aware of the potential contribution of space derived data, information and services to development and capable of efficiently integrating them into the decision-making process. Most developing countries lack well-trained people at all these different levels; however, almost all do have at least small nuclei which need to be identified and expanded through suitably tailored national and international efforts on training and education (see para. 212 below and A/CONF.101/BP/9). There is need for both national and international action in this field (see paras. 237-240 below and chap. III, para. 379).

199. The use of space technology in developing countries, especially in connexion with the import of equipment (see para. 200), frequently entails the need for hiring foreign expert services at considerable cost in foreign exchange. In most

cases, development agencies too insist on providing experts as part of a total aid package, although similar expertise might be available in the country itself. While the assistance of foreign experts can - in some cases - be of great help or even be necessary, it is obvious at the same time, that total reliance on such external experts discourages development of indigenous expertise in the respective fields and impedes self-reliance. Identification and maximum utilization of already existing expertise in one's own country, or in other developing countries with similar conditions, together with a systematic development of knowledge and abilities required, are important pre-conditions for effective development. External assistance can of course be useful, but a provision of experts should not be a mandatory part of any aid package provided by international agencies.

(c) Equipment and its suitability

200. Space technology applications in developing countries generally require the import of costly equipment. This may be a major obstacle to the use of space technology, especially by developing countries facing severe balance-of-payments problems. However, it is true that imported equipment is generally more sophisticated and has a proven record. Nonetheless, some basic questions have to be asked and points to be considered in this regard:

(a) Is the sophistication really necessary to meet the particular needs? (In many cases, it will be found that it is not.)

(b) Does imported equipment, which entails the problem of spares and servicing, pose serious difficulties under the country's economic and logistic conditions?

(c) Is imported equipment suitable for the developing country's physical (temperature, dust, humidity, etc.) or cultural environment (way of operating equipment, etc.)?

(d) Although building equipment indigenously might be "risky", is it not an essential pre-condition to the development of an indigenous technological base? Since this "unproven" equipment will almost certainly not be used first by any other country, the opportunity to prove, field-test and - if necessary - improve it, must be provided by the country in which it is developed.

201. The risks in using a particular piece of unproven indigenous equipment instead of a standard foreign item have obviously to be assessed and weighed by each country and compared with the short and long-term benefits. A great deal depends on the values and development strategy of a country. However, in order for each country - however small or economically poor - to have some element of technological autonomy, it is necessary that due encouragement be provided to indigenous technological development.

(d) Transfer of technology

202. In some cases, the difficulty in the use of indigenous capability is not so much a question of the willingness to use such capability, but rather the mechanisms of doing so. For example, the transfer of know-how from research laboratory to industry is not easy. The making of a single unit in a laboratory is quite different from fabricating it in large quantities in an industrial situation. This

is a problem of great importance to developing countries in particular, and has implications for fields other than space technology. Countries which desire to engage in the manufacture of various space hardware should, therefore, seek the advice of competent agencies concerning problems of transferring technology from the laboratory to industry and from country to country in the field of space technology. The problems of technology transfer from developed to developing countries are discussed further in section D below.

(e) Internal co-operation and organization

203. Almost any space application requires the involvement of persons from various fields and sectors, who are inevitably affiliated with different departments, agencies, ministries, institutions or enterprises within a country. Lack of co-ordination and co-operation between these different agencies is often a major problem that hinders the application of space technology and the extraction of its full benefits. In many developing countries the lack of these managerial and organizational structures and of co-operative inputs - rather than insufficient technical manpower - is a major obstacle and bottle-neck in the use of technology to accelerate development.

(f) Continuity, compatibility and complementarity

204. There are many developing countries which, recognizing the potential of space, would like to invest in expensive ground hardware, e.g., for the direct reception and processing of satellite remote sensing data. But a major impediment to this is the inability of some major space segment operators to assure the continuity of services. Another obstacle to broader utilization of existing systems is the fear of many developing countries, including those which have already made substantial investments in ground facilities, that rapid technical developments will force them to frequent and costly upgrading and/or modification of their ground segments in order to cope with increasing satellite sophistication or changes in data formats. Thus, there is need for assured continuity and to bring about - to the extent possible - compatibility and complementarity between various satellite systems. (This is discussed in greater detail in section F below.)

(g) Availability of data and information

205. Doubts about continued availability of data from space sensors may deter countries without their own space segment from using space technology for various applications since they would feel vulnerable if they use such data on an operational basis. The non-availability of information with regard to various aspects of space technology and space applications is another serious obstacle to the greater utilization of space technology. Information on costs and benefits, on manpower requirements, on alternatives and new applications, etc., are often not easily or readily accessible. Important information about sources for equipment, experiences of others with the particular application or specific piece of equipment, etc., are also not easy to come by. Much of this information does exist, but its availability is not widely known or access to it is difficult. Often, it is available in a different form or is scattered in different places. A system of locating, collating and providing access to such information would be an invaluable aid to the spread of appropriate space technology - especially in developing nations, for whom information access is a serious problem.

(h) Other difficulties

206. While many of the previous difficulties will be observed in the near term, in the medium and long term very important potential difficulties could face all countries, in particular developing countries. Necessary steps must therefore be taken which will allow all the countries to use space technologies at economically justified costs.

C. Possibilities and mechanisms for enabling all States to benefit from space technology

207. It has repeatedly been emphasized (see introduction and para. 149) that space technology is not the solution to all problems and that - depending on the actual situation, needs and resources - conventional means might in many cases be a more suitable answer. Nevertheless, there is little doubt that space technology - in appropriate situations and if properly used - can lead to faster economic growth and quicker over-all development. If, however, it continues to be dominated by a few nations who invest in it, there is a danger that it may result in widening further the chasm between developing and developed nations. At the same time, this very stimulus of space technology has the potential to help the developing countries narrow the gap and to accelerate the process of development along paths of their choice. This, however, requires that all countries be encouraged to participate in various space applications so as to derive the fruits of space technology. All countries should take all possible steps to further such universal participation in the benefits of space technology. The following paragraphs outline alternative lines of action that could be taken by countries, as also by the United Nations and other international agencies.

208. Concrete and practical benefits of space emerge mainly from "end-to-end" applications projects. Thus, the real benefits from a remote sensing system come not merely from making and launching a satellite or collecting and receiving data; nor from processing and analysing the data. Rather, the practical benefits come only after the analysed data is given to the user and actually used by him in resource management, cartography, etc. While the earlier steps are obviously necessary and important, their novelty and glamour unfortunately often obscure the later, essential links in the chain which consequently do not get the attention they deserve. Similar examples can be given from meteorology - where the payoff can come only when the forecast actually reaches the individual farmer, for instance; or broadcasting, where it is the content of the broadcast that is as (or more) important than the technical means of transmission.

209. Thus, it is clear that countries without any "space" activity can not only derive benefits from space technology, but can actually participate in an important element of space applications - viz., the final utilization of the data. Clearly, in remote sensing this is possible only if all countries obtain the data collected over their territory at reasonable costs.

210. However, the use of such data - even analysed information - needs mechanisms and organizations in the country concerned which can ensure its proper dissemination and utilization. The experience of a number of countries has indicated that this is no easy matter; further, social, cultural and other differences make it difficult to transfer successful models, even when they do

exist. Thus, there is here a challenge for each country - whether developed or developing - to experiment, develop and evolve a model for its own situation. In order to derive fully the benefits of various space applications, countries should give priority to developing such information utilization mechanisms, appropriate to their needs and situation. Since this requires neither sophisticated technology nor large financial resources, this activity - essential for deriving the benefits of space applications - can be taken up even by small and developing nations.

211. In the context of data analysis, it is important to note that a crucial element in machine analysis is the software of computer programmes. Developing countries could consider assigning special priority to the training of computer programers and engineers. However appropriate hardware is also necessary and this may require fairly substantial investments. It is also important to note that there is concern about continued data availability (see para. 205). While assurances about continued data availability are desirable and would encourage many countries to proceed with investments and operational uses, there is also a need for easy and quick access to data through data banks with national functions, regional data banks with supply and/or support functions and international data banks with mainly support functions. In acordance with their respective national, regional or international functions, the data content of these would be differentiated with emphasis on one or more broad categories: general purpose data, specific data for didactical and other non-commercial purposes, programme and project related data and indexes to data. National data banks which form part of the national data base, would mainly incorporate general purpose data on the national territory, whereas data banks at regional and international levels would normally incorporate mainly specific, programme and project related data. With the very substantial - and rapidly increasing - volume of satellite-acquired data and the growing number of data banks of specialized or general nature, there is a growing need felt by users to have essential information concerning these data banks. This information could be obtained through a central clearing-house that can link needs with sources. It would also provide information on availability and location of satellite-acquired data in the various data banks, and information on how to have access to them. It is therefore recommended that:

(a) Data banks at national and regional levels be strengthened and expanded;

(b) Existing international satellite data banks composed of data for (non-commercial uses such as for training and project purposes) of the Remote Sensing Centre of FAO and of the Remote Sensing Unit in the United Nations Department of Technical Co-operation for Development be strengthened in so far as required to support regional and national centres;

(c) The FAO Remote Sensing Centre and regional centres for remote sensing should also continue to assist Member States in the development of remote sensing of renewable resource, including the provision of training;

(d) An information service having the function of a central clearing-house should be established (see chap. III, para. 432).

212. There is sometimes a notion that space technology is an altogether new discipline, education and training for which can be done only in new, specialized centres. In fact, space technology does not involve any "new" disciplines, but is mainly a transdisciplinary combination of well-established fields, including

physics, astronomy, chemistry, mathematics, electronics, various engineering disciplines (mechanical, structural, chemical), etc. Many developing countries do have at least some infrastructure in these fields, and can therefore - with only marginal help - develop a core of people who understand and can, in the first instance, make decisions regarding space technology and applications relevant to their country. Even if a country does not plan to embark immediately on development of space technology, it will have before it a range of choices with regard to various applications: should it have an (another) earth station for international communications; what type and from which manufacturer; should it get involved in remote sensing data processing; what meteorological information should it receive directly from satellites - and a host of other such questions will have to be decided upon. Meanwhile, it is likely to experience pressure from over-enthusiastic suppliers, vested interests of various kinds, and others. In such a situation, it is obviously essential that all countries have at least a nucleus of experts who can make knowledgeable decisions in the field of space technology. Already existing nuclei need to be identified and organized, and the necessary institutions and conditions for expanding them rapidly must be created. Where necessary the United Nations and its specialized agencies could help countries to develop this expertise by arranging fellowships for training and visits to appropriate centres (see sect. D below). In the short term, the United Nations system should utilize and improve existing mechanisms to provide - on request - advice to countries regarding choice of systems, equipment, etc.

213. The importance of trained manpower at all levels is recognized by all countries embarking on development and use of space technology (see also para. 198). Besides the need for technologists and application specialists there is also a need for developing a cadre of technical managers for the planning and speedy implementation of technological as well as application programmes. Equally important is that - with the growing role of technology - countries also induct appropriate technologists and application-oriented specialists from various disciplines into the administration or government decision-making machinery. This will certainly enable countries to make better choices and to derive greater benefits from space technology through more efficient and knowledgeable ways of integrating the results and services from space applications into the decision-making process. Popularization of space technology and its potential contribution to socio-economic advancement can help to create this broad awareness at all levels of a society. The United Nations, through its appropriate bodies, might play an important role in this respect.

214. However, adequately trained manpower is - by itself - not sufficient. The organization of this manpower into productive teams through appropriate institutional frameworks and the over-all mechanisms for co-ordination and co-operation within a country are equally important. Especially in an applications project, there is a need for considerable and close co-ordination between a wide variety of agencies. Such co-ordination has taken different forms in various situations: committees, joint management, a focal agency, etc. While the precise mechanisms of co-ordination will vary from country to country - dependent as they are on social, economic, cultural and other factors - the need for them has been clearly established. Therefore, countries embarking on the use of space technology should organize and set up interagency co-ordination mechanisms appropriate to their situation and needs. In order to facilitate this and to provide examples of alternatives, the United Nations should collect, collate and disseminate information on the mechanisms devised by various countries who have had experience

in space applications. Even prior to - or alongside - such efforts at co-ordination is the need to efficiently organize the resources (human as well as material) for planning and implementing space activities. Here again various alternatives do exist - ranging from allocation of specific space responsibilities to existing agencies to the creation of a new agency specially for space activities. Obviously, there is no unique solution applicable to all countries and all situations. However, the critical importance of a good organizational structure is now an established fact and countries planning to use space technology need to pay special attention to the organizational frameworks, appropriate to the country and task, conducive to the co-ordination and speedy implementation of efforts.

215. Developing countries span a wide range in the spectrum of technological capabilities and infrastructure. Thus, while some may limit themselves to "end-use" (e.g., information utilization - see para. 210) or to operation of an earth station for international communications, others may be in a position to do more. For example, countries with trained personnel could perform for themselves the all-important job of systems studies: carrying out studies to determine the best means (space or non-space) to meet the country's needs in specific fields, in keeping with national priorities. This work should necessarily be done by a country itself, so as not to be influenced directly or indirectly by equipment suppliers or others, except in cases where such expertise is not available. In this situation, the United Nations and its specialized agencies should assist countries (see para. 212), but the involvement of local people even in such cases is a necessity.

216. More detailed systems planning, including conceptual designs and laying down of system specifications, is a further step that must be undertaken indigenously by countries that do have such expertise. This, and the subsequent step of preparing a document for inviting bids (often referred to as a request for proposals), are crucial steps that determine the extent of competition that will take place in bidding and therefore the costs. The ability to analyse the resulting bids - in technical and managerial terms, in particular - generally requires a further level of expertise.

217. In this context, apart from the United States and the USSR, other countries either nationally or through regional co-operation, have built up or are building up a capacity in the field of space science and technology. It is desirable that these efforts be pursued in order to make it possible not only for these countries to utilize space science and technology for their own needs, but also to offer an alternative as partners for developing countries in their efforts to use space science and technology.

218. In this context, it is important to note that some developing countries not only have such expertise. Other developing countries could greatly benefit by drawing on this experience as an independent source of expertise.

219. A few developing countries now have both the human resources and the industrial infrastructure to fabricate ground hardware for space applications. This is a very important capability, because the ground segment for domestic space applications frequently needs to be tailored to the needs and the environment of the particular country. Equipment bought abroad might not only be too sophisticated and expensive but could also be less suitable than indigenous

hardware and require local adaptation. Also, with indigenous fabrication comes better maintenance, development of know-how, employment and - above all - greater self-confidence. However, as a rule, such equipment has teething troubles in the early stages and is not as sophisticated as the latest equipment available in the world market. Because of this, most developing countries tend to ignore and even discourage indigenously-developed equipment. However, it must be realized that long-term benefits from modern technology, including space technology, can accrue only when a country develops to the maximum extent its own technological capability. Developing countries should strive to build their technological capabilities to the limit of their human and infrastructural resources. Also, developing countries must adopt a pragmatic, need-based approach with regard to equipment: unnecessary sophistication and forced obsolescence must be avoided, as should an addiction to owning the "latest" equipment.

220. Sometimes, the equipment needs of developing countries may be unique. An example of this is the direct reception equipment for receiving television programmes beamed via satellite. The developed countries are focusing on development of individually-owned receivers, whereas the need of developing countries is for community reception equipment, operable on low-cost, local power-sources (preferably using renewable energy sources). In many such instances, developing countries would be well advised to first look for appropriate equipment from other developing countries. Alternatively, they may have to adapt off-the-shelf developed-country equipment.

221. Apart from the benefits mentioned, the indigenous fabrication of equipment has been found to lead, in many cases, to advantageous industrial and management spin-offs. There is, therefore, a strong case for encouraging indigenous fabrication to the maximum extent possible.

222. A handful of developing countries now have active programmes to develop space hardware. Here again there are considerable direct and indirect benefits, but the magnitude of investment and the technological base required obviously limit the number of countries that can at present embark on such programmes. However, there is scope here for joint effort - a pooling of financial, human and industrial resources - by groups of developing countries, aimed at building a base that could lead eventually to space-hardware capability. Developing countries should explore the feasibility of such co-operative effort for both space-based and ground equipment and mechanisms for implementing them. The United Nations system should encourage and provide assistance to such efforts.

223. The utility and importance of "pilot projects" that provide countries with first-hand experience and the opportunity to evaluate a particular space application has been proven and recognized. Such demonstration projects seem to be a necessary step that helps to prove the utility of an application and to evolve appropriate mechanisms of co-ordination and implementation. It also enables the operational user-agency to gain confidence in handling the technology involved. However, demonstrations of space technology require a satellite, and therefore considerable financial resources. Much of this investment would be fruitless if the country decided not to go in for the particular application or to use a different system. Therefore, developing countries are encouraged to negotiate with launching States for the use of their spacecraft on a trial basis for experimentation or demonstration. Some developed countries have already provided such services, on a bilateral basis, with considerable success, and have thereby

contributed substantially to the beneficial use of space technology by some developing countries. These promising examples should be multiplied, and more developing countries should be encouraged to determine - through first-hand experience - how best (or even whether) they should use space technology to meet their national needs and priorities. Such pilot projects are inevitably beneficial to all co-operating parties. Developed countries should continue to provide such services on equitable terms wherever feasible. Of course, in the case of meteorological and remote sensing applications, it may be sufficient - in the first instance - merely to provide access to the data. International financial agencies should provide financial support, as appropriate, for demonstration projects undertaken by developing countries.

224. In the fields of communication, meteorology and remote sensing, international organizations have played a vital role in making the benefits of space technology available to nations, particularly to the developing ones. WMO has, by its efforts, created a truly co-operative international network for meteorological purposes, benefiting all nations (see chap. III E). However, it has no space facilities of its own. Given the global nature of the environment and the crucial importance of weather forecasting to the economic well-being of nations (especially developing ones, with a very large proportion of their gross national product derived from weather-dependent agriculture), the crucial role of meteorology is obvious. While a great deal of international co-operation exists in this field, fostered by Member States through WMO, there is need to build further on this foundation, especially in view of the growing importance and demonstrated potential of space technology in this field. Some countries, however, believe existing systems under WMO are excellent and that United Nations efforts might best be directed at this stage to provide training to enable developing countries to make use of available data. All countries should continue to have free access to meteorological data. To fulfil this objective, WMO should be encouraged to ensure optimal use of space techniques, in particular in the related aspects of facilities for data reception and processing, data analysis and dissemination. In the same spirit, WMO should also envisage to undertake a study concerning the possibility to set up an international structure providing continuous availability of and access to satellite meteorological data.

225. Remote sensing by satellites is another application of great promise, and one of particular importance to developing nations. Lack of trained manpower and high costs of processing and analysis facilities have been major obstacles preventing mainly developing countries from deriving greater benefits from this technology. Agreement should be reached on principles governing satellite remote sensing. Work to this effect within COPUOS should be continued as a matter of priority, aimed at speedy agreement on such principles. Satellite operators should give assurances about continuity of data flows and provide indications about estimated lifetime pre-operational and operational systems in order to help all countries, in particular the developing countries. Compatibility of various systems and data formats is another important aspect; it is discussed in section F below.

226. Since remote sensing satellites can collect data from all countries, it is therefore possible to use shared or internationally-owned remote sensing satellites. Some suggestions for such international systems have been made. Also, on the basis of resolutions adopted by the General Assembly, a detailed study on an international satellite monitoring agency has been carried out (reference document A/AC.206/14, "Study on the implications of establishing an international satellite monitoring agency").

227. It is suggested that a study be undertaken to assess the need for and the viability of a world-wide remote sensing system. Such a study could consider various ways of providing remote sensing data - including regional, bilateral, multilateral and international arrangements - with the users bearing therefore the development, production, launching and operation costs of the satellites. Assuming that any one of these systems could provide assurance of continuity of data formats, avoid forced obsolescence of equipment, and enable the development and use of standardized data analysis software, the study should in particular indicate the comparative cost of such systems to the users vis-à-vis systems currently in operation and/or under development.

228. Satellite broadcasting is an application of special relevance to developing countries, since it can be used as a powerful tool for education. Benefits from a satellite broadcasting system for education and development can be very substantial, but the organizing of such a system requires a great deal of effort. In this field, studies have been initiated by UNESCO to find optimum solutions. This is discussed in greater detail in section E below.

229. Satellite communication is a field in which there has been a great deal of international co-operation for many years. However, intra-country communication - especially to and from rural areas - continues to be a major problem in developing countries. Satellite communications can provide a quick and efficient solution in many cases, and some developing countries do have plans for their own domestic systems.

230. Despite the low per-channel costs and the possibility of using inexpensive earth stations, the capital costs associated with the setting up of a satellite communications system are substantial. Since a large proportion of these costs is attributable to the satellite and its launch, a sharing of this between different countries would make for lower investments by each. Technology has now made it possible to build and launch large satellites, each of which could carry enough transponders to meet the telecommunications needs of a few countries. When the capacity is saturated, another satellite could be launched. Such a shared system has obvious advantages, and developing countries, in particular, could greatly benefit by joining together in the setting up of systems using a shared or common satellite(s). ARABSAT is an example of such a system and it is desirable that other groups of developing countries study the feasibility of such regional systems. INTELSAT is not optimally designed for domestic communications, but an increasing number of countries, including many in the developing world, are using it for this purpose. The feasibility and desirability of systems for rural telecommunications should be examined. It is also most desirable to examine whether such systems could become available on a non-profit basis.

231. While communications, broadcasting, remote sensing and meteorology are the major applications of space technology, there are others that can be as important in certain situations. Satellite geodesy, for example, has important applications - in cartography, seismology, etc. The related field of satellite navigation is also of growing importance to developing countries, especially those with maritime interests.

232. As noted earlier, INTELSAT provides one example of an internationally-owned space segment; similarly, INTERSPUTNIK has operated through leased space segment. More recently, the setting up of INMARSAT confirms once again the need and benefits

of international co-operation in space. These systems also provide a paradigm of a mechanism for channelling such co-operation into an operational and beneficial system.

233. Clearly, international co-operation is essential if all countries even more so the developing ones - are to derive maximum benefits from space technology. While developing countries will need assistance from developed countries and from international organizations, they can achieve a great deal on their own and by co-operating with each other also. In all this, the role of the United Nations will be of crucial importance. Some aspects of these issues are discussed in chapter III.

D. Facilitating access, use and development of space technology

234. It is sometimes assumed that any involvement in space technology or applications requires a substantial infrastructure of very sophisticated industry and very large research laboratories, and is therefore outside the reach of leveloping countries. In fact, it is not so and quite a few developing countries are actively involved in a variety of space applications and also in the development of space technology. Some infrastructure is certainly required - even for only using space technology - but this is not more substantial than what exists now in many developing countries.

235. The basic requirement is, of course, human resources. What is needed is not "space technologists", but experts in various disciplines that contribute to space technology - electronics, computer science, engineering, and application specialists (meteorology, agriculture, geodesy, etc.) as well as the necessary support personnel. A country can begin to apply space technology with just some simple equipment - costing a few thousand United States dollars - data products from a remote sensing or meteorological satellite, and a few applications experts who convert the data into useful information. This data analysis itself can, of course, be taken to increasingly sophisticated (and expensive) levels, requiring large, sophisticated computers and other equipment that could cost millions of dollars. How far a country wants to go would depend upon its needs, priorities and extent of matching infrastructure to utilize the information.

236. Infrastructure and the extent of use of space technology are, thus, interdependent. Simple uses of space technology (as in data analysis) needs only minimal infrastructure - mainly for equipment maintenance and operations - while more complex uses need a bigger and more sophisticated infrastructure. At the "basic" level, the greatest need is for equipment operation and maintenance, which need mainly adequately trained technicians. Beyond this, one needs human and engineering capabilities for equipment modification, fabrication and development. These activities, in the case of equipment for terrestrial use, obviously require less infrastructure than in the case of space-worthy equipment.

237. Development of human resources is probably the single most important - and time-consuming - element of infrastructure augmentation. Though some developing countries do have a fairly good base of qualified manpower, most are deficient in this important aspect. While each country will have to decide for itself the best approach to this problem, it can be generally recommended that countries examine and modify as necessary their education system and curricula to place greater emphasis on science and technology. Also, at post-graduate level, interdisciplinary

work on areas connected with space technology and its applications must be encouraged.

238. These measures can have an impact only in the medium or long term. In the short term, it is recommended that the United Nations organize a fellowship programme through which selected graduates or post-graduates from developing countries can get in-depth, long-term exposure to space technology or applications. These fellowships - numbering at least 100 each year - may be at universities or training institutions, but should preferably include a substantial amount of on-the-job experience. It is also desirable to encourage the availability of opportunities for such exposures on other bilateral and multilateral bases, outside the United Nations system. As far as possible, the selected institutions/training centres should also be in developing nations, and carry out training programmes relevant to the needs of the concerned developing countries.

239. Simultaneously, the United Nations should support the development of appropriate training centres at regional levels, linked, whenever possible, to institutions implementing space programmes. These could be located in developing countries that have active space programmes or extensive training facilities. Necessary funding for the development of such centres should be made available through international financial institutions. These training centres should organize - with United Nations assistance if necessary - regular training courses of varying durations for different levels of trainees from developing countries. In the long term, technicians' training should be done nationally and these regional centres should become centres of excellence, partly for high-level "training", but primarily for exchange of knowledge through seminars, etc. The faculty should be international and drawn from developing countries to the extent possible.

240. As a third step, the United Nations should itself conduct - as part of its space applications programme and in association, where appropriate, with the concerned specialized agency - regular three to five-week seminars for high-level personnel concerned with space applications and space technology. These seminars should focus on the organization of technological or applications efforts and be broadly "managerial" in content. The primary purpose would be the enhancement of knowledge and skills of key leaders through exchanges of experience with others, discussions on problem areas and seminars on new and potential applications. These seminars would be in addition to the specialized training courses that are conducted (and should be expanded as necessary) by various specialized United Nations agencies.

241. Past experience indicates that there is no organized institutional framework in many of the home countries of the trainees, to ensure that the training is drawn upon to best advantage. Countries should therefore plan some organizational infrastructure when they send out people for training. In this context the training of managerial or leadership personnel through the seminars mentioned earlier assumes special importance. A minimal amount of physical infrastructure (equipment etc.) is also necessary, so that the returning trainees can practice and sharpen their skills, even if no application is immediately taken up. Countries also need to take note of the need for a "critical mass" before good work can take place. It is therefore advisable to take into account these situations in the planning of training with a view to training several people from each country in a given discipline.

242. It is clearly desirable that there should be wide access to knowledge and that steps should be taken to facilitate such access. While scientific meetings and seminars - including, in particular, those organized by IAF, COSPAR and other bodies of ICSU - play an important role in facilitating the free exchange of scientific data and findings, there is also a need to consider arrangements for transfer of technologies. In this context, the recommendations of the United Nations Conference on Science and Technology for Development (see A/CONF.81/16) on this subject are of importance and should be implemented. In keeping with this, countries should not place undue restrictions on the sale of components, subsystems or systems required for space applications.

243. While it is possible to undertake space applications on the basis of imported equipment, it is necessary that countries develop at least a minimal capacity for development of space technology. This "minimal capacity" will depend upon the extent of involvement - and proposed involvement - of the country in space. Such a base is necessary to ensure independent decision-making, to absorb and adapt technology and to promote endogenous development. It is therefore essential that developing countries organize and encourage indigenous development of capabilities, even while they may resort to import of equipment or technology in order to "buy time". Developed countries, the United Nations and international financing agencies should consider providing all possible help to developing countries in the setting up of such indigenous centres for absorption, adaptation and development of space technologies. The basic nuclei for such centres already exist in most countries, either in a university or in an existing research laboratory or institution.

244. It is a fact that in many developing countries indigenous expertise and capabilities are not given due recognition and encouragement. Developing countries should take steps to encourage and develop fully their already existing technological capabilities and take planned measures to decrease their dependence on foreign expertise. While imports of components and equipment may be necessary - even desirable, from an economic angle - countries must strive to develop their own system-design and system engineering capability. In this context, developed countries should not always provide equipment in complete-system or "package" form, but should be willing to provide individual elements. Developing countries should strive to import such separate elements instead of integrated systems so that system-design, engineering and integration can be done by each developing country according to its needs, requirements, capacity and environment.

245. In the long run, countries should consider if and how their industrial development should cover space technology. Equipment for almost any space application requires a great deal of simple mechanical/structural fabrication work which needs only a fairly rudimentary industrial infrastructure. Of course the fabrication is often to high accuracies, but even so, most of this work can be done without large investments. Developing countries could therefore begin indigenous production of space technology elements with mechanical items - e.g., fixed pointing antennas. Comparatively simple mechanical elements often account for a substantial proportion of system costs and therefore such indigenous fabrication will also result in lower outlays of scarce foreign exchange. It will also upgrade skill, quality control and reliability in the particular sector with general benefits for non-space activities also.

246. Design and production of professional electronics items - even from imported components - often need fresh investments (especially in test instruments) and new skills. However, the electronics industry in general is characterized by a high employment-to-investment ratio: a factor of vital importance to developing countries. Therefore, countries which have the capability and the nucleus of an electronics industry could consider expanding this for space needs if they are planning to get into applications like satellite broadcasting, which call for a large amount of electronics.

E. Use of space technology for education

247. One of the important requirements for sustained growth and creating autonomous technological capabilities in developing countries is to improve the educational infrastructure. The needs go beyond educating the young, to providing a continuing source of information, knowledge and know-how to the adult population, some of which might be illiterate. Conventional methods of addressing these problems sometimes do not meet the appropriate needs of the rural population in this regard. While the use of space technology cannot provide instant solutions to these problems, it can complement conventional methods and accelerate the spread of education and improve its quality, particularly in remote rural areas.

248. Radio and television have been used as educational tools for many years. Radio has the advantages of wide reach and low cost and can be used even in unelectrified locations; despite this, and notwithstanding the fairly extensive radio coverage even in developing countries, radio has not yet been fully exploited for educational purposes. However, it does have the constraint of being only an aural medium. Television, on the other hand, can be an extremely powerful instrument for spreading education. Until recently, its use was constrained by the fact that reception of the broadcasts was possible only within about 100 kilometres of a transmitter. Thus, to broadcast television programmes to a given area, one had to set up a television station nearby, or set up a television transmitter and link it to a television studio or station. Now, however, space technology has made possible the reception of television programmes, even in very remote areas, without the need for a television station nearby or ground links. The technology of DBS has been demonstrated by Canada, Japan and the United States, and a large-scale educational television experiment using the ATS-6 satellite of the United States was carried out in India in 1975/76. Some other countries also have carried out experiments involving the reception of satellite-relayed television programmes by specially augmented television receivers. Canada now has an experimental DBS system and many countries or groups of countries are planning operational DBS systems.

249. A DBS system basically uses the principle of "complexity inversion", so that simple and inexpensive receiving equipment on the ground is made possible by a powerful and complex satellite. Obviously, such a satellite is expensive, and, therefore, the economics of a DBS system are dependent to a large degree on the number of receiving stations on the ground. There are, of course a large number of other variables - including, in particular, the frequency band used and the EIRP of a satellite - and the cost of the receiving equipment is largely determined by these. However, it seems clear that a DBS system becomes worthwhile only if it serves a fairly large number of receivers. Many systems for direct-to-home television broadcasting are being proposed and planned. Selection of an appropriate

reception mode, individual and/or community, will be determined by the specific characteristics of each country. For the developing countries, emphasis may be put more on the community mode of reception. At the same time, it would seem economically attractive and beneficial for small countries to share a satellite, especially on a regional basis. Another possibility is a satellite space segment, owned internationally or regionally, that provides direct broadcast service to countries. In both cases, there could be transponders dedicated to each particular country, or countries could share a transponder, depending upon their usage. Differing time-zones could also enable a sharing of transponders, if the use was limited to a few hours only and the countries were widely separated along the east-west direction. Such a sharing of a satellite - which could be as large as necessary, within technological limits - would also contribute to reducing the pressure on GSO. It is therefore suggested that:

(a) Countries might examine the feasibility of using DBS to aid the spread of education, including, as appropriate, the use of satellites having a lower EIRP than those normally associated with DBS;

(b) Countries could explore the possibility of sharing the space segment of a DBS system, including the possibility of using any existing/planned satellites that might be suitable;

(c) Interested countries should examine the feasibility of satellite space segment, owned internationally or regionally, for providing direct broadcast television service;

(d) The United Nations and concerned specialized agencies should encourage and provide assistance - as appropriate and if requested - for the above; and

(e) Existing organizations such as INTELSAT may choose to consider developing broadcasting satellite systems which could be used for educational purposes.

However, in any planning and provisioning of DBS, it is essential to bear in mind the need for strict compliance with the applicable plans and other regulatory provisions agreed upon within ITU.

250. It should be noted that some countries which are now planning direct broadcast satellites intend to combine this service with other telecommunications, with possible economic advantages. Other countries - or an international satellite system - could examine the cost-effectiveness of such multimission satellites.

251. Community reception will probably be - as noted earlier - the primary mode of receiving satellite television broadcasts in developing countries. Tens of thousands of receivers will be needed in each country and it is essential to reduce the cost of each installation as much as possible. Also, given the lack of rural electrification in most developing countries, it is necessary to think of power sources that are inexpensive, and preferably use renewable forms of energy rather than hydrocarbons. It is therefore desirable that strong encouragement - including financial and technical assistance, if necessary - be given to efforts aimed at developing low-cost community receivers for DBS and low-cost, preferably renewable, power sources to operate the system in unelectrified locations.

252. Since the cost of the reception system for a given coverage area is influenced by the frequency and EIRP of the satellite, it is suggested that efforts at

developing more powerful broadcasting satellites should be continued in conformity with the applicable international agreements and regulations and taking into account pertinent operational arrangements.

253. The allocation of frequency bands for the different telecommunication services involves consideration of a large number of complex issues. The current international radio regulatory framework is the outcome of international agreements reached at a series of world and regional radio conferences. In this context, there are several points to be noted. Flux density limits exist for all space telecommunication services including BSS to protect extensive terrestrial operations and the investments involved therein. Similarly, there are technical constraints also on terrestrial telecommunication services with a view to protecting space telecommunication services against interference. In agreeing on the flux density limits for the various services including BSS a variety of technical parameters have been taken into account with a view to ensuring satisfactory co-existence of all services, both space and terrestrial. In view of the foregoing no significant relaxation of flux density constraints particularly in the lower frequency bands allocated to BSS seems feasible in the foreseeable future. These constraints, however, have not in practice inhibited the development of BSS.

254. While considerations with regard to the hardware elements of a DBS are of obvious importance, the other "software" elements unfortunately tend to be neglected. Experience has, however, indicated that these aspects are crucial to the success of a DBS system for education. The main ones include:

(a) Educational system planning and integration;

(b) Organizational aspects including educational system management and co-ordination;

(c) Design and production of appropriate television programmes, relevant to the needs of the audience and in keeping with national priorities;

(d) Feedback and evaluation mechanisms, especially with regard to audience reactions and impact;

(e) Organization of viewing arrangements and of post-programme follow-up ("utilization"), including ensuring of actual availability of recommended items, training of teachers for optimal use of the system, etc.;

(f) An efficient field maintenance system.

255. The importance of these aspects cannot be over-emphasized, especially because they have all to be taken care of indigenously: unlike the satellite or even receiving equipment, they cannot be imported nor do they exist in ready-made form. Even when similar elements do exist elsewhere (e.g., educational television programmes), they should be used - if at all - only with great caution, since their relevance, their ability to create audience-identification and their cultural effects may pose problems. Countries which plan to set up a DBS system would therefore be well-advised to devote effort and attention to these "software" aspects.

256. The community receivers that form part of a DBS system need not be used merely for one purpose - e.g., educating school children - but could fulfil many needs in diverse fields. A case in point is the SITE in India, during which the system was used for school education in the morning and for health, family planning, nutrition, agriculture, etc. in the evening. During school vacations, teacher-training and special programmes for agricultural extension workers were broadcast. Canada too has made use of a DBS for tele-health and tele-education. Thus, one could use the same system for specialized education (for teachers or agriculture/health extension workers), school education and general education of the total audience (e.g., in fields like health or nutrition). Such multipurpose use obviously increases the benefits; however, it does call for closer and greater co-ordination between various agencies - e.g., the Ministries of Health, Education and Agriculture.

257. While television is a powerful tool, it does provide only one-way communication. To overcome this limitation, experiments have been carried out using a return audio channel from the audience to the source - either via land-lines or by again using a satellite. In some experiments, a return video link has also been tried out. However, the additional cost of return audio links is high - because, in most developing countries, land-lines do not exist in remote areas - while return video links are prohibitively expensive. It does not, therefore, seem worthwhile now to provide such return links, except for very special purposes when the very substantial additional cost is justified by the resulting benefits or by the particular situation. In any case, the fact that such return links can only be originated from a few places at a time acts as another constraint. Thus, while immediate "on-line" feedback is a desirable part of the educational process, in a DBS system this is not easy, and the teacher or animator must provide the interventions and clarifications that are required.

258. The telecommunications sytems in almost all countries have seen tremendous expansion in the last few years. The introduction of satellites in the communication system will lead to an even more dramatic growth. Of late, more and more countries are considering how this large system can be used for educational purposes. While the availability of telecommunications in rural areas is as yet very meagre, it is now possible to think of extending coverage even to remote areas by the combination of a satellite and UHF/VHF transceivers. Through the use of appropriate terminal equipment, it is possible to receive and transmit voice, data, facsimile and slow-scan pictures. The educational possibilities that such a system (interactive communication system) - with two-way communication capabilities - could open up are substantial. It is therefore suggested that the United Nations, in co-operation with the appropriate specialized agencies (including, especially, UNESCO which has done much work in this field), initiate a study on the educational opportunities that emerge from satellite and related telecommunications technologies and firmly support the implementation of studies which have already been carried out and programmes which relate to the use of satellite systems for technical training and education and are of regional, sub-regional and national, especially those involving developing countries.

259. Advances in technology have given rise to a number of new products and equipment in communications. In order to meet the particular needs of a country, it is necessary to put together these various elements in a system appropriate to those needs. This system engineering, the configuration of the various elements into an integrated whole, determines to a large degree the success and benefits

that will result. It is essential that this be done by persons completely familiar with the needs, capabilities and resources of the country for which it is meant; however, in the absence of indigenous expertise, the United Nations system should, upon request, provide or arrange to provide assistance to countries to develop appropriate system configurations for using space technology for education.

F. Compatibility and complementarity of satellite systems

260. Compatibility between different satellite systems enables users of one system to use other sytems at relatively little additional cost; to the extent that this provides additional useful data or redundancy, it increases the benefits for the user. Since a vast majority of countries use space technology to some degree, the benefits of compatibility could be truly global.

1. Meteorology

261. A striking example of the advantages of compatibility is provided by the world-wide meteorological satellite system. All the satellites have been designed and built primarily to meet the needs of specific countries or regions; accordingly, the characteristics and sensor package vary from system to system - sometimes even from satellite to satellite within a single system. However, in the vital area of data dissemination - where compatibility is both more feasible and desirable - the transmission frequencies have been standardized, so that the ground equipment of users can receive data from different systems. Member States, working through WMO and ITU, have brought about this very happy and mutually beneficial situation by continuing the traditionally close co-operation existing between States in the field of meteorology. As a result, WWW is now supported by the orbiting and geostationary meteorological satellites of various countries and of ESA.

262. Completely compatible data dissemination has made it possible for countries to receive APT imagery from the polar orbiting United States TIROS-N/NOAA and USSR METEOR satellites. The same format is also used for relaying processed imagery from geostationary satellites, as part of the Weather Facsimile Service. While technological advances and innovations are obviously to be encouraged, the need and importance of continuing compatibility must not be lost sight of to prevent any disruption in the continuity of data reception.

263. Complementarity of systems for meteorology involves complementarity of: (a) spatial coverage, (b) volume and content of data and (c) temporal coverage. As far as observations from GSO are concerned, there will soon be complete world-wide spatial and temporal coverage up to about 60 to 70 degrees latitude. In the case of polar-orbiting satellites - which typically provide global coverage once a day - the frequency of coverage can be increased by the use of complementary orbits. Complementarity of data depends on sensor design and close co-operation among system designers and also among designers and meteorologists should be encouraged.

264. WMO has played a very positive role in encouraging and bringing about close co-operation in the field of satellite meteorology. Specifically, WWW has proved to be an effective mechanism for promoting compatibility and complementarity among different meteorological satellites. The co-ordination on geostationary meteorological satellites is an example of successful and voluntary co-operation

among current operators of meteorological satellites, and operators should be encouraged in these efforts. WMO should continue to actively promote international co-operation in this field, encourage compatibility and complementarity among different systems and take all necessary steps to ensure continuity in data availability to all countries. This aspect should be considered in the study proposed in paragraph 224 and in the procedures outlined for access to non-real time information.

2. Remote sensing

265. Unlike meteorology, remote sensing is not yet at the operational stage. Though much work has been done, the systems are yet at what may be called a "pre-operational" stage. However, it is only a matter of time - and a short time - before this very important application attains a completely operational status in some countries at least. It is therefore opportune now to look at ways in which compatibility and complementarity could increase or spread wider the benefits from this important space application.

266. Compatibility between different systems would enable use of the same equipment for reception of data from more than one system and thus minimize both capital and operating costs. Further, compatibility of formats could permit the use of the same equipment for processing data received from different systems, and also possibly, use of the same software for analysis. Thus, compatibility would greatly benefit users of remote sensing data.

267. Discussions among several countries planning remote sensing satellite systems are taking place to consider measures for ensuring compatibility of future systems. Some co-ordination is already taking place among some of the satellite operators in this field. For instance, the United States and France have ensured compatibility of satellite-to-ground transmissions (using the 8 GHz band) of image data from the LANDSAT-D and SPOT satellites. This will enable reception of data from both systems with the use of a single station. ITU is also playing a role by allocating a band (8 GHz band) for transmissions by remote sensing satellites, so that the same antenna, feed and RF receiver could be used on the ground for reception of data from more than one remote sensing satellite.

268. However, aspects other than transmission frequency are also important, in terms of compatibility. These include format, annotation and data product standardization. To discuss these and issues like co-ordination of data acquisition, processing and distribution, the United States initiated some years ago meetings of a LANDSAT Ground Station Operators Working Group. Similar groups are likely to be set up by other remote sensing system operators: France, for example, has already announced that it will form a similar group of operators of SPOT ground stations. These are positive developments and co-ordination between these different groups should also be encouraged.

269. Data products are produced in various formats and classes, including quick-look photographic images; standard photographic images; standard CCTs; precision and geometrically corrected CCTs and HDDTs. Standards with regard to these could be useful but may require changes in equipment. Also, user needs vary so much that this may not be desirable. However, standard annotation on photographic images, and on standard family of formats for CCTs (as suggested by

the LANDSAT ground station operators) could be useful. The latter is adaptable to non-image data as well and can be used for interchange of data. With regard to precision-corrected CCTs, there is need for some standardization about pixel (picture element) sizes, data orientation and map projections, even though needs of users do vary a great deal. The present differences cause difficulties to users obtaining data from different ground facilities.

270. To overcome some of these problems, and particularly to facilitate the utilization of data from multiple complementary missions, efforts should be devoted to the development of CCT and film products which are platform and sensor independent in appropriate cartographic projections. These products, with subpixel geometric accuracy in multitemporal registration and in absolute geodetic control, might be offered in subscene format to meet a range of user coverage needs and in projections compatible with various geographical data bases. Ground station operators should be encouraged to undertake this effort.

271. Remote sensing missions depend upon a variety of factors, including user need, sensor technology, launch capability, ground system technology, etc. The combination of all these factors severely limits flexibility for achieving co-ordination and complementarity. While co-ordination of systems is a desirable goal, its practical feasibility is limited.

272. Given the investments already made on the ground by many countries - in the form of ground stations, processing equipment, data archival, software, etc. - the important element is continuity of data availability in a form compatible with present systems. System operators might keep this consideration in mind in the planning of future systems.

3. Communication

273. The need for compatibility in the field of satellite communication was obviously essential for international communication. Further co-ordination among different systems is necessary in order to avoid harmful interference. These needs have been well recognized by the international community and, through ITU, there exists an established system of co-ordination in this field. The problems with regard to GSO and the RF spectrum are being discussed in the ITU forums, and are dealt with separately in section G below.

4. Navigation and other services

274. The need to ensure compatibility and to co-ordinate certain other services like search-and-rescue, distress signalling, etc. are obvious and the situation regarding co-operation in these fields is encouraging. However, with regard to navigation applications, the picture is not so positive. This is an area of growing importance, and it is recommended that a study be made of the feasibility of establishing an international system with the active participation of all States.

5. Over-all considerations

275. While compatibility and complementarity between different systems would generally be beneficial, and therefore desirable, certain considerations need to be borne in mind. Briefly, these may be summarized as follows:

(a) It should not inhibit new ideas, innovations or advances in technology;

(b) It must not act as a hindrance to technological self-reliance;

(c) Systems must be need-based and user-oriented; desirable as it is to facilitate further system development by avoiding undue constraints, systems must nevertheless evolve within the framework of the international regulations in force;

(d) It should not result in higher costs or excessive dependence on one State by many others;

(e) For non-global systems, independence of individual systems may sometimes be advantageous.

Due consideration should be given to the requirements (a) to (e) above in the establishment of international regulations.

276. Though some of the above may seem to restrain compatibility and complementarity, these considerations need to be borne in mind in evolving a pragmatic approach towards co-operation in space, and one in which all countries have genuine opportunities to reap benefits.

G. The geostationary satellite orbit

277. GSO is a unique natural resource of vital importance to a variety of space applications, including communications, meteorology, broadcasting, data relay from and tracking of orbital satellites, etc. It could also be used for such possible future applications as solar power satellites. Though not depletable, GSO is a limited natural resource. Therefore, as with any limited resource, its optimal utilization requires co-ordination, planning and/or arrangements.

278. Utilization of GSO cannot be considered in isolation: the associated issues of use of the RF spectrum and the probability of physical collision must be simultaneously looked at. The RF spectrum is also - like GSO - a limited (in practice) though non-depleting resource. While in theory it does extend indefinitely, practical constraints limit its present use to a comparatively small band. Hence, its optimal use also requires planning and/or arrangements.

279. It is in the light of this that the members of ITU have been making concerted efforts to evolve systems for planning and regulating the use of the GSO and the RF spectrum since 1963. It is noted that the forthcoming ITU Conferences in 1985 and 1987, which will continue this process in the light of technical progress and in the light of the broad considerations outlined here, will decide, in accordance with resolutions 2 and 3 of WARC 1979, which space services and frequency bands should be planned and evolve actual plans as determined to be necessary.

280. Recent years have seen the explosive growth in the use of GSO, especially for communication satellites. To the extent that this signifies increasing use of space technology for beneficial purposes, it is to be welcomed. However, while GSO is occupied largely by developed countries' satellites and international systems (see sect. III A), there are countries which have not yet placed satellites in GSO; and increasing concerns have been expressed that these positions may not be

available when they desire to use them, and that assignments in certain frequency bands (e.g., 4 or 6 GHz) may become more difficult to obtain in future due to congestion. While there now seems to be general awareness of this concern, and certain regulations have been adopted, the present system of registration and co-ordination may need to be improved to guarantee, in practice, for all countries, equitable access to the geostationary satellite orbit and the frequency bands allocated to space services. In this regard, it may be noted that WARC 1979 resolution 2 states that "the registration with the IFRB of frequency assignments for space radio-communication services and their use should not provide any permanent priority for any individual country or groups of countries and should not create an obstacle to the establishment of space systems by other countries".

281. Despite lack of agreement on defining the precise boundary between air space and outer space, it is accepted by most nations that GSO is a part of outer space and, as such, it is available for use by all States, in accordance with the Outer Space Treaty of 1967. However, the equatorial countries consider that GSO constitutes a physical phenomenon related to the reality of our planet in that its existence depends exclusively on its relation to gravitational phenomena generated by the earth, and that for this reason it should not be included in the concept of outer space and its utilization should be regulated under a sui generis régime. The International Telecommunication Convention states that GSO and RF spectrum must be used efficiently and economically so that countries or groups of countries may have equitable access to both in conformity with the provisions of the Radio Regulations according to their needs and the technical facilities at their disposal. Given the limited nature of the resource, efficiency of use is certainly important and any plan and/or other arrangement that is formulated must encourage greater efficiency. However, efficiency of GSO and RF spectrum usage should not be a barrier to attempts at technological self-reliance, consistent with the provisions of international regulations. A leading role in the promotion of more efficient use will no doubt be taken by countries with advanced space technology; and the positive efforts of the developed countries to increase efficiency should be supported and continued. It is desirable for all users of the geostationary orbit to keep in view the advantages of adopting, wherever practicable, newer technologies which could in practice facilitate more effective use of the geostationary orbit. The improvements in the utilization of GSO that would arise from the use of new technologies should permit all countries to have access to space technology at a level of sophistication appropriate to their needs, requirements and capabilities. It should be noted that there is already a positive trend toward the utilization of new technology, and this should be continued.

282. Efficiency of use cannot be an end in itself: it is only a means of ensuring all countries equitable access to this scarce resource. In particular, there are many developing countries which do not now have either the resources or the need to use GSO but are likely to do so in the future. Any planning method and/or arrangement that is evolved should recognize and accommodate the future needs of developing countries and should not result in unnecessarily hastening their plans to the detriment of their financial and self-reliance interests.

283. GSO is getting increasingly crowded with objects that have outlived their utility. While the danger of collision or physical damage by these objects to active satellites is yet small, this is a problem that is likely to become more serious in future. Therefore, ITU should examine the feasibility of incorporating in its future regulations a stipulation that a satellite owner is responsible for removing its satellites from GSO when they are no longer usable to be able to have spare satellites in the orbit.

284. In noting the phenomenal growth in the use of GSO - especially for communication satellites - and the consequent usage of RF spectrum, it may become necessary for each country or international organization to examine whether all the satellites it is operating are really required. Increasing numbers of satellites are being used for various purposes by different countries. To the extent that these systems use national resources, it is the concern of the country involved. However, these systems use increasing amounts of a limited resource that is for use by all States. It is therefore desirable that Member States, within the ITU, continue to evolve some criteria for the most equitable and efficient usage of GSO and the RF spectrum and to develop planning methods and/or arrangements that are based on the genuine needs, both present and future, identified by each country. Clearly, such a planning method should take into account the specific needs of the developing countries, as well as the special geographical situation of particular countries.

285. For certain purposes and locations, it may not be essential to use GSO. Since increasing concerns have been expressed regarding the congestion of GSO, countries should also examine whether for their needs they could use a satellite in elliptical orbit rather than in GSO. Similarly, the feasibility and over-all advantages of using elliptical orbits for international communication merit re-examination.

286. Lower launch costs and advances in other areas of space technology have now made it possible to conceive of a very large variety of possible systems including large space platforms in GSO. A single such platform could be designed to meet simultaneously the needs of a number of countries. However, it is not yet clear that such a concept will offer the flexibility required by the varying and special needs of these countries, lead to lower cost for each of them and help improve use of GSO and the RF spectrum. In order to demonstrate the possibility of this concept, it would be useful for those countries that are interested to evolve a broad design for such large platforms. In this context, it should be mentioned that improvements in the use of GSO could also be achieved by using both ground and satellite-based narrow-beam antennas. The planning method and/or arrangements developed by ITU should be flexible enough to permit the introduction of new types of systems taking into account the needs and requirements of all countries.

287. It needs to be noted that the development efforts undertaken by the technologically advanced nations have resulted in new techniques that contribute to more efficient use of GSO and of the RF spectrum. These efforts must be encouraged and continued, for success in this could effectively increase the capacity of GSO and thereby alleviate possible pressures on its use. New developments in the field of fibre-optic technology are also likely to contribute positively, by directing high-capacity traffic on transcontinental and transoceanic routes to fibre-optic systems.

288. In conclusion, considering the long-term implications of the growing activities in GSO, any solution on the use of GSO should be both equitable and flexible and take into consideration the economic, technical and legal aspects.

H. The nature and protection of the near-earth environment

289. The rapid advances in space technology have led to a considerable increase in the extent and type of applications, as well as to greater use of space for

scientific research in a variety of fields. The resulting increase in the number of both space objects and launches is, however, not an unmixed blessing. One facet of this problem is the vast number of space objects - estimated to be in the thousands - now orbiting the earth. A majority of these are now "space debris": dead satellites, spent rocket motors, nuts and bolts, etc. While the probability of accidental collision with a "live" space object is yet statistically small, it does exist and the continuation of present practices ensures that this probability will increase to unacceptable levels. To minimize such an eventuality, the international community should, on the basis of more detailed studies, agree to appropriate measures, such as designating certain orbits as "disposal orbits", removing from orbit all inactive satellites, minimizing space debris or even organizing scavenging missions.

290. A more serious facet of the problem concerning the near-earth environment is the possible danger associated with environmental modifications caused by space activity. Pollution and reactions resulting from rocket launches are a cause for increasing concern: even though the number of launches per year has remained more or less the same from 1965, bigger and bigger rockets are being used. Also, many of the effects could be cumulative. Although no major and continuing ill effects have yet been detected, substantial and sometimes serious regional disturbances - affecting radio propagation, for example - have been documented, especially when large thrusters were ignited at higher altitudes. Effects on radio communication have also been observed due to re-entry of large objects. Such problems could assume serious proportions if very large launch vehicles - of the type proposed for the construction of an SPS, for example - were to be used on a frequent basis.

291. The disturbances in the ionosphere due to the release of gases by rockets is a problem that is under study, but which is not completely understood yet. The depletion of the ozone layer due to space activities, though not serious yet, could also become a problem with many implications.

292. Certain scientific experiments involve the release of chemically reactive substances - for example, metal vapours - into space. These are undoubtedly important tools for research, but such activities could also result in unintentional changes causing a deterioration in the natural environment. They could affect the electron density, cause plasma depletion and create a "hole" in the ionosphere. Some experiments to intentionally create such holes are planned, and will probably produce scientific insights that cannot be obtained from laboratory experiments. However, the excessive release of materials in space can be risky, and caution is called for, in particular at high altitudes even though environmental impact studies have, to date, indicated no serious long-term consequences.

293. Use of ion engines for propulsion seems to be a promising development, and some scenarios of large-scale construction in space call for the use of powerful ion engines for transfers from low altitude to GSO. However, the deposition of argon in the magnetosphere due to powerful ion engines could produce strong and long-lasting distortions in the outer environment of the earth. While a number of environmental impact studies have been performed to assess this problem, the time delay for natural recovery is yet an open issue, as are other uncertainties.

294. While the benefits of large numbers of launches and of various scientific experiments may not be available to all countries equally, many of the potential risks of these activities can be truly global. For the guidance of all States, the United Nations - in particular, UNEP - should encourage the continuation and expansion of ongoing studies by groups of independent experts to:

(a) Study the deleterious effects of intentionally releasing gaseous or other material in space for scientific studies and recommend limits on such releases;

(b) Collate existing findings and - if necessary - undertake further studies to determine the effect of rocket launches, particularly of frequent and large-rocket launches, with the aim of recommending desirable limits on size, frequency or fuels from the point of view of minimizing ill effects on the global environment;

(c) Evaluate the effects of using ion engines for propulsion and suggest means of minimizing the distortions caused in the outer environment of the earth due to their use.

295. Electromagnetic waves in space are also an issue that could cause concern. Some controlled experiments in producing electromagnetic waves in space have been carried out and no serious consequences have been detected. There is also the large radiation of energy into space from radio transmitters used on earth for a variety of uses, including powerful radars, and from power distribution lines. While the effects of these have been detected, their magnitude is yet debated and it seems likely that larger effects may be produced in future. In particular, radio transmitters on board satellites - essentially in HF and VHF bands - can generate electric and magnetic fields at large distances from the satellite, and their sidelobes can cause disturbances to other satellites. ITU is considering this problem with regard to the present range of applications. However, if and when SPSs are in service, this problem will become rather serious, due to the enormous energy flux involved.

296. For certain space applications, the use of nuclear power sources (NPS) presents advantages. However, the use of NPS may entail risks that concern all States. The issue of the use of NPS is at present under discussion in the two sub-committees of COPUOS in the context of examining the use of nuclear power sources in outer space and the possibility of supplementing the norms of international law relative to the use of such power sources in outer space.

297. The biologial risks to mankind from space activities have been examined. These include the risks of:

(a) Terrestrial micro-organisms contaminating other planets;

(b) Extra-terrestrial micro-organisms contaminating the earth;

(c) Space environment causing dangerous mutations of terrestrial micro-organisms.

Continuing studies should keep these risks in mind.

298. Astronomy - especially infra-red and radio astronomy - is in danger of being affected by space activities. SPS and exhaust gases from rockets could be a hindrance to infra-red astronomy, while the increasing electromagnetic radiations from satellites can cause interference with radio astronomy. CCIR of ITU is looking into the latter question and working towards ensuring co-operation between radio astronomers and satellite designers. Large numbers of small satellites, or large space structures like SPS, could also cause interference to radio astronomy due to spurious emissions and also as passive reflectors. However, it should be

noted that space activities have contributed very positively and substantially to the growth of astronomy, not just indirectly through better instruments etc., but very directly by providing platforms in space for telescopes, away from the "noise" of Earth. The Einstein Observatory and the planned Space Telescope are examples of this very substantial contribution.

299. Apart from radio emissions, certain other terrestrial activities are likely to cause irreparable damage to the earth's environment unless checked in time. A major concern is the use of CFCs for various purposes, possibly resulting in the depletion of the ozone layer. While the effects of this are being studied, existing research already indicates some depletion in the protective ozone layer with possible health and biological hazards to human, plant and aquatic life due to increased ultra-violet radiation. Within the framework of UNEP, the risks of such depletion have led to a decision by UNEP (EC-9) to start work on a global framework convention for the protection of the ozone layer. An ad hoc legal and technical expert group has recently initiated its work on this matter. The function of monitoring ozone depletion is therefore of obvious importance, and space technology - through satellite and rocket-borne sensors - is contributing substantially in this. A well maintained, regularly calibrated ground network is also of great importance and efforts must be undertaken to increase the quality and spatial spread of observations. In this context, the research being undertaken by various countries - with the co-ordination and assistance of WMO and UNEP - should be encouraged. Specifically, an integrated global ozone observing system should be created, under the aegis of WMO and UNEP (as recommended by the UNEP Co-ordinating Committee on the Ozone Layer).

300. While space activities have given rise to some concern about their effects on the environment, they have also contributed very substantially to the monitoring of these - and other - effects. Environmental monitoring satellites will contribute increasingly to providing information about pollution on Earth as well as in its immediate environment. However, action on this information has to be instituted in good time, especially because of the cumulative - and sometimes irreversible - resulting effects. Since such changes affect all mankind, the international community must together take action as required. Such world-wide monitoring of the earth's environment and necessary remedial action should be co-ordinated by UNEP which is already undertaking, within the framework of its Global Environment Monitoring System (GEMS), various activities in this field. All countries should promptly provide all relevant data required for such monitoring purposes to UNEP.

I. Implications of projected developments in space technology

301. The next quarter century is likely to see a growth in space technology and applications surpassing even the phenomenal progress of the last 25 years. These advances bear the promise of great benefits for mankind; unfortunately, however, some of the potential developments could also pose serious hazards. Also depending upon how many of the applications are organized, they could lead to a skewed distribution of benefits between countries - accentuating, thereby, the existing inequities in the world economic scene. However, appropriate and co-operative actions by States - individually and acting in concert - could lead to a happier situation of more widely shared benefits. Even if this is not completely possible, an understanding of the technical, economic, social, environmental and legal implications of likely future developments could help in achieving this desired goal.

1. Space solar power systems

302. Among the major new applications of space technology, probably none has drawn as much attention as proposals for a space solar power system (SPS). This visionary concept, first put forth in the United States, may be particularly relevant in the context of growing world-wide energy needs and dwindling conventional resources (oil, coal, wood). Though its actual realization would involve efforts and finances far surpassing any that man has yet undertaken, this is not an impossible task, nor do there seem to be any technological obstacles that could not be surmounted in the next two decades or so, if the effort is undertaken. However, there are some doubts about the economics of such a venture, and it is unlikely to be worth while unless there are some major technological breakthroughs.

303. Even though SPS is unlikely to be a reality before the end of this century, it is well to keep in mind the implications that it could have. The effects on the environment due to frequent launches of the very large rockets required for the construction of such a system could be a cause for concern (see sect. H above). Should microwaves be considered for power transmission, their biological and ecological effects may also be a cause for concern because of the lack of precise knowledge about the effects - especially the long-term effects - on living organisms and in particular on man; and their potential effects on the ionosphere also warrant further studies. Interference with radar and communications systems could, however, be a problem if microwave transmission is used, due to the very large power of the SPS transmitter, which would produce RF noise almost all over the spectrum. A concerted research and technology development effort would be required to resolve some of these problems.

304. As mentioned earlier, the economics and advantages of SPS relative to other methods of energy production is by no means yet established. However, if - and when - technological breakthroughs should change this situation, and provided that the previously mentioned implications are solved to the satisfaction of all countries that may be affected, SPS would be an ideal project for co-operative international effort: its magnitude, technological challenges, financial and material requirements, its potential benefits, and its vulnerability would make international efforts not only worth while, but probably also necessary. The feasibility of undertaking a joint international effort should therefore be examined and - as a corollary - the means of sharing internationally the benefits that result. While the SPS may yet be in the distant future, it is advisable to initiate such efforts now, so as to try and evolve a harmonious mechanism for international participation and co-operation.

2. Space manufacturing

305. The technologies applicable to space manufacturing are discussed at length in paragraphs 48 to 54 and paragraph 61 in chapter I.

306. With regard to the use of extra-terrestrial material for space processing, or for use on Earth, note should be taken of the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (this Agreement is not yet in force).

307. The special environment of space is also being used to carry out scientific studies with regard to metallurgy, fluid dynamics, chemical reactions, etc., and also for various biological experiments. Co-operation and exchange and dissemination of scientific results in these fields should be encouraged.

3. Communications and remote sensing

308. Future developments in certain existing applications - particularly communications, broadcasting and remote sensing - hold out great promise but also have the potential to cause serious problems. In broadcasting, for example, the development of very powerful satellites will soon make it possible to broadcast radio or television programmes directly to home receivers. This could be a tremendous means of spreading education and disseminating information, especially in developing countries which now have very poor means of communication. Nevertheless, broadcasting via satellites could also have negative effects in certain fields and could affect the sovereign rights of States.

309. COPUOS has examined these issues at length and in great depth. It is now time for countries to agree on the legal implications of remote sensing of the earth from space and on principles governing the use of artificial earth satellites for international direct television broadcasting.

4. Search for extra-terrestrial intelligence

310. SETI is a technical undertaking with profound philosophical implications. Since this is so basic an issue we should use part of our resources for this quest, which is of relevance to all mankind. It should therefore be considered a joint international effort, with each country contributing whatever it can.

5. Space settlements

311. For the more distant future, certain scientists have proposed the setting up of settlements in space - either in orbiting space stations or on celestial bodies. These concepts have given rise to many technical studies and, in fact, there now exist fairly detailed conceptual visions for such settlements. Some research and studies have, for example, been carried out on self-sustaining systems and concepts based on recycling. While there is little likelihood - and less immediate need - of such space settlements in the next few decades, this may yet be an idea meriting continuing study, especially if materials processing in space or SPS become realities.

6. Conclusion

312. The rapid advances in space technology continue to give rise to romantic visions of new worlds, new frontiers and new possibilities. While these are generally beneficial, many of them have side-effects which are of concern to all nations. Also, some of the new developments could have negative social and economic implications, especially for developing and non-space nations. Thus, while advances in space technology are to be generally welcomed, their implications

need careful consideration and dissemination so as to catalyze appropriate international action. Since many developing nations do not always have the technical expertise to assess these implications for themselves, the United Nations - in association with concerned specialized agencies - should organize periodically such studies to examine all the global implications - technical, social, economic, environmental and legal - of new space developments, especially for developing countries. However, studies on matters within the competence of a specialized agency should be carried out by that agency.

CHAPTER III

INTERNATIONAL CO-OPERATION AND THE ROLE OF THE UNITED NATIONS

A. Multilateral co-operation

313. Co-operation between nations on matters concerning space has a long and rather fruitful record, though recent trends leading to the extension of the arms race into outer space are a cause of great concern to the international community. It is hoped that space does not become a new arena for rivalry between nations - not only for the sake of continuing peace, but also as a stimulus to development. There are few fields of human endeavour where the need for co-operation is more essential and the pay-off greater. In fact, it is the recognition of this necessity and benefit that has led to such very successful examples of co-operation as the operational international communication and meteorological data systems. Space activities have shown a way of how different countries, with widely varying political systems, levels of development, and culture can work together for mutual benefit.

1. International Telecomunications Satellite Organization

314. An example of multilateral intergovernmental co-operation is the INTELSAT system. Established in 1964 - within a few years of the dawn of the space age and very soon after the feasibility of geostationary communication satellites was first demonstrated - this organization has seen phenomenal growth. Begun by 11 nations, it now has 106 countries as members and serves over 130 countries and territories. INTELSAT operates on a commercial basis. In all its organs, each member State has one vote, except in its Board of Governors, in which votes are in proportion to the investment of each State; this, in turn, is based on the capacity-utilization of the system by each signatory. While the satellites and associated facilities are owned by INTELSAT, the earth stations and links are owned by individual countries. At present, INTELSAT has 13 satellites in orbit, and over 325 earth stations are using them. Full-time telephone circuits have grown from 75 in 1965 when the system began operation, to over 25,000 in 1981. At the same time, despite continuing world-wide inflation, the space segment charge for full-time voice circuits has been reduced from $US 64,000 per year in 1965 to $US 9,360 in 1981. INTELSAT also leases capacity for domestic use, and some countries are using INTELSAT satellites for intra-country communication; many others are planning to do so. INTELSAT will also lease four (and possibly more) maritime communications satellite subsystems to INMARSAT (see paras. 337 to 343 below).

315. In 1978, the INTELSAT Assistance and Development Programme was established to help achieve more effective utilization of INTELSAT facilities. The assistance is normally provided on a free-of-charge basis, generally on a first-come, first-served basis. Where the assistance requested would require more than two man-months of effort or extensive outside consultant services, the request would be considered on the basis of a cost-reimbursement contract or, alternatively, would be presented to the Board of Governors for approval.

316. Apart from the important role it has played in international communication and the stimulus it is trying to provide to domestic satellite communication through

leased capacity, INTELSAT has been instrumental in the rapid advancement of space technology, both through its own work and by placement of development contracts. In placing contracts, it has also attempted to involve industries from several countries - though success in this has necessarily been limited because of the technological and infrastructural constraints in most countries.

317. INTELSAT has established formal links with several international organizations and is in the process of forging additional formal links with others. It also submits annual reports to the United Nations and to the concerned specialized agencies.

318. It is interesting to note that a majority of the INTELSAT members and users are the developing nations, and to this extent INTELSAT has helped to spread the benefit of space technology to developing nations. It is also likely that no single nation would have felt the need for such a world-wide system - it would, in any case be very expensive. What has made it necessary and worthwhile is the participation of a large number of nations.

319. Similarly, there are other applications of space technology that may not be so attractive for individual countries, but would be very beneficial if nations got together and co-operated. In this regard, the organizational structure of INTELSAT, which provides, in particular, for the participation of both governmental and non-governmental entities, may merit close study as one possible model for other such ventures.

2. Programme on International Co-operation in the Study and Peaceful Utilization of Outer Space (INTERCOSMOS programme)

320. A programme of co-operation amongst socialist countries in the peaceful exploration and use of outer space was proposed by the USSR in 1965. Following an understanding on this proposal, a programme of multilateral co-operation was adopted in 1967 and, in 1970, given the name INTERCOSMOS. In 1976, as a consolidation of their favourable experience, the nine countries then participating in the programme signed an intergovernmental "Agreement on Co-operation in the Peaceful Exploration and Use of Outer Space". The Agreement is open to accession by other countries interested in co-operating in the investigation of space, subject to the consent of the contracting parties. In 1979, a tenth country acceded to the Agreement.

321. The INTERCOSMOS programme embraces joint activities in the following basic areas:

(a) Study of physical properties of outer space;

(b) Space meteorology;

(c) Space biology and medicine;

(d) Space communication;

(e) Study of the natural environment by remote sensing.

322. Co-operation in the INTERCOSMOS programme is conducted in the form of joint development of scientific instruments and service systems and in their integration

into satellites, other space vehicles and research and meteorological rockets, and also in the form of joint research, experiment-design, development of methodology, and joint analysis of data. One of the features of INTERCOSMOS co-operation is the absence of a common budget which would restrict the scope of joint work in space research. Every country finances the development of scientific instruments and the implementation of experiments in which it is interested. The Soviet Union provides to its partners in co-operation the facilities of space rocket technology and ensures the launching of space vehicles. Scientific results of joint experiments form a common asset of all parties to the work done and are accessible to the international scientific community.

323. From October 1969 to December 1981, 22 INTERCOSMOS satellites, 10 high-altitude research rockets and a large number of meteorological rockets have been launched for various studies. In addition, instruments developed within the framework of the INTERCOSMOS programme have been mounted on a number of space vehicles launched by the USSR as part of its national programme.

324. As an important part of the INTERCOSMOS programme, international crews have worked on-board Soviet spaceships - Soyuz and Salyut-6 - and from March 1978 to May 1981, nine international space crews have been orbited. During these flights, international crews carried out about 150 experiments in the fields of space biology and medicine, materials science, space and atmospheric sciences and remote sensing of the surface of the earth.

325. The INTERCOSMOS programme demonstrates the feasibility of countries at different levels of economic and technological development co-operating in space activities.

3. International System and Organization of Space Communications

326. Work in the field of space communications as part of the INTERCOSMOS programme led to the creation in 1971 of INTERSPUTNIK. It was created to meet the need for exchange of radio and television programmes, telephone and telegraph links and other types of information between different countries. Currently, INTERSPUTNIK has 14 members. Any State that shares the goals and principles of INTERSPUTNIK activities and assumes the obligations under the Agreement may become a member. INTERSPUTNIK works on a commercial basis, and on the principle of one country - one vote.

327. INTERSPUTNIK currently operates using Soviet satellites on a lease basis. All earth stations are nationally owned. Two STATSIONAR satellites in geostationary orbit are being used and 14 ground stations in 13 countries operate as part of the system; more earth stations in other countries are also planned. In addition to members of the organization, other countries also use channels of the INTERSPUTNIK system.

328. The INTERSPUTNIK system is used mainly for exchange of television programmes, in which more than 20 countries participate. About the same number use its channels for international telephone and telegraph links.

329. INTERSPUTNIK has concluded agreements with various international organizations and with INTERCOSMOS participants, identifying specific areas and forms of co-operation. It also co-ordinates its activities with ITU and other international organizations regarding frequency spectrum, standards, etc.

4. European Space Agency

330. ESA was established in 1975, combining the activities previously embodied in two other European organizations, set up for developing scientific satellites (ESRO) and launch vehicles (ELDO). This intergovernmental organization has as its purpose the promotion, for exclusively peaceful purposes, of co-operation among European States in space research, technology and applications. The Agency has 11 member States, two associate member States and a special co-operation agreement with a non-European State.

331. The ESA budget is financed by its member States, with contributions for mandatory activities (including the general budget and the scientific programmes) based on national incomes, whilst contributions to optional programmes are negotiated for each such programme. The bulk of the contributions are paid out by ESA to European aerospace industries, with the industrial work being shared in a manner commensurate with the financial contributions of each member State. This helps to attain one of the goals of ESA: improving the competitiveness of European industry.

332. The ESA programme includes scientific satellites, applications satellites for communication, meteorology and remote sensing, and space transportation systems development - culminating now in the development and successful launchings of Ariane. The programme also includes SPACELAB (to be launched by the United States Space Shuttle), which will enable European astronauts to carry out research in space. Several of the Agency's programmes involve close co-operation with NASA, including especially the SPACELAB and Space Telescope programmes.

333. The scientific programme includes study of the earth's environment and also of celestial objects. The application programme includes both earth observation and communication. The former includes METEOSAT (Europe's contribution to WWW and GARP), SIRIO-2 (for meteorological data distribution and clock-synchronization by means of laser techniques) and remote sensing involving a network of data reception and dissemination stations (EARTHNET), remote sensing payloads on SPACELAB and satellite systems for ocean-observation and land-related applications.

334. The communications programme led to the development of the OTS satellite and its launch in 1978 following the Symphonie satellite (a joint venture by the Federal Republic of Germany and France) and the Italian SIRIO satellites. The next generation will be ECS, five of which will be supplied to EUTELSAT. A derivation of the ECS - called MARECS - provides maritime communication; the first two satellites of this series are being leased to INMARSAT. In the area of broadcasting, the L-SAT programme aims - among other things - at providing a direct-to-home television capability, so that television broadcasts can be received using a 1-metre-diameter antenna and a converter adaptable to conventional television receivers.

335. Development of the Ariane launcher has been a major programme of ESA and its successful flights have now established its capability and operational availability. A programme for further development of Ariane, to double its payload capacity, is already under way.

336. ESA is an example of regional pooling of resources to achieve objectives and develop capabilities that are beyond the reach of individual nations. While the member States are all developed countries with substantial technological and

industrial infrastructures, the basic principle of pooling resources to achieve otherwise unattainable objectives could also be adopted by groups of developing countries. In the framework of interregional co-operation, ESA gives assistance to several regional and national entities outside its member States, in particular by training specialists in various fields of space science and technology relevant to the activities of those entities. In these activities ESA is collaborating closely with the European Communities.

5. International Maritime Satellite Telecommunications Organization

337. In November 1973, the Assembly of IMCO decided to convene an international conference to consider the establishment of an international maritime satellite system. Accordingly, an International Conference on the Establishment of an International Maritime Satellite System was convened in April 1975. After three sessions, the Conference adopted in September 1976 the following two instruments:

(a) Convention on the International Maritime Satellite Organization (INMARSAT);

(b) Operating Agreement on INMARSAT.

338. The main purpose of INMARSAT is to make provision for the space segment necessary for improving maritime communications; it shall act exclusively for peaceful purposes. INMARSAT is open to all States for membership. In addition, ships of non-members may use the space segment on conditions determined by the organization. By January 1982, 37 States had become parties to the Convention, and others are in the process of joining.

339. INMARSAT is financed by the contributions of its signatories, each in proportion to its investment share, which is intended to reflect the actual utilization of the INMARSAT system. It provides services such as transmission of distress messages, distribution of urgency and safety messages, public correspondence by telex and telephony, and data transmission. Later, after appropriate agreements and co-ordination with other international agencies and technical developments, it wll provide other services such as safety advisory messages, navigation and automatic warning of navigational hazards, etc. The International Conference on the Establishment of INMARSAT also recommended a study on the use by INMARSAT of multipurpose satellites providing both maritime and aeronautical services. Studies aimed at integrating land-mobile services are also proceeding in INMARSAT. In adopting the INMARSAT Convention, Governments envisaged that there would be a need for a satellite navigation system and provided accordingly in defining the purposes of the organization.

340. The organizational structure of INMARSAT, which is similar to that of INTELSAT, comprises three organs: the Assembly, in which all member States are represented and have equal votes; the Council, a smaller body of 22 signatories, with the voting power of each being equivalent to their investment share; and the Directorate, which is the executive organ.

341. While INMARSAT provides the space segment - the satellites and related tracking, telemetry, command and control facilities - ship owners are responsible for the shipborne stations. The coast earth stations and landline connexions are the responsibility of the countries concerned. Five coast earth stations were in

operation by July 1982, and another 5 are under construction, to be operating by the end of 1982, and 12 more are planned to be in use by 1984. By July 1982, about 1,350 vessels were equipped with shipborne terminals. This number is growing rapidly, so much so that all initial forecasts are now regarded as having been too conservative. INMARSAT began operation in February 1982, using satellite capability leased from the United States (MARISAT), ESA (MARECS) and INTELSAT.

342. INMARSAT works in close co-operation with a number of international organizations, including the United Nations, ITU, IMO, WMO, INTELSAT and ESA. In particular, it has established and is maintaining co-ordination and consultations with IMO on the development of the Future Global Maritime Distress and Safety System.

343. INMARSAT provides another example of co-operation in space and the benefits that result. It has the unique feature of combining public service (safety and distress messages) with a revenue-earning objective. It also provides a model of an organizational structure and a financial mechanism for such international ventures. (For further details regarding INMARSAT, see A/CONF.101/BP/IGO/2.)

6. Arab Satellite Communications Organization

344. ARABSAT was founded in April 1976 by the countries of the Arab League. It has 21 States as members and its headquarters is located in Riyadh, Saudi Arabia. The main objective of ARABSAT is to establish, operate and maintain a telecommunication system for the Arab region. It will complement the terrestrial network for routing regional telecommunication traffic and provide new possibilities for television programme exchange between Arab countries. The system will be equipped to provide:

(a) Regional and domestic telephony, telegraphy, telex and data transmission;

(b) Regional and domestic television;

(c) Community television.

345. The space segment will include two satellites in geostationary orbit and a third one as a spare. The control centre will be at Riyadh. It is planned to bring the system into use by 1984. (For other details regarding ARABSAT, see A/CONF.101/BP/IGO/4.)

346. ARABSAT is the first such co-operative venture by developing countries and is aimed specifically at providing the operational benefits of space technology to its member States. Not only does this co-operation result in sharing costs - thereby increasing the economic attractiveness of the system for each country - but it will also result in developing closer links and greater understanding amongst its member States. Other developing countries may like to study the system closely from the point of view of determining the feasibility of similar co-operation in their region.

7. African Remote Sensing Council

347. The establishment of ARSC was decided by an intergovernmental meeting (Nairobi, 1976) and approved by the ECA Conference of Ministers (Kinshasa, 1977)

which adopted resolution 313 (XIII) calling for the adhesion of all OAU member States. The Council is a co-operative body established by an international treaty and is entrusted with the harmonization of remote sensing policies within the continent and promotion of such activities in the spirit of technical co-operation among member States.

348. To date, the Council has held four conferences of plenipotentiaries and the membership rose from its initial signatories of 10 in 1979 to 22 in 1982. It is noteworthy that the Secretariat of the Council has now started its activities at its headquarters in Bamako, Mali, and that the Training and User Assistance Centres in remote sensing and their Management Committees are effectively operational. Also gratifying to note is the successful completion of the feasibility studies of two of the planned three ground receiving stations.

8. European Telecommunications Satellite Organization

349. The Interim EUTELSAT is a European organization created in June 1977 by a number of European telecommunications administrations in order to establish and operate space segments of European satellite telecommunication systems. It has at present 20 members. The primary objective is the construction, establishment, operation and maintenance of a European space segment for regional or domestic fixed services such as telephony, telex and data transmission as well as sound radio or television transmissions. The first generation of these satellites will be procured and launched by ESA and placed in orbit as from 1982. A definitive European telecommunications satellite organization based on an intergovernmental treaty will replace the present Interim EUTELSAT organization as soon as the international convention adopted in Paris on 14 May 1982 enters into force.

9. Other multilateral co-operation

350. Besides the organizations described in the preceding paragraphs, a great deal of multilateral co-operation takes place through other bodies or through special arrangements. There exist, for example, regional broadcasting and telecommunications bodies, remote sensing councils, etc. which provide for a for multilateral co-operation. There are also efforts under way to establish regional space agencies, and some regional remote sensing centres already exist. In addition, a great deal of multilateral co-operation takes place around specific programmes. Examples of this include the LANDSAT Ground Stations Operators Working Group and a similar group to be set up for SPOT; discussions on compatibility and complementarity of satellite systems between various satellite operators; co-operation with regard to scientific missions - e.g., the proposed European, Japanese and Soviet missions to Haley's comet - and applications programmes - e.g., the search and rescue system involving Canada, France, the Soviet Union and the United States. Such co-operation has proven to be extremely useful and has led to better scientific understanding of various phenomena at a lower cost. This tradition of co-operation in scientific ventures has, of course, been long-standing and is particularly exemplified by such programmes as the International Geophysical Year, the International Quiet Sun Year, GARP, MONEX, etc. It is desirable - and even necessary - that such extensive and ongoing co-operation now take place in the field of applications also. Not only would this provide benefits to all countries - developing and developed - but would also create greater understanding between nations and a better international climate.

351. Non-governmental bodies such as COSPAR of ICSU and IAF have also played important roles in encouraging and organizing scientific meetings, dissemination of scientific data, etc. (For an elaboration of their role, see A/CONF.101/BP/12.) Both COSPAR and IAF enjoy observer status with COPUOS and have been commissioned from time to time to carry out studies and prepare reports for its consideration. They provide an extremely useful mechanism by which expertise from many countries can be tapped and international teams of experts can be assigned to prepare reports or conduct studies. The special character and effectiveness of these non-governmental scientific organizations depends upon their widespread membership. In view of this and their positive contribution, it is desirable that all countries might support the participation of their scientists and relevant institutions in these organizations.

352. Space is the common environment of all mankind. Our well-being and very survival depends upon the state of the environment. Studying it, understanding it, monitoring and maintaining the delicate balance between its various constituent elements, are all necessary activities that are of global interest. Weather forecasting, monitoring of pollution, ensuring safety at sea, enabling people to see and talk to each other, the fact that combination of two separate scientific observations is greater than the sum of the parts - all these dictate the need for making space an arena of international co-operation.

353. It is urgent to encourage countries to set up appropriate regional mechanisms designed to achieve international co-operation among them for the purpose of joint preparation, implementation and financing of space technology, research and application projects. The United Nations should promote initiatives aimed at establishing regional mechanisms and should encourage its regional economic bodies to carry out studies that will facilitate their establishment

B. Bilateral co-operation

354. Bilateral co-operation between countries in the field of space is widespread and has had very successful results. It constitutes a major segment of international co-operation in the peaceful uses of outer space. A partial list of activities fostered through such co-operation includes:

(a) The provision of a launch for satellites;

(b) The "loan" of an orbiting satellite or of part of its capacity;

(c) The loan of ground equipment;

(d) Providing sounding rockets for scientific experiments;

(e) Providing tracking support for spacecraft;

(f) Permitting the reception of data;

(g) Exchanging or providing scientific and other data;

(h) Providing training facilities;

(i) Providing advice and consultancy;

(j) Joint planning, development and manufacturing of space systems;

(k) Integrating payloads/experiments of one country in the other country's satellites/space vehicles;

(l) Rendezvous of space vehicles;

(m) Complementary space missions;

(n) Joint flights by cosmonauts from two countries on space stations of one of these countries.

355. The above list - merely representative and not exhaustive - is indicative of the very wide range of bilateral co-operation that has and continues to take place in the field of space. Such co-operation extends from basic science to operational applications; it includes co-operation between developed countries, and between developed and developing countries. For example, the United States has entered into more than 1,000 bilateral agreements with over 100 countries, both developing and developed. However, as there has been little or no bilateral co-operation between developing countries, it will be necessary to structure appropriate mechanisms for co-operation between them. There is both need and scope for this and, in view of its importance, this aspect is discussed in greater detail in a separate section (see sect. D below).

356. Bilateral co-operation between nations with advanced capabilities in space technology and some developing nations has had very beneficial results. It has often begun the processes of space technology development and application in some developing countries and has, in many cases, led to demonstration or experimental projects in space applications and science. Such demonstration projects have been of great importance for the adoption of various space applications in developing countries.

357. Some developed countries have also provided training opportunities to scientists, engineers and technicians from developing countries in space science and technology, and also in related fields. This training and work experience has often been instrumental in developing a core of experts who have been the backbone of their country's space programme.

358. Bilateral co-operation between developed countries has also been very productive. It has enabled a pooling of skills and a sharing of costs, to mutual advantage. It has resulted in development of new technologies and systems, and to this extent such co-operation has benefited developing countries also.

359. The extent and examples of bilateral co-operation are so very numerous that they cannot be summarized easily in a report of this type. While some details of such co-operation are outlined in the national papers of various countries, it may suffice to note here that almost every country participating in any form of space activity has been involved in co-operation with others in one way or another. It is important that such co-operation not only continue, but be intensified.

C. An assessment of multilateral and bilateral co-operation

360. An over-all assessment of multilateral and bilateral co-operation in space - described briefly in sections A and B above - indicates a rather positive picture and many concrete achievements. Nevertheless, it seems clear that the full potential of the exciting possibilities opened up by space technology has not yet been tapped. More extensive co-operation, and more co-operative projects aimed at specific problems, are necessary. Greater benefits from space can be derived by intensifying international co-operation, and in this the technologically-advanced nations have a special responsibility.

361. Co-operation in space could cover a wide range of activities including the following, some of which are already being carried out:

(a) Setting up and operating regionally- or internationally-owned systems or promoting continued co-operation among satellite operators in areas such as communications, remote sensing, meteorology, navigation, geodesy, etc.;

(b) Creation of mechanisms for assuring international availability of space-derived data in fields such as meteorology, remote sensing, navigation, geodesy, etc.;

(c) Co-ordination of national, regional and international systems so as to prevent interference, especially in communications and broadcasting;

(d) Co-ordination between programmes and systems so as to maximize benefits by making systems compatible with each other and complementary to the extent possible, especially for meteorology and remote sensing;

(e) Joint planning of scientific missions and general dissemination of scientific data to all countries;

(f) Provision of opportunities and facilities by space-nations to all other nations, so that the benefits of space technology are available to all. This could include the integration of experiments/payloads in spacecraft or rockets, launch of satellites, loan of satellite capabilities for experimentation/demonstration, etc.;

(g) Provision of learning and educational opportunities; joint development and sharing/transfer of technology; exchange of experiences and specific data, etc.;

(h) Assistance in the creation of necessary infrastructure for space as appropriate for each country;

(i) Further development of international space law concerning the use of space technology and its peaceful applications.

362. While some of these activities may seem rather ambitious, international co-operation has already resulted in the significant progress of some. For example, there have existed for some time operational systems for international communication (INTELSAT and INTERSPUTNIK), and co-ordination with regard to the geostationary orbit, including use of the RF spectrum, is taken care of through ITU. In the field of meteorology, WMO has evolved an international co-operative programme of satellite observation and data dissemination, and - at the

recommendation of COPUOS - two centres for remote sensing have been set up in the United Nations system (in FAO and in the Department of Technical Co-operation for Development). COPUOS has initiated a number of treaties, agreements and/or conventions, most of which are now in force. Similarly, there exist examples of co-operation that meet some of the goals listed under each of the items mentioned above. In order for the benefits of space technology to be fully exploited and particularly to be more widely available to the mutual advantage of all nations, more work is required. In certain areas - e.g., remote sensing - there is an urgent need for achieving greater co-ordination.

363. While the benefits from space technology can be substantial, the investment called for is sometimes large and often beyond the means of a single nation. Therefore, in order to maximize benefits from space, it is necessary to devise ways of sharing the large investment costs. This is particularly so in regard to developing countries. The feasibility of this approach has been demonstrated at the international level by INTELSAT, INTERSPUTNIK and INMARSAT and at the regional level by ARABSAT, ARSC, EUTELSAT and ESA. Multilateral, regional and bilateral co-operation could result in similar systems in other fields - allowing countries to utilize space technology without themselves making very large investments. These possibilities are promising and merit further study, as has been recommended in paragraphs 224, 227 and 230 of chapter II.

364. However, paucity of funds is not the only constraint inhibiting developing countries from greater utilization of space technology. Two other major - and related - limitations are the shortage of adequately trained manpower and a lack of industrial and research infrastructure. While the major efforts in these fields have obviously to be undertaken by the country concerned, co-operation with other countries can do a great deal to accelerate progress in these areas. Existing co-operative arrangements have undoubtedly provided some help to many countries. However, it is clear that these efforts need to be intensified in the face of a problem of such magnitude. As discussed, intensive co-operation and exchange of experience between countries is an essential element in developing adequate technological capability - both human and material - in each country. The experiences may be particularly meaningful and relevant if it takes place between two developing nations, rather than from a developed to a developing one. Such exchanges between developing countries must, therefore, be encouraged. In view of the importance and potential of co-operation between developing countries, this issue is discussed in greater detail in a separate section.

365. Though a start has been made in many regions, the extent and depth of regional co-operation in space is yet rather meagre. ESA and INTERCOSMOS provide the only examples of organized, ongoing multilateral co-operation between groups of countries in the field of development and application of space technology, while ARABSAT and EUTELSAT provide examples of regional co-operation for the establishment of an operational system. There is some present and proposed regional co-operation among other groups of countries (e.g., ARSC, regional remote sensing centres, proposals for the African Satellite System for Common Carrier and Broadcasting Communication (AFROSAT) and for a Latin American remote sensing system, the Asian Regional Remote Sensing Programme, co-operation of ASEAN regarding the use of Indonesia's PALAPA satellites, etc.) - however, little progress has been made towards operational systems except in the case of PALAPA. Clearly a great deal more needs to be done.

366. The formulation and elaboration of principles of international space law and the creation of appropriate co-ordinating and regulatory mechanisms to ensure the

smooth and orderly growth of space technology and applications are functions that have been performed basically under the aegis of the United Nations and its related agencies. The specialized agencies - ITU, WMO and IMO in particular - have played a vital role in co-ordination and regulation, while COPUOS has served as the focal point for United Nations activities in the field of space. COPUOS and its two sub-committees have been instrumental in the elaboration of space laws and treaties. The United Nations system has contributed much to fostering co-operation in space; its role is dealt with more extensively in section E below.

367. In the context of international co-operation in space, it may be worth pondering over some of the lessons that have been drawn by some countries with active co-operative programmes. These may be summarized as follows:

(a) Co-operation must be the result of agreed means to reach a common goal or of complementary goals; these must be based on real needs and priorities of the countries concerned;

(b) Due regard must be paid to cultural, social, technological and economic differences, and particularly to administrative and organizational differences, between co-operating countries;

(c) Co-operation must bear promise of benefits to all parties concerned;

(d) Commitment to the ideals and benefits of co-operation among all concerned is essential, as is at least some degree of personal rapport at the operational level;

(e) Greater benefits are derived from co-operation which involves sharing of experiences and learning together rather than donor-recipient "co-operation" situations;

(f) Co-operation usually intensifies and becomes more productive as countries working together over a period of time discover the benefits of working together, and develop efficient mechanisms for doing so.

368. While these insights obviously cannot be universally true in all situations, they may serve as useful guidelines to start with.

D. Co-operation between developing countries

369. The developing countries - despite their widely varying levels of economic, scientific, technological and industrial development - recognize the similarity of their problems and the complementarity of their needs and resources. Their widely varied levels of scientific, technological and industrial development, can, in fact, provide the basis for mutually beneficial co-operation in space applications, technology and science. Developing countries with greater experience in a particular space application, or with greater scientific and technological capability in a given field, can help other developing nations which may only now be getting into these areas. It is therefore highly desirable that developing nations get together and co-operate with each other, so as to collectively make the most of what they have.

370. While satellites operate in a common "neutral" environment, the ground equipment - which often forms a larger part of the total investment - has to operate in varying climatic and cultural environments. Equipment developed in and for developed countries is not always suitable for the physical environment of developing countries, and is even less suitable for their cultural environment: the way it is handled, carried, operated, etc. is generally somewhat different. In this regard, equipment developed by a developing country is more likely to be relevant and suitable for the total environment of another developing country. Efforts should therefore be made - both by the countries concerned and by international agencies - to encourage and stimulate the flow of equipment made by developing countries to other developing countries.

371. The above argument is equally applicable to "environmentally-suitable" experts. Experience has shown that an expert from a similar socio-economic and physical environment is likely to adapt quicker and work better in a foreign country. His experience is often more relevant and his recommendations generally more practical. Developing countries might, therefore, find it to their mutual advantage to seek and provide expert assistance - when required - from and to each other. National and international funding and technical assistance agencies, when providing expertise assistance, might first seek the necessary experts from developing countries.

372. For historical and other reasons, users from developing countries are more familiar with the equipment and expertise available in the developed nations rather than in other developing countries. It is necessary to increase, in developing countries, knowledge about the work being done and expertise available in other developing countries. To facilitate this, it is extremely important that developing countries should promote exchange of information and visits of scientists, technologists and decision-makers amongst themselves.

373. In this context, the global network for exchange of scientific information, recommended by the Conference for Science and Technology for Development, in its Vienna Programme of Action on Science and Technology for Development, should play an important role and should be given urgent consideration.

374. One problem faced by many developing countries - and small countries in particular - is the high cost of maintaining large inventories of spares for their limited operational facilities (e.g., satellite communication earth stations). As a result, critical spares are sometimes not available, leading to a system breakdown. Rather than maintaining large inventories for just one or a few facilities, it would be far more economical to have a joint regional store for selected critical but expensive spares. This would reduce inventory costs and at the same time reduce system down-time also. While the initiative to organize such regional stores must come from the countries concerned, they should be provided all possible support and encouragement by international agencies.

375. Collectively, the developing countries have between them accumulated a vast amount of experience in a wide array of space applications. They also have a great deal of experience in non-space areas relevant to space applications - e.g., photo interpretation, broadcasting, etc. - and on a variety of equipment. However, there has so far been very little exchange of this experience between the developing countries - especially on specifics like performance and problems of a particular piece of equipment in a particular operating mode and environment. Clearly, such

information would be invaluable during planning, procurement and operation/maintenance. Besides encouraging multilateral, regional and bilateral co-operation between the developing countries, the United Nations and concerned specialized agencies should examine how best to organize the collection, collation, documentation and dissemination of such experience.

376. Concrete and mutually beneficial co-operation between developing nations need not be restricted merely to the exchange of information, experts and experiences, or to regional stores of spares; it can extend much further - even to jointly-owned and shared ground and space hardware. While there are already some positive examples (see para. 363), such co-operation needs to be carried further and extended to more countries. The establishment of regional space agencies by groups of developing countries - as proposed for Latin America, for instance - could provide an effective mechanism for co-operation and a significant impetus to the use of space technology. Such initiatives should therefore be encouraged. The United Nations system and its regional economic commissions could play a supporting role in these initiatives.

377. Developing countries should take concrete steps to conceive, initiate and implement specific co-operative programmes among themselves on a regional, bilateral or multilateral basis. Such programmes can be of considerable mutual benefit in almost all fields of space applications - including communications, broadcasting, remote sensing, meteorology and navigation. Such co-operation could range from regional receiving stations for remote sensing data to joint ownership of complete systems. Cost-sharing and the use of complementary resources of the countries involved will result in far better cost-benefit ratios, while simultaneously helping to develop the infrastructure in these countries. At the same time, as in the case of ARABSAT, EUTELSAT, INTELSAT and INTERSPUTNIK, it is possible to devise appropriate organizational mechanisms combining joint ownership of one part of the system (e.g., spacecraft) with national ownership of other parts (e.g., earth stations).

378. Since the technical and economic advantages of jointly-owned systems are already obvious in many situations, the developing countries should, through an act of political will, take steps to implement such co-operative programmes. Where necessary, the United Nations and its specialized agencies should be provided with the means to fund expert missions to define specific, need-based, co-operative programmes between groups of developing nations.

379. While short-term and immediate benefits from space technology can be expected to be reaped by outright purchase of systems and turn-key contracts, including operation of facilities, in the long run it is obviously desirable - even essential - for each country to have its own pool of knowledgeable experts. The size of this pool, the depth of knowledge and breadth of disciplines required, would obviously vary from country to country. Training and education are therefore essential ingredients in any long-range plan for beneficial applications of space technology. Developed countries do have the best equipped, and often best run, training/educational facilities. However, these facilities often do not have the specific purpose of providing training and education compatible with the needs of developing countries. Therefore, the experience gained in such institutions is often not relevant for developing country situations. There are now, in some developing countries, at least a few centres which can provide training or on-the-job experience that is of high quality and of far greater relevance to

developing country situations. This is because of the similarity of situations and problems in developing countries, making work-experience gained in a developing country more useful than similar experience gained in a developed country. Thus, it would be most useful if developing countries with active programmes of space applications would provide on-the-job experience or training opportunities to persons from other developing countries. Such co-operation should be actively encouraged by the United Nations and its specialized agencies by providing available assistance, inter alia, funding for fellowships.

380. For many years the concept of technical co-operation between developing countries has been discussed extensively and was given special attention in the United Nations Conference on Technical Co-operation among Developing Countries, held in Buenos Aires in 1978. The implementation of this concept is still in the early stages and the important field of space applications presents another opportunity to put this idea into practice. If developing nations do not want to be denied the fruits of space technology, if instead they would like to use it as another means of accelerating development, then it is imperative that they take steps to work co-operatively and to derive the maximum benefit by pooling their limited resources. The recommendations in this section are an attempt to provide concrete shape to this desire, and should be considered as only the first steps in a series of bigger initiatives, which must follow.

E. The role of the United Nations system: a review

381. The United Nations, along with its specialized and associated agencies, has been playing an important role in stimulating international co-operation and in helping to promote the utilization of space technology by all countries. A large number of United Nations divisions, agencies, etc. have been involved in this and their efforts have ranged from creating awareness about space technology to themselves undertaking or setting up agencies for operational activities in space applications. Here, no attempt is made to describe the activities of all the agencies or even to identify all of them. The focus is on the over-all impact of their collective efforts and recommendations to increase this.

1. Committee on the Peaceful Uses of Outer Space

382. A key role with regard to United Nations activities in matters concerning outer space is played by COPUOS. An ad hoc committee on outer space established by the General Assembly in 1958 was replaced by COPUOS (established in 1959). In a resolution in 1961, the General Assembly decided that within the United Nations system COPUOS should provide a focal point for international co-operation in the peaceful exploration and use of outer space. The Committee, which has a membership of 53 countries, has the mandate to discuss the state-of-the-art and future developments in the peaceful uses of outer space, to review international co-operation in this area and to study practical and feasible means for giving effect to programmes which promote such co-operation. It was also requested to study the legal problems that might arise from the exploration and uses of outer space and to organize exchange and dissemination of information relating to space activities. In accordance with this, it also carries out the task of progressive development and codification of international space law.

383. In undertaking these functions, the Committee is assisted by the two permanent sub-committees (Legal, and Scientific and Technical), and can draw on the experience of the specialized agencies and other bodies invited to participate in its work. On specific or technical matters, the Committee has, from time to time, established working groups to assist it.

384. The Committee has carried out several scientific, technical, economic and social studies relating to space communications, direct broadcasting, remote sensing, navigation and the use of nuclear power sources in outer space. It has taken important steps to promote the systematic and orderly growth of space activities, particularly by drafting and concluding five international treaties covering a number of vital issues (Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies; the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space; the Convention on International Liability for Damage Caused by Space Objects; Convention on Registration of Objects Launched into Outer Space; and the Agreement Governing the Activities of States on the Moon and other Celestial Bodies). Discussions on a number of other issues are continuing. These are legal aspects of remote sensing, direct international television broadcasting via satellite, use of nuclear power sources in space, and definition and delimitation of space, including matters relating to GSO. It has also given the impetus to an international education and training programme by establishing and guiding the United Nations Programme on Space Applications.

2. Outer Space Affairs Division

385. The Committee, its working groups and its Scientific and Technical Sub-Committee are serviced by the Outer Space Affairs Division in the Department of Political and Security Council Affairs of the United Nations Secretariat. The Division has responsibility for implementing decisions of the Committee and its subsidiary bodies related to the promotion of international co-operation and peaceful uses of outer space. It provides expert advice - on request - to Member States, carries out studies requested by COPUOS, disseminates information on space events to Member States through a monthly bulletin and maintains the international registry for objects launched into space. It services the Sub-Committee on Outer Space Activities of the Administrative Committee on Co-ordination. It also oversees the Programme on Space Applications, which was initiated in 1969, following the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space. This Programme and the Expert on Space Applications have played an important part in increasing the awareness of all countries about the benefits to be derived from the applications of space technology.

386. Through the Programme on Space Applications, the Outer Space Affairs Division organizes, sponsors and conducts a variety of seminars, panels and workshops in fields of practical applications of space technology, particularly in space communications, space meteorology and remote sensing as applied in various disciplines including cartography, agriculture, forestry, geology, oceanography and other related earth sciences. As interest is expressed, various seminars/panels/ workshops relating to specific problems or regions are organized in co-operation with concerned Member States and/or specialized agencies as a complement to activities undertaken by them. Over 30 such international seminars/panels/

workshops (with some 1,100 participants from developing countries) have been held in various parts of the world, including developing countries which have undertaken programmes aimed at integrating space technology in their economic and social development. Other organs of the United Nations have made important contributions in these, as have non-governmental scientific organizations.

387. Under the Programme on Space Applications, the United Nations can, upon request by Member States or organizations within the United Nations system, provide within the limits of resources available, technical advisory services in the applications of space technology for development. The Programme has also co-ordinated several surveys on the needs of developing countries in the utilization of space technology for development, including visiting missions to countries in the Middle East and Africa. The Programme is also responsible for the administration of fellowships for advanced training in fields of space science and technology which are offered by interested Member States to individuals of developing countries.

3. Office of Legal Affairs

388. The Office of Legal Affairs in the United Nations Secretariat provides secretariat assistance and services the Legal Sub-Committee of COPUOS. On request by the Legal Sub-Committee, the Office of Legal Affairs prepares reports and studies on items under consideration by the Legal Sub-Committee.

4. Natural Resources and Energy Division

389. Within the Department of Technical Co-operation for Development, the Natural Resources and Energy Division is responsible for a broad programme of activities in the fields of cartography (surveying and mapping), energy, geology and mining, and water resources. The programme consists of two basic types of activities: operational or field projects for technical assistance, and non-operational projects including studies, seminars and conferences. Both aspects of the programme focus on meeting the needs of developing countries.

390. Of primary interest to the Natural Resources and Energy Division is the use of remote sensing as a tool for resources exploration, particularly as it can benefit the developing countries. In this connexion, the Remote Sensing Unit within the Division co-operates with those sectors of the United Nations and its agencies responsible for project execution, particularly in the field of natural resources development. This co-operation involves such activities as providing substantive assistance in the design and evaluation of space-related remote sensing projects, facilitating access to satellite remote sensing data, advising on the feasibility of particular remote sensing applications and providing support for remote sensing centres being established in various regions. In a non-operational context, the Division participates, together with other United Nations bodies, in sponsoring various seminars and training programmes and in providing fellowships to individuals from developing countries.

5. Regional commissions

391. The regional commissions of the United Nations have made efforts to promote the use of modern technology to accelerate economic development. As a part of this function, they have promoted the use of space technology, as appropriate, to tackle the problems of the regions concerned.

392. The Conference of Ministers of the Economic Commission for Africa (ECA) adopted in 1975 a resolution which entrusted the Secretariat of the Commission with the development of an African remote sensing programme. The primary objectives of the programme are to make available to African countries satellite data needed for the development of renewable and non-renewable resources. To achieve this goal, an expert study lead by ECA recommended the establishment of three ground-receiving stations at Ouagadougou (Upper Volta), Nairobi (Kenya) and Kinshasa (Zaire) which would provide at least 90 per cent coverage of Africa. Also recommended was the establishment of five regional Training and Users Assistance Centres at Ouagadougou, Nairobi, Kinshasa, Cairo (Egypt), and Ile-Ife (Nigeria).

393. ECA initiated the African Remote Sensing Programme and arranged financial and technical assistance for the establishment and development of the needed supporting facilities. The Natural Resources Division was then entrusted with the responsibility to co-ordinate relevant projects and to provide technical backstopping to national and regional projects having a remote sensing component. At the instance of the African Remote Sensing Council, ECA carried out in 1981 an assessment on the harmonization and improvement of training policies in the regional centres.

394. ECA contributed to the establishment and development of the Pan-African Telecommunications Network (PANAFTEL), which will include a satellite component also. In the framework of the communication decade and in accordance with the Lagos Plan of Action which became the blue print of all African countries, the secretariat of ECA will collaborate with specialized intergovernmental agencies for the study of a regional communications satellite, AFROSAT.

395. The regional commissions also have been actively involved in a number of activities aimed at enabling countries to derive benefits from space technology. ECA and the Economic Commission for Latin America (ECLA), the Economic and Social Commission for Asia and the Pacific (ESCAP) and the Economic Commission for Western Asia (ECWA) helped in organizing regional/interregional seminars on space applications. ESCAP has initiated the Asian Regional Remote Sensing Programme and is actively promoting this. ECLA is also involved in promoting regional co-operation in remote sensing in the Latin-American region.

6. Office of the United Nations Disaster Relief Co-ordinator

396. UNDRO was established in 1972 to mobilize, direct and co-ordinate relief activities of the United Nations system in response to requests from disaster-stricken countries. Through appropriate international technical agencies, it promotes the study and prediction of natural disasters so that, working with such agencies, it can advise Member States and member of specialized agencies on preparedness measures through which the disastrous consequences of natural phenomena can be mitigated.

397. UNDRO activities focus on the development and use of data-gathering techniques for forecasting and predicting natural phenomena likely to cause disasters. It is studying the use of satellites for obtaining imagery for post-disaster relief co-ordination purposes and co-operates in sponsoring training programmes in the use of remote sensing for disaster forecasting and in the dissemination of information on relevant technological developments. Further details about UNDRO are to be found in Conference background paper A/CONF.101/BP/IGO/5.

7. United Nations Environment Programme

398. UNEP, created in 1972, has responsibilities which include co-ordinating environmental programmes within the United Nations system, reviewing their implementation and assessing their effectiveness. It also advises, as appropriate, intergovernmental bodies of the United Nations system on the formulation and implementation of environmental programmes.

399. Of primary interest to UNEP is the use of satellite remote sensing for the systematic collection of environmental data. UNEP is responsible for co-ordinating GEMS, a major and long-term programme that includes environmental survey activities in Member States, the specialized agencies and UNEP. The purpose of GEMS is to ensure the systematic collection of quantitative data for determining the state of the environment and for monitoring changes in critical environmental variables as a necessary input for environmental programmes. As part of GEMS a variety of projects are being executed in co-operation with FAO in such fields as the control of desertification, rangeland development and management, and the assessment of earth resources including forests and soils.

400. It seems certain that remote sensing techniques will play an increasingly important part in the activities of UNEP related to agriculture and land-use practices, climate impact studies, global ozone monitoring, etc. (see also chap. II H, para. 299).

8. United Nations Development Programme

401. The United Nations Development Programme (UNDP) is actively involved in developmental activities almost all over the world and has funded many projects in the space field. The majority of UNDP-funded projects relating to space science and technology are in the three fields of natural resources surveys, technology transfer and planning. Activities of special interest to UNDP include those in communications, weather and pest forecasting, radio and television broadcasting for development, and a variety of resource surveys, including crops, forestry, minerals, and soil and water. In addition, a number of projects related to different facets of space technology are currently in progress by collaboration with different United Nations specialized agencies.

9. International Telecommunication Union

402. The countries members of ITU and the ITU organs progressively have played a major and important role in the systematic planning, management and regulation of space communication activities through allocation, co-ordination, notification and registration of radio frequencies and positions on the GSO for the various radio

communication services using space techniques. The international co-ordinating and registering mechanisms for space radio communication are essentially those used and carried out over many years for conventional terrestrial radio communication. Essentially, the right of protection to an existing/registered radio operation is the premise on which the regulatory mechanism rests. The countries members, having included the necessary provisions in the international treaty (International Telecommunication Convention and the Radio Regulations annexed thereto), entrusted IFRB from 1963 with the added responsibility for the registration of technical basic characteristics of each space network station co-ordinated and notified under the Radio Regulations including the geostationary satellite orbital information, and, in 1973, included among the purposes of the Union specified in the International Telecommunication Convention "to effect, in the same conditions and for the same purpose, an orderly recording of the positions assigned by countries to geostationary satellites". A new article on "Rational use of the radio frequency spectrum and of the geostationary satellite orbit" has been added. CCIR and CCITT carry out various studies which result in important recommendations.

403. ITU organizes frequent WARCs to review and, where necessary, revise the pertinent portions of the ITU Radio Regulations, inter alia, (1) to take into account technical progress in the various fields and new requirements in radio communication services submitted by all countries in the light of article 33 of the International Telecommunication Convention which provides for equitable access to, and efficient and economical use of the geostationary satellite orbit and the radio frequency spectrum by all countries, and (2) to provide the basis for countries in a position to do so to develop techniques designed to improve the utilization of the radio frequency spectrum and the geostationary satellite orbit with a view to increasing the total radio communication facilities available to the world community. As early as 1959, at a WARC in Geneva, frequency allocations were made for the space research service; and in 1963, another world conference at Geneva was held at which frequency bands were allocated for the various radio communication services which were to use space techniques; and obligatory procedures, between countries and through IFRB, for the co-ordination, notification and registration of the use of radio frequencies and the geostationary satellite orbit were developed and adopted. These allocations and procedures were progressively reviewed, developed and revised in world conferences at Geneva in 1971, 1977 and 1979. The 1971 Conference established and adopted frequency allocations, technical criteria, and procedures dealing with Space Telecommunication Services. These were somewhat modified by WARC '79, and include the most up-to-date international radio-regulations for co-ordinating satellite systems. The WARC'77 agreed on a specific orbit/frequency assignment plan for the Broadcast Satellite Service in 12 GHz band for the countries of Europe, Africa, Asia and Oceania. A plan for the countries of the Americas is to be formulated by the Regional Administrative Radio Conference to be held in 1983. In 1985, another WARC is scheduled with the objective "to guarantee in practice for all countries equitable access to the geostationary satellite orbit and the frequency bands allocated to space radio communication services" (WARC, 1979, resolution No. 3), as part of a programme of world and regional administrative radio conferences to be held up to 1988.

404. Obviously, the whole régime of frequency allocation and co-ordination is dependent on co-operation for mutual protection and benefit. As the demand on resources like GSO and the radio frequency spectrum grows, and as the complexity of services increases, there is greater need for sharing and therefore for co-operation. All countries should therefore continue to work together in order to maximize the benefit to each.

405. Member States of ITU - themselves and through IFRB, CCIR, CCITT and the Technical Co-operation Department of the General Secretariat - also provide technical assistance in telecommunications. Short-term technical assistance is funded by UNDP, UNESCO and voluntary contributions by Governments. Such assistance includes frequency management and technical seminars, special pre-conference seminars, experts, fellowships, training in developed countries and provision of equipment. ITU also assists in the setting up of training centres - for example, in India, Malaysia, Angola, Malawi, Honduras, Ecuador - at which training is given to nationals both from the host country and from other countries in the region. ITU also presents an annual report to COPUOS on telecommunication and peaceful uses of outer space which summarizes the activities and progress made in this area.

10. World Meteorological Organization

406. The advent of artificial satellites has had a considerable impact on the activities of WMO and has resulted in very great benefits to national meteorological services throughout the world. The effect on WMO has in fact been so important that practically all the constituent bodies of the organization are engaged directly or indirectly in outer space activities. In this, it works in close co-operation with FAO and other concerned agencies.

407. The role of satellites has considerably increased not only in obtaining various kinds of observational data, in particular quantitative data, but also in providing a capacity for collection and distribution of information in support of various WMO programmes. Indeed, it is now generally recognized that satellites are indispensable for the success of the World Climate Programme (jointly with UNEP), WWW, GARP, the Tropical Cyclone Programme, IGOSS - jointly with IOC - the Hydrology and Water Resources Programme, agro-meteorological programmes and other WMO programmes.

408. WMO has also undertaken extensive education and training programmes for experts from developing countries in order to train them in the use of meteorological satellite data.

11. Food and Agriculture Organization of the United Nations

409. FAO has been using satellite imagery as an aid to its activities since 1969. It carried out experimental studies, using satellite imagery, in some countries in 1972-1973 and, in recognition of the great utility of space techniques to its work, FAO set up a remote sensing unit in 1976. In 1980, this was upgraded to a remote sensing centre, on the basis of the recommendation by COPUOS to set up two such centres in the United Nations system (the second centre is in the Natural Resources and Energy Division of the Department of Technical Co-operation for Development - see paras. 389, 390). The FAO Remote Sensing Centre has the responsibility within the United Nations system for renewable resources, and undertakes the following functions: advisory services and technical assistance to Member States, training courses for developing countries, support to the FAO field programmes, co-ordination of remote sensing activities at FAO headquarters and in the field, and serving as the liaison point between FAO and other major organizations concerned with space applications.

410. The Remote Sensing Centre acts as the organization's focal point for space activities. It provides technical backstopping to a large number of field projects whose work involves the application of remote sensing and develops projects where such applications predominate. It is closely involved in the formulation and execution of regular programme activities with a remote sensing component, including a range of activities carried out in collaboration with other United Nations agencies. It has developed facilities at FAO headquarters, among which are a global index of satellite imagery, including the LANDSAT 16 mm browse file, a library of such imagery for developing countries and of remote sensing literature, and a laboratory for the interpretation and analysis of aerial photographs and satellite imagery.

411. FAO organizes, sponsors and conducts a range of educational activities and training seminars, workshops and panels in fields of practical application of space technology in developing countries and by using the facilities of its Remote Sensing Centre for renewable resources in Rome. Much of its work is devoted to assisting Member States in establishing their own national centres and national infrastructures and advising and assisting developing countries and other international organizations in relation to the applications of remote sensing and the development of programmes and facilities for this purpose. The Centre is assisting towards the international co-ordination of satellite and airborne data and the development of associated national data bases, and also represents FAO in a range of bodies within the United Nations system and in international scientific organizations concerned with remote sensing. A more detailed exposition of FAO activities in this field is to be found in Conference background paper A/CONF.101/BP/IGO/6.

12. United Nations Educational, Scientific and Cultural Organization

412. UNESCO is also involved in space technology applications, especially space communication. It has sent expert missions to various countries to study the feasibility of satellite communications and has acted as executing agency for UNDP-funded projects aimed at strengthening programme production capabilitiy for satellite broadcasting experiments. It has also been a forum for discussion of matters relating to satellite broadcasting, and in 1972 adopted a declaration of guiding principles on the use of satellite broadcasting. The International Programme for the Development of Communication (IPDC) of UNESCO, established in 1980, expects to reinforce the activities in this field. A symposium on regional and international mechanisms for the dissemination and exchange of information took place in Paris in Autumn 1981. As a result of the meeting, a mission was sent to INTELSAT in Washington to discuss the use of satellite facilities by developing nations. A tentative agreement was reached on an experimental project for the use by third world broadcasts and the press of this satellite capability. This project was among those receiving some funding from the IPDC meeting in Acapulco, from 18 to 25 January.

413. The interests of UNESCO in remote sensing of the earth are mainly connected with its programmes concerning monitoring of the natural environment and its resources. The applications of space remote sensing and conventional (airborne) remote sensing techniques are being promoted and conducted in operational projects within the framework of MAB, IGCP, IHP, the Interregional Project on research and training leading to the Integrated Management of Coastal Systems, as well as in

several projects undertaken by its IOC. UNESCO has been sponsoring a number of regular post-graduate training courses in this general field and has promoted a series of activities on remote sensing applications in the form of symposia, seminars, workshops and ad hoc training courses, in collaboration with national and international institutions.

13. International Maritime Organization

414. IMO has, especially since 1966, taken a considerable interest in the development of space technology for maritime purposes. The culmination of this has been the creation of INMARSAT (see para. 337). IMO is now developing requirements of a future global maritime distress and safety system which is expected to be implemented in later years. This will make use of low-power distress transmitters (on ships and also on ships' survival craft) operating through geostationary and polar orbiting satellites which will also be used for shore-to-ship long-range alerting. This system will be developed in close co-operation with ITU and INMARSAT. IMO is also developing an international plan for the provision of maritime search and rescue services which will include procedures for routing distress messages to appropriate rescue co-ordination centres. Further details on IMO activities are to be found in Conference background paper A/CONF.101/BP/IGO/3.

14. International Civil Aviation Organization

415. ICAO has as an important objective: the economic application of satellite services to international civil aviation. It has accordingly been engaged in the definition of appropriate operational requirements and the best means of satisfying those requirements. The aeronautical fixed service, which interconnects the ground infrastructure responsible for the safety of flight, already utilizes satellite communication links where available and feasible. The aeronautical mobile service, which provides communications between aircraft in flight and the ground communication network, could benefit for the first time from the provision by satellites of instant, static-free communication between pilots and controllers over all parts of the earth's surface. The aeronautical radio navigation service could benefit from the application of satellites to provide radio-determination of aircraft position during flight over any part of the earth's surface, utilizing a variety of navigation techniques. In each of the two latter applications, the desirability of providing service over the polar regions adds to the complexity of possible solutions and extends considerably the range of technical problems which must be considered by ICAO.

416. ICAO is also concerned with other aspects of space, including use of satellites for search and rescue services, the obtaining and exchanging of aeronautical meteorological data, the definition of outer space, transport to and from outer space, problems related to safety, including the hazard caused to civil aircraft in flight by space debris returning to earth, etc.

417. The ICAO Assembly has resolved that ICAO be responsible for stating the position of international civil aviation on all related outer space matters. The resolution also requested the Secretary-General of ICAO to "ensure that the international civil aviation position and requirements are made known to all organizations dealing with relevant space activities and to continue to arrange for

the organization to be represented at appropriate conferences and meetings connected with or affecting the particular interests of international civil aviation in this field". The recent session of the ICAO Assembly decided that the Council of ICAO should continue to monitor the work of COPUOS and should request the ICAO Legal Committee, if and when necessary, to study with due priority the implications for the Chicago Convention, Annexes and other international air law instruments, of important decisions taken within the framework of the United Nations and other international bodies. Further details on ICAO activities are to be found in Conference background paper A/CONF.101/BP/IGO/1.

15. World Bank

418. The World Bank has been involved mainly in the funding of telecommunications earth stations for domestic and international traffic and is involved in studying the feasibility of using satellites for education. The World Bank also has an active interest in remote sensing and makes extensive use of satellite imagery, especially for the identification, preparation and monitoring of agricultural, irrigation and transportation projects. It provides assistance to many countries in the field of remote sensing, particularly for applications in the area of renewable resources.

16. Other agencies

419. Other specialized agencies, divisions, etc. within the United Nations system also have an active interest in space technology and its applications. A summary of this, and more details about the work of the agencies etc. mentioned above, are to be found in the Conference background papers (see A/CONF.101/BP/11 and A/CONF.101/BP/IGO/1, 3, 5, 6, 7 and 8).

17. Co-operation and co-ordination

420. Acting upon recommendations of COPUOS, the General Assembly has called upon organizations concerned to consider undertaking space science and technology programmes jointly or in close consultation or co-operation with one another. Such recommendations have included, for instance, those calling for co-operation in the implementation of WWW in the 1960s as well as in the subsequent programmes for the strengthening of meteorological services and research and for the expansion of training and educational opportunities in these fields, and those calling for co-operation in technical and other assistance to help meet communications needs of Member States and for the effective development of domestic communication.

421. Co-ordination of the space activities of the United Nations system is carried out by an Ad Hoc Sub-Committee on Outer Space Activities established under ACC. This interagency sub-committee, whose meetings are attended by representatives of the organizations concerned in the United Nations system, meets annually to work out joint programmes and co-ordinate their related activities. The results of its work are reported annually to COPUOS and its Scientific and Technical Sub-Committee.

F. The role of the United Nations: an assessment and recommendations

422. As is obvious, space science and technology have developed over the last quarter of a century at a most dramatic rate. In recent years there has been an equally dramatic growth in the field of space applications, many of which have now reached an operational stage. Space technology clearly has important socio-economic implications, some of which are already visible; at the same time, its effects on all mankind - not merely on those who use it - could be substantial. All these considerations, which led to the convening of this Conference, and the initiatives which will result from it, call for an assessment of the role of the United Nations and for appropriate recommendations regarding its contribution to the process of enabling all States to benefit from space technology.

423. Regarding the financial implications of the recommendations made by this Conference, it is understood that the proposed new or expanded activities, including personnel costs, of the United Nations are to be funded mainly through voluntary contributions of States, either in money, or in kind. However, the decision itself to convene UNISPACE 82 demonstrates clearly that space science and technology are an area of increasing importance at the international level and should thus be given adequate priority within the United Nations. The Conference recommends therefore that the General Assembly through its competent organs rearrange priorities within the United Nations next regular budget in such a way that the modest increase in personnel costs proposed below may be absorbed within the available resources.

424. From the foregoing paragraphs reviewing the role of various elements of the United Nations system and taking into account concerns and suggestions expressed by States in their national papers, in COPUOS and other fora, the Conference examined the following specific points with regard to the role of the United Nations:

(a) Strengthening and expanding the role of COPUOS in accordance with its mandate as the only standing committee of the General Assembly for international co-operation in the peaceful uses of outer space;

(b) Giving fresh impetus and reorientations where necessary to the United Nations Programme on Space Applications;

(c) Strengthening and expanding the role of the Outer Space Affairs Division and the relevant divisions of the regional commissions so as to better enable them to fulfil their tasks in the implementation of the recommendations of the Conference;

(d) Finding appropriate ways and means to ensure smooth and prompt implementation of the Conference recommendations;

(e) Ensuring full co-ordination within the United Nations system with regard to space activities.

425. The following paragraphs briefly examine these and related issues and make specific recommendations.

426. The Conference strongly recommends that the competent organs of the United Nations - in particular the General Assembly and also the Committee on

Disarmament - when dealing with measures aimed at a prevention of an arms race in outer space - in particular those mentioned in the relevant resolutions of the General Assembly - give appropriate attention and high priority to the grave concern expressed in paragraphs 13 and 14.

427. COPUOS, which is responsible to the General Assembly, will remain the only intergovernmental body exclusively concerned with all aspects of peaceful uses of outer space and all related activities in the United Nations system. It should include on its agenda regular items pertaining to the follow-up of the Conference recommendations. COPUOS continues to be assisted by its two sub-committees, the Legal and the Scientific and Technical Sub-Committees. The Conference recommends that COPUOS should continue consideration of the best and most suitable working methods for the Committee and its two sub-committees.

428. Earlier sections of this report have recommended the conduct of a number of studies. While some of these studies fall into the prerogatives of Member States and regional organizations and require their direct initiative, many of the proposed studies will have to be conducted within the United Nations in association, where appropriate, with concerned specialized agencies and intergovernmental or non-governmental organizations. The studies proposed vary in scope and importance as well as in qualitative aspects. It is therefore recommended that the primary responsibility for arranging and/or conducting those studies remain with COPUOS, in accordance with the order of priorities established by COPUOS. The Committee will also have to decide on the most appropriate methods of conducting these studies, be it through the establishment of working groups of governmental experts within the framework of the Committee and its sub-committees, through ad hoc task forces or through hired consultants.

429. As noted earlier, the United Nations Programme on Space Applications plays an important role in promoting awareness about space technology and its benefits. It has performed this task to the satisfaction of Member States despite the very limited resources at its disposal. However, as needs grow and more and more countries become interested in the applications and use of space technology, it may not be able to meet satisfactorily the demands made on it. Developing countries have pointed out the need for not only more seminars, training courses, etc. but also for longer periods of exposure, greater depths of training and adequate financing for these activities. COPUOS has discussed for several years the need to expand the Programme on Space Applications and, at its request, the Expert on Space Applications has prepared a plan for such an expansion (see A/CONF.101/BP/11/Add.2).

430. At the same time, the Programme on Space Applications should move forward and play a more concrete role in helping requesting countries to select, execute and benefit from appropriate applications. Therefore, the Programme should be directed towards the following objectives:

(a) Promotion of greater exchange of actual experiences with specific applications;

(b) Promotion of greater co-operation in space science and technology between developed and developing countries as well as among developing countries;

(c) Development of a fellowship programme for in-depth training of space technologists and applications specialists, with the help of Member States and relevant international organizations; establishment and regular up-dating of lists containing available fellowships in all States and relevant international organizations;

(d) Organization of regular seminars on advanced space applications and new system developments for managers and leaders of space application and technology development activities as well as seminars for users in specific applications for durations as appropriate;

(e) Stimulation of the growth of indigenous nuclei and an autonomous technological base, to the extent possible, in space technology in developing countries with the co-operation of other United Nations agencies and/or Member States or members of the specialized agencies;

(f) Dissemination - through panel meetings, seminars, etc. - of information on new and advanced technology and applications, with emphasis on their relevance and implications for developing countries;

(g) Provision or arrangement for provision of technical advisory services on space applications projects, upon request by Member States or any of the specialized agencies.

The Programme should continue to make full use of the expertise available in other organs of the United Nations system, and should be implemented in close co-operation and co-ordination with the concerned specialized agencies/departments of the United Nations system.

431. Apart from the Programme on Space Applications, being executed through the Outer Space Affairs Division, a number of other units of the United Nations system are involved in operational activities, training, etc. The Conference recommends that these activities be continued and strengthened as appropriate, but places special emphasis on the imperative need to avoid duplication of programmes and to achieve full co-ordination in this field (specific recommendations have been covered in chapter II).

432. As mentioned in chapter II, the need and the desirability of setting up an international space information service has been emphasized by many countries. The Conference therefore recommends that this international space information service should be established, initially consisting of a directory of sources of information and data services, so that Member States or any of the specialized agencies, upon request, could be directed through the service to accessible data banks and information sources. It is desirable that the basic information mentioned above is made available to all countries - particularly developing countries - requesting for it, at a reasonable cost. At a later stage, COPUOS could evaluate its performance and examine the need and possibilities of expanding the service, bearing in mind the financial implications of such a step.

433. The expanded role of the Outer Space Affairs Division and the relevant divisions of the regional commissions, the new orientation of the Programme on Space Applications and the setting up of an international space information service will require augmentation of technical personnel as appropriate, though a nucleus does exist. Closer and more active co-ordination of space activities is needed, especially in light of their growing importance and magnitude and in order to

ensure the best possible cost-efficiency. In addition to servicing COPUOS, the tasks to be carried out by the Outer Space Affairs Division and the relevant divisions of the regional commissions will thus considerably increase.

434. Those tasks will include:

(a) Present tasks of the Outer Space Affairs Division;

(b) Servicing COPUOS in the implementation of the approved Conference recommendations, with special regard to the proposed studies;

(c) Conduct of studies if so requested by COPUOS;

(d) Implementing the reoriented and expanded programme on space applications as recommended by the Conference;

(e) Organizing and operating the international space information service.

In order to meet these enlarged responsibilities, one possibility could be to consider an integration of the activities mentioned above into a Centre for Outer Space which would consist of the Outer Space Affairs Division of the Department of Political and Security Council Affairs. Alternatively, the proposed integration and expansion could take place within the existing Outer Space Affairs Division strengthened with additional personnel and resources. The Conference requests the General Assembly at its thirty-seventh session to consider both alternatives. In either case the financial considerations set out in paragraph 423 should be borne in mind.

435. Since this is basically an intensification of present functions of the Division, the activities of specialized agencies and other United Nations organs will not be infringed upon or duplicated. Indeed, the Conference stresses the need to avoid duplication of efforts and to observe the best possible cost-efficiency in the execution of programmes. This goal could be achieved by establishing or expanding close linkages between all United Nations bodies engaging in space or space-related activities, such as, for instance, the United Nations Centre for Science and Technology and UNDP. Also, the Ad Hoc Sub-Committee on Outer Space Activities of ACC* should continue to meet annually. It should discuss ways of ensuring closer co-ordination between the various agencies concerned and should also examine the feasibility of using each other's expertise more fully through joint co-operative programmes. All space-related programmes of each of the agencies should be discussed and co-ordinated at this forum before finalization. The procedures of co-ordination should be such as to minimize delays in implementation.

436. The Outer Space Affairs Division with enlarged responsibilities or the Centre for Outer Space should work in close co-operation with the various technical agencies in the United Nations system - ITU, WMO, FAO (Remote Sensing Centre), UNEP, UNESCO and the Department of Technical Co-operation for Development (Natural Resources and Energy Division), in particular - as well as with funding agencies like the World Bank and UNDP, so that proper co-ordination of projects is ensured within the United Nations system.

437. The Conference recognizes that the effective participation of the regional commissions in the execution of activities resulting from the recommendations of

the Conference necessitates the reinforcement of the role of the regional commissions concerned and therefore recommends the provision of adequate resources.

438. The basic considerations of the Conference with regard to the aspect of financing its recommendations are set out in paragraph 423 above. In addition, however, the Conference recommends that its approved proposals be forwarded to the funding agencies and bodies with established operational activities, so that they may be taken into account in the planning and setting up of programmes.

PART TWO

PROCEEDINGS OF THE CONFERENCE

CHAPTER I

ORIGINS OF THE SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

439. The General Assembly, at its thirty-third session, decided in resolution 33/16 of 10 November 1978 that a second United Nations Conference on the Exploration and Peaceful Uses of Outer Space should be convened. The General Assembly designated the Committee on the Peaceful Uses of Outer Space as the Preparatory Committee for the Conference and the Scientific and Technical Sub-Committee as Advisory Committee to the Preparatory Committee.

440. In resolution 34/67 of 5 December 1979, the General Assembly recalled that the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space was held in Vienna in 1968 and that the intervening period had seen rapid progress and growth in space exploration and in the development of space technology and its applications. The General Assembly considered that there was a need to assess these developments, to exchange information and experience on their present and potential impact and to assess the adequacy and effectiveness of institutional and co-operative means of realizing the benefits of space technology.

441. In the same resolution, the General Assembly recognized the importance of wider participation of Member States in the activities of the United Nations in the field of outer space, and noted the need to increase the benefits of space technology and its applications, as well as the need to contribute to the orderly growth of space activities favourable to the socio-economic advancement of mankind, in particular of the peoples of the developing countries. Taking into account new developments in space science and technology which are being projected and envisaged in the coming decade, as well as the applications emerging therefrom and their potential benefits and possible implications for national development and international co-operation, the General Assembly noted tht need to increase further the awareness of the general public with regard to space technology and its applications and expressed the desire to stimulate an enhanced co-ordinating role for the United Nations, which was eminently suited to bringing about increased international co-operation and assistance to the developing countries in the field of exploration and peaceful uses of outer space.

442. The question of convening such a conference had been before COPUOS, and its Scientific and Technical Sub-Committee since 1974. At the request of the Committee, the Secretary-General in 1974, sent a questionnaire to all Member States soliciting their views on the question of convening a conference.

443. In 1976, the Scientific and Technical Sub-Committee, at the suggestion of the Committee, established an informal working group to consider various proposals regarding a conference. Upon the recommendation by the Sub-Committee, the Committee requested the Secretariat to prepare a study in depth on the question of convening a United Nations conference on space matters.

444. The Committee, at its 1977 (twentieth) session, called on the working group of the Scientific and Technical Sub-Committee to consider the question and, to facilitate the work of the task force, requested the Secretariat to invite Member States to submit their views on the subject, focusing on the specific objectives, organizational aspects and financial implications of the proposed conference.

445. In 1978, the Committee noted that the working group of the Scientific and Technical Sub-Committee had considered all relevant facts and information relating to the proposed conference, including views expressed by Members of the United Nations. The Committee endorsed the views and recommendation of the Scientific and Technical Sub-Committee and recommended to the General Assembly that a second United Nations Conference on the Exploration and Peaceful Uses of Outer Space be convened. As noted above (para. 439), this recommendation was adopted by the General Assembly at its thirty-third session.

446. As recommended by COPUOS at its 1978 session and endorsed by the General Assembly in resolution 33/16, the report of the 1978 (fifteenth) session of the Scientific and Technical Sub-Committee was circulated to all Member States, which were invited to comment in particular on the views and recommendations of the Sub-Committee on the need for a conference, the objectives of the conference and the organization of the agenda.

447. COPUOS held its first session as the Preparatory Committee for the Conference under the chairmanship of Ambassador Peter Jankowitsch (Austria) in June 1979, having before it the report of the Scientific and Technical Sub-Committee (A/AC.195/238) which had met under the chairmaship of Prof. J. M. Carver (Australia) in February 1979. The Preparatory Committee, in its report, 2/, made detailed recommendations to the General Assembly concerning the title, agenda, final report, preparation and organization of the Conference, and proposed a ceiling for its cost. It was agreed that the Conference should be held in the second half of 1982. Those recommendations were endorsed by the General Assembly in resolution 34/67 of 14 December 1979.

448. In 1980, the Advisory Committee held its first session from 28 January to 13 February, and the Preparatory Committee held its second session from 23 June to 3 July. The Preparatory Committee recommended that the Conference be scheduled for a duration of two weeks and approved the arrangements made by the Outer Space Affairs Division for the preparation of background papers for the Conference as requested by the Advisory Committee. The Preparatory Committee also made detailed recommendations on Conference participants and public information activities. The Committee noted with appreciation the invitations received from the Governments of the USSR and Austria to host the Conference and recommended to the General Assembly that it be held in Vienna from 9 to 21 August 1982. The General Assembly endorsed those recommendations in resolution 35/15 of 3 November 1980.

449. As requested by the General Assembly in resolution 35/15, the Secretary-General of the United Nations invited:

(a) All States Members of the United Nations or members of the specialized agencies to participate in the Conference;

(b) Namibia, represented by the United Nations Council for Namibia, to participate in the Conference;

(c) Representatives of organizations that have received a standing invitation from the General Assembly to participate in its sessions and the work of all international conferences convened under its auspices in the capacity of observers to participate in the Conference in that capacity, in accordance with General Assembly resolutions 3237 (XXIX) of 22 November 1974 and 31/152 of 20 December 1976;

(d) Representatives of the national liberation movements recognized in its region by the organization of African Unity to participate as observers, in accordance with General Assembly resolution 3280 (XXIX) of 10 December 1974;

(e) The specialized agencies and the International Atomic Energy Agency, as well as interested organs of the United Nations, to be represented at the Conference;

(f) Interested intergovernmental organizations to be represented by observers at the Conference;

(g) Directly concerned non-governmental organizations in consultative status with the Economic and Social Council to be represented by observers at the Conference.

The General Assembly also invited Member States to submit national papers for the Conference.

450. In October 1980, the Secretary-General of the United Nations appointed Prof. Yash Pal (India) as Secretary-General of the Conference. Prof. Yash Pal took office in March 1981. The other senior members of the Conference secretariat, including the Executive Secretary, three Deputy Secretaries-General and three Senior Advisers, were appointed and took office in January 1982.

451. In 1981, the Advisory Committee held its second session from 2 to 13 February and the Preparatory Committee held its third session from 22 June to 2 July. The Preparatory Committee, in its report, 3/ noted that the background papers had been issued and circulated, that national papers were being submitted and that regional seminars of the United Nations Space Applications Programme were oriented to focus on the preparations for the Conference. Such seminars were held in 1981 in Addis Ababa, Buenos Aires, Toulouse and Djakarta and in 1982 in Quito and Addis Ababa. The Preparatory Committee approved an outline of the draft report of the Conference and approved the draft provisional rules of procedure /CONF.101/1). The Preparatory Committee also agreed on the officers that would be required for the Conference and on the distribution of these posts among the regional groups.

452. The Secretary-General of the Conference prepared a draft report of the Conference (A/CONF.101/PL/L.17 and Add.1-4) based on the outline approved by the Preparatory Committee and taking into account the information in the background papers and the views expressed in the national papers and regional seminars. That draft report was submitted to and discussed by the Advisory Committee in January 1982.

453. In 1982, the Advisory Committee held its third and final session from 11 to 22 January and the Preparatory Committee held its fourth and final session from 22 March to 6 April. The Preparatory Committee considered and revised the draft report of the Conference, which had been prepared by the Secretary-General of the

Conference and revised to take into account the comments and observations made in the Advisory Committee, together with those received from specialized agencies (A/CONF.101/PC/L.20). As requested by the Preparatory Committee, the Secretary-General of the Conference circulated the revised draft report of the Conference (A/CONF.101/3) to all States 90 days before the opening of the Conference.

454. A variety of pre-Conference publicity activities, as approved by the Preparatory Committee, were conducted in 1981 and 1982. Those included five issues of a bimonthly newsletter, world-wide poster and essay contests, postage stamps issued by the United Nations and several countries, a series of monthly exhibits at United Nations Headquarters and a variety of articles and interviews in newspapers and magazines and on radio and television. In resolution 36/36 of 18 November 1981, the General Assembly invited Member States to promote public awareness of the Conference.

CHAPTER II

ATTENDANCE AND ORGANIZATION OF WORK

A. Date and place of the Conference

455. The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space was held in Vienna from 9 to 21 August 1982, in conformity with General Assembly resolution 35/15. During that period, the Conference held 13 plenary meetings.

B. Pre-Conference consultations

456. Pre-Conference consultations open to all States invited to participate in the Conference were held in Vienna on 8 August 1982 to consider a number of procedural and organizational matters. The pre-Conference consultations were conducted under the chairmanship of Ambassador Peter Jankowitsch (Austria), Chairman of the reparatory Committee for the Conference, who presented the report on the consultations (A/CONF.101/L.1) to the Conference at its opening meeting. The Conference accepted that report as a basis for the organization of its work.

C. Attendance

457. The following 94 States were represented at the Conference:

Albania
Algeria
Angola
Argentina
Australia
Austria
Bangladesh
Belgium
Benin
Bolivia
Brazil
Bulgaria
Byelorussian Soviet Socialit Repubic
Canada
Chile
China
Colombia
Costa Rica
Cuba
Cyprus
Czechoslovakia
Democratic Yemen
Denmark
Ecuador
Egypt
Finland
France
Gabon
German Democratic Republic
Germany, Federal Republic of
Greece
Guatemala
Holy See
Hungary
India
Indonesia
Iran
Iraq
Ireland
Israel
Italy
Japan
Kenya
Kuwait
Lebanon
Lesotho
Libyan Arab Jamahiriya
Luxembourg
Malaysia
Mali
Sri Lanka

Mexico
Morocco
Netherlands
New Zealand
Nigeria
Norway
Pakistan
Panama
Peru
Philippines
Poland
Portugal
Qatar
Republic of Korea
Romania
Rwanda
San Marino
Saudi Arabia
Senegal
Somalia
Spain
Sudan
Sweden
Switzerland
Syrian Arab Republic
Thailand
Tunisia
Turkey
Uganda
Ukrainian Soviet Socialist Republic
Union of Soviet Socialist Republics
United Kingdom of Great Britain and Northern Ireland
United Republic of Cameroon
United Republic of Tanzania
United States of America
Upper Volta
Uruguay
Venezuela
Viet Nam
Yugoslavia
Zaire
Zimbabwe

458. The United Nations Council for Namibia was represented at the Conference.

459. The following national liberation movements were represented by observers: African National Congress (South Africa) and Pan-Africanist Congress of Azania.

460. Members of the secretariat of the following United Nations offices were present throughout or during part of the Conference:

Centre for Disarmament;

Centre for Science and Technology for Development;

Department of Political and Security Council Affairs.

461. The Secretariat of the Economic Commission for Africa was represented at the Conference.

462. The following United Nations Secretariat units and bodies were also represented:

United Nations Centre for Human Settlements (Habitat)

United Nations Environment Programme

United Nations Industrial Development Organization

United Nations Disaster Relief Organization

United Nations Development Programme

463. Representatives of the following specialized agencies and related organizations participated in the work of the Conference:

Food and Agriculture Organization of the United Nations

United Nations Educational, Scientific and Cultural Organization

International Civil Aviation Organization

World Health Organization

World Bank

International Telecommunications Union

World Meteorological Organization

International Atomic Energy Agency

464. The following intergovernmental organizations were represented by observers:

African Remote Sensing Council

Agency for Cultural and Technical Co-operation

Arab Communications Satellite Organization

Council for Mutual Economic Assistance

Council of Europe

European Communities

European Space Agency

Intergovernmental Oceanographic Commission

International European Telecommunications Satellite Organization

International Maritime Satellite Organization

International System and Organization of Space Communications

International Telecommunications Satellite Organization

League of Arab States

Organization of African Unity

Pan African Telecommunications Union

465. A large number of concerned non-governmental organizations in consultative status with the Economic and Social Council were represented by observers.

D. Opening of the Conference and election of its President

465. The Conference was opened by the Secretary-General of the United Nations, Mr. Javier Pérez de Cuéllar. He noted that space technology, which has advanced demonstrably in the past 25 years, offered man a new tool, a tool that could be used for the common good or for the benefit of a privileged few. Space technology, he pointed out, was a tool of immense versatility and great power. It could be used to help improve life on earth or to devastate the planet, to spread knowledge, education and enlightenment or to destroy cultures and values.

467. He went on to note that space provided an ideal and necessary arena for international co-operation in aeas ranging from communication to weather data. International co-operation in the utilization of outer space would not only benefit

humanity at large, but would further decrease spheres of international confrontation, leading closer to the final goal - namely, the use of outer space for exclusively peaceful purposes.

468. This optimistic picture, he observed, was marred by the fact that not all countries had been able to participate equally in space technology, nor had all partaken equally of its benefits. However, in trying to harness space technology for development, it was not necessary - nor even desirable - that all countries should follow the same, well-trodden path. The needs, resources, culture and national genius of peoples varied from country to country and the applications of the new space technology should, therefore, be tailored to fit in with the socio-economic and cultural fabric and goals of each nation. If this was not done, the Secretary-General warned, there was a danger of space technology acting as a disruptive force, as a means of accentuating disparities within a nation, even as one attempted to reduce inter-country disparities.

469. He went on to observe that space science and technology demonstrated as never before the total interdependence of nations and he stressed the importance of acting quickly to avoid the escalating militarization of outer space, a trend which ran against the principle of international co-operation for the advantage of all, and the peaceful use of outer space to build rather than to destroy. An arms race in space, he remarked, would increase the areas and the potential for confrontation, adding a new dimension to the human destruction that would stem from it; it would also divert urgently needed resources from programmes of economic and social development. Hence, the increased militarization of outer space must be vigorously opposed. There was time - but very little. Almost daily one read of proposals and plans to increase the military component of space programmes. He underlined that it was therefore essential that the forces of reason and peace join together to counter what could be a frightening escalation of the arms race.

470. In conclusion, the Secretary-General stated that, as more and more countries become increasingly dependent on space technology for essential services, the need for co-operative planning and co-ordination would grow. This would involve new relationships between national, regional and international organizations. While much of this co-operation and co-ordination would be bilateral, global structures would also be required. Therefore, he believed that the United Nations system would continue to have an important role to play in this area, as well as in the continued development of space activities.

471. Dr. Rudolf Kirchschlaeger, Federal President of the Republic of Austria, the host country for the Conference, in his inaugural address, welcomed the participants and stated that based on its geographical position and its history, his country had been striving to offer a meeting place for conferences, negotiations and talks which it regarded as the most reliable means to find solutions to global problems.

472. The Austrian President expressed the hope that the Conference would intensify international co-operation in space research and ensure that outer space was used for peaceful purposes. In noting the extraordinary and impressive development of space science and technology which had occurred over the last decade and a half, he asked what that scientific progress would be worth if it were to be accompanied by new and additional threats to world peace. He appealed to the countries and organizations represented at the Conference to use all their scientific knowledge and technologies for peaceful purposes only.

473. In conclusion, Dr. Kirchschlaeger cited the necessity for internatioal co-operation in the uses of outer space, because global problems call for global solutions. Furthermore, he saw co-operation in space as a symbol and example for coping with other problems existing in the world today. He expressed the hope that the Conference would advance the goal of a peaceful and harmonious future for one mankind, not divided into races and classes, or into rich and poor, but one that had learned to live in lasting peace.

474. The Conference elected by acclamation Dr. Willibald Pahr, Federal Minister for Foreign Affairs, head of the delegation of Austria, as President of the Conference.

475. The President of the Conference addressed the assembled representatives and participants. In acclaiming the development of international co-operation in outer space activities over the past 25 years, he noted the increasing concern and involvement of the non-space Powers, including developing countries, in space-related fields. Space applications, he pointed out, were no longer the domain of solely a few rich and highly industrialized nations; rather, the potential of space technologies for accelerating the process of development had been recognized by developing countries as well.

476. The President praised the effectiveness of the 1967 Treaty on the Peaceful Uses of Outer Space, as well as of other international treaties and conventions which had resulted form the work of COPUOS, in preventing a situation of confrontation and conflict from rising along with the development of space technologies. In the recent past, however, many of the ideas and principles enshrined in those instruments had been exposed to an incresing challenge. There had been a deterioration in the very spirit of international co-operation which, the President warned, was being eroded by incresingly nationalistic considerations. As he noted, for the first time in many years the spectre of military confrontation in space was rising, fuelled by the pursuit of technological research and applications which could lead to a costly and destabilizing arms race in space. As long as those programmes were not fully operational, however, he saw a chance for the world - and, in particular, the two major space Powers - to stop those dangerous developments. He urged, therefore, that appropriate consideration be given by the Conference to providing the international community with the effective machinery to guarantee the exclusively peaceful uses of outer space.

477. The second plenary meeting of the Conference opened with live televised messages via satellite from the heads of State of Sri Lanka and Brazil.

478. The President of Sri Lanka, H.E. J. R. Jayewardene, greeted the delegates and wished them all success in their endeavours. In his view, the Conference must have as its purpose not just the sharing of knowledge, but the use of knowledge in the service of all mankind. While noting the fact that earthly preoccupations had, in the past, prevented developing countries from participating in the exploration and uses of outer space, he stated that those countries were no longer satisfied with remaining mere spectators of the great adventure of space science and technology. He went on to warn of the potential use of satellite technology for destructive ends aS the greatest challenge facing humanity today.

479. In his message to the Conferenc, the President of Brazil, H.E. Joao Baptista de Oliveira Figueiredo, called the task at hand the leading edge of human activity. He urged the participants not to detach the technical discussions

of space research and development from the economic, social and political facts of the planet. Nothing would contain a greater element of risk than to pretend that science existed in the abstract, with no influence on human relations or without being influenced by them. He went on to contrast the many benefits attainable by remote sensing by means of satellites with the potentially harmful effects in developing countries by impinging on sovereignty of States over their natural resources. Similar advantages and disadvantages, he noted, derived from direct television broadcasting by satellites. Finally, he warned of the growing possibility of the use of outer space for war-like purposes.

480. Three messages from other heads of States were read to the Conference participants by the heads of their respecteive delegations.

481. The Premier of the State Council of the People's Republic of China, H.E. Zhao Ziyang, extended warm congratulations to the Conference on behalf of the Chinese Government and people. He expressed the hope that the Conference would make a positive contribution to the promotion of outer space science and technology in the service of peaceful purposes, to the enhancement of co-operation based on equality between all States Governments and peoples and to the furtherance of the economic and social progress of all countries, in particular developing ones.

482. The Prime Minister of India, H.E. Mrs. Indira Gandhi, noted that the past 25 years since man first successfully demonstrated his ability to launch objects into space had witnessed many notable achievements. However, she asked whether those advances had also contributed to reducing the glaring disparities which divided peoples. The promise of gains from advanced technologies eluded the majority of humankind, whose aspirations for a better life remained unfulfilled. She therefore urged scientists and world leaders to see the world in its wholeness and, through their collective wisdom, to take practical steps to ensure that global differences would not be extended into space.

483. In his message, Mr. Leonid I. Brezhnev, Chairman of the Presidium of the Supreme Soviet of the Union of Soviet Socialist Republics, noted that the Conference was convening on the twenty-fifth anniversary of the launching of Sputnik I, one of the greatest achievements in man's history. He noted the present wide use of space technology in different fields of earth-bound economic activities and the prospect that space laboratories based on large orbital complexes with changing crews would be permanently operational in orbit in the near future. He expressed satisfaction with the development of international co-operation in the exploration and use of outer space, in which the United Nations played a remarkable role, and stressed that the first international crews were placed in orbit thanks to INTERCOSMOS programmes. He emphasized his country's constant advocacy of outer space remaining an arena for peaceful co-operation and the urgent necessity to keep the space free from weapons of any kind.

484. Further messages from the heads of State of Pakistan, Bulgaria and the United States were received during the course of the general debate and were read at the outset of their statements by the heads of their respective delegations.

485. In the message read on his behalf, President Mohammed Zia ul Haq of Pakistan noted that activities in space had begun to exercise a significant and, to a large extent, beneficial influence on people's lives in many diverse ways. Unfortunately, he pointed out, there was another side to the coin, inasmuch as an estimated 75 per cent of the satellites launched since the first Sputnik had

military applications. He hoped, therefore, that UNISPACE 82 would do its best to ensure that the promising new frontier of space did not become an arena for military competition and confrontation, but rather that outer space would be used only for peaceful purposes and for the benefit of all humanity.

486. A message from Todor Shivkoff, Chairman of the State Council of Bulgaria, was read to the assembled delegates by the head of the Bulgarian delegation. In it he noted that the exploration and peaceful uses of outer space were among the great achievements of the scientific revolution of the twentieth century. The Chairman stated that outer space was the common heritage of mankind, as well as was peace. Therefore there must be no weapons of any kind stationed in space.

487. President Ronald Reagan of the United States of America, in his message, stated that the Conference provided leaders from around the globe with an unprecedented opportunity to chart a course for greater co-operation among nations in exploring mankind's last and endless frontier. He urged countries to work together to ensure that the benefits of space continue to contribute to a bright and peaceful future on Earth and to chart new pathways to the stars to serve as avenues of peaceful exploration and adventure for our generation and for generations to come. Since 1968, he pointed out, developing countries had made some use of space technology, but their social and economic hopes had not been fulfilled. Indeed, Prof. Pal noted, the gap between rich and poor nations had widened, owing in part to the pattern of use of technology, including space technology. While one could not expect an instant "technological fix", technology properly used could be an engine for development and well-tailored applications could help reduce economic and social disparities. The challenge was to devise methods and means to accomplish that aim on a large scale and in an ongoing manner.

488. Following messages from heads of State, the Secretary-General of the Conference, Prof. Yash Pal, made a statement in which he noted that when one spoke of space, the perspective must necessarily be global. One must consider and discuss how space could contribute to the well-being of humanity as a whole.

489. In recent years, Prof. Pal said, ever-greater numbers of countries had been making use of space technology in one form or another. However, despite the seemingly extensive use of such technology, the fact was that the benefits had been minimal in most cases - and certainly far less than their potential. Meanwhile, Prof. Pal pointed out, applications that could create a real impact - communication and education in remote rural areas, or integrated weather-forecasting and communication systems, for example - had not been extensively used. In those fields, countries had been provided with snippets and their appetites had been whetted. An increasing addiction was being developed with little effort to understand distinctive needs or to suit systems to requirements. Such an approach, an over-selling of space technology, could only bring it into disrepute. At the other extreme was the view that space technology was bad <u>per se</u> and that developing countries should limit themselves to so-called "intermediate technologies". According to Prof. Pal, both those viewpoints betrayed a lack of understanding of the relationship between needs and technology in general, and space technology in particular. While every country need not embark on a space programme, he underlined the belief that space technology could be an important tool for combating poverty, for spreading education and for strengthening indigenous cultures.

490. However, the growing use of space applications and the widespread sharing of its benefits would seem, Prof. Pal felt, to require some assurance that the availability of satellites, launch services or equipment would not depend upon the vagaries of political relations. He noted that while that might appear to be a tall order, such insulation from politics had indeed been achieved, to a large extent in such fields as international telecommunication and maritime communication. At the same time, however, Prof. Pal felt obliged to mention the realities of outer space today. The "weaponization" of outer space, he emphasized, was a dangerous and regrettable step, which must be combatted.

491. In this last quarter century, Prof. Pal concluded, man had acquired capabilities undreamt of even a few decades ago, including the capacity effectively to abolish distances and thereby create a completely new concept of "neighbourhoods". In this situation, he asked, should mankind not begin to conceive of new "minimal human rights" which would include the right to communicate and the right of access to meteorological information.

E. Adoption of the rules of procedure

492. At its 1st plenary meeting, on 9 August 1982, the Conference adopted the provisional rules of procedure recommended by the Preparatory Committee (A/CONF.101/1).

F. Adoption of the agenda

493. At the same meeting, the Conference adopted the following agenda recommended by the Preparatory Committee (A/CONF.101/2):

1. Opening of the Conference
2. Election of the President
3. Adoption of the rules of procedure
4. Adoption of the agenda
5. Establishment of the Main Committees and organization of work
6. Election of officers other than the President
7. Credentials of representatives to the Conference
    (a) Appointment of the members of the Credentials Committee
    (b) Report of the Credentials Committee
8. General debate
9. State of space science and technology
    (a) Review and projection of the current and future state of science and technology for space research and applications

(b) Evaluation of the major developments in space science, technology and applications and assessment of the usefulness of these developments so far

10. Applications of space science and technology

(a) Evaluation of the current and potential applications of space technology, taking into account present and foreseeable national and international programmes in the areas of space research

(b) Examination of the possibilities and mechanisms for enabling all States to benefit from space technology, *bearing in mind* their various levels of development, varying capacities to absorb new technologies and particular needs and priorities

(c) Examination of the choices for utilizing space technology available to countries at various stages of technological growth and of the difficulties they face in this regard

(d) Examination of the existing infrastructure and scientific and technological development in various countries, especially the developing countries, and of appropriate measures to augment their capabilities to develop space technology and facilitate access to such technology and to participate and co-operate in space activities so as to derive maximum benefit from space technology and its applications

(e) Examination of developments and system configurations appropriate to the use of space technology for education

(f) Discussion of compatibility and complementarity between various satellite systems, including those used for remote sensing, meteorology, communications and navigation

(g) Consideration of the implications of projected developments in the areas of space technology such as earth-orbiting solar power stations, space manufacturing, space transportation and manned space stations; consideration of the implications of the use of the geostationary orbit, the need and possibilities for optimizing that use, as well as of the measures to be taken to that end

(h) Discussion of the nature of, and ways of protecting, the near-earth environment including the upper atmosphere and magnetosphere

11. International co-operation and the role of the United Nations

(a) Consideration of reports on the nature and extent of the bilateral and multilateral co-operation in outer space activities

(b) Consideration of reports on the activities of the United Nations, including its specialized agencies, and of other international organizations dealing with the exploration and peaceful uses of outer space

(c) Evaluation of the role of the United Nations, its specialized agencies, other international organizations and programmes of bilateral and multilateral co-operation in order to ensure broad international co-operation on an equal basis

(d) Evaluation of the role of the United Nations in the realization of benefits of space technology for all countries and examination of the need and possibilities for enhancing this role

12. Adoption of the report of the Conference

G. Establishment of the Main Committees and organization of work

494. Also at the 1st plenary meeting, the Conference decided to establish three Main Committees. It further decided:

(a) That items 1 to 8 and item 12 would be considered in plenary meetings;

(b) That item 9, as well as the introduction to the draft report, would be considered by the First Committee;

(c) That item 10 would be considered by the Second Committee;

(d) That item 11 would be considered by the Third Committee.

H. Election of officers other than the President

495. Also at its 1st plenary meeting, the Conference elected the following 17 States as Vice-Presidents:

Australia	Egypt	Pakistan
Bulgaria	Germany, Federal Republic of	Peru
Canada		Romania
China	Indonesia	Senegal
Colombia	Iraq	Uganda
Ecuador	Nigeria	Upper Volta

496. The Conference elected Mr. Carlos Antonio Bettencourt Bueno (Brazil) Rapporteur-General by acclamation.

497. The Conference elected by acclamation Dr. Robert Knuth (German Democratic Republic) Chairman of the First Committee, Dr. Minoru Oda (Japan) Chairman of the Second Committee and Mr. David K. Andere (Kenya) Chairman of the Third Committee.

498. The Conference appointed as "Friends of the Rapporteur-General" Mr. Alain Chappe (France), Mr. Rogelio Driollet (Argentina), Mr. Ahmed Fawzi-Hilal (Libyan Arab Jamahiriya), Mr. Juwana (Indonesia), Mr. Reinhard Loosch (Federal Republic of Germany), Mr. Mostafa Masmoudi (Tunisia), Mr. Boris Mayorsky (USSR), Miss Alba Petracio (Venezuela), Mr. Y. S. Rajan (India) and Mr. Ales Triska (Czechoslovakia).

I. Appointment of the members of the Credentials Committee

499. At the 5th and 6th plenary meetings, the Conference appointed the following States as members of the Credentials Committee: Algeria, Angola, Chile, China, Netherlands, Panama, Philippines, USSR and the United States.

J. Implications of Conference decisions for the programme budget of the United Nations

500. At the 13th (closing) plenary meeting of the Conference, on 21 August 1982, the Executive Secretary of the Conference made a statement to the effect that any provisions of the decisions or recommendations of the Conference that had implications for the programme budget of the United Nations would be brought to the attention of the General Assembly by the Secretariat at the time when the General Assembly considers the report of the Conference.

CHAPTER III

SUMMARY OF THE GENERAL DEBATE

501. The general debate, agenda item 8 of the Conference, took place in the course of nine plenary meetings, held from 9 to 13 August 1982. During the general debate, the Conference heard statements by the representatives of 67 States, of 3 specialized agencies, and 5 other United Nations Secretariat units and bodies, and of 5 other intergovernmental organizations as well as by observers for non-governmental organizations. Following is a brief account of the points which were stressed by the speakers in the debate.

502. Many delegations noted the great strides that had been made in the exploration and peaceful uses of outer space since the first artificial earth satellite was launched 25 years ago. Human beings have been in space, in some cases for extended periods, and have walked on the Moon. It was noted that unmanned spacecraft had landed on the Moon, Venus and Mars and had made detailed observations of Jupiter and Saturn from trajectories passing close to those planets. Astronomical observatories in orbit were observing celestial objects and phenomena that were not readily observable from the ground.

503. Many delegations referred to the great impact space activities were having in many countries, not only on economic activities, but also socially, culturally and even philosophically. It was suggested that space science and technology were creating a "new global awareness" due to the new capabilities and the new needs for communication and exchange between countries. The scientific study of space and the study of the earth from space had provided people with new perspectives. Space science provided new information on the evolution of the universe and the solar system and on the origin of life on earth. The study of other planets could make important contributions to the understanding of the stability of the earth's environment and the potential effect of human activities on that stability.

504. Many delegations pointed out that the Conference was meeting at a time when space activities were gaining an ever-increasing significance in everyday life in all regions of the world and advances in space technology were assuming ever greater relevance, not only for the industrial countries, but also for the economic and social progress of the developing world. Among the major themes that recurred in many statements were (a) the rapid, even accelerating, advances in space technology which have taken place during the past quarter century; (b) the increasing gap in space technology between the developed and developing nations; (c) the need for international co-operation to enable all countries, and in particular the developing countries, to enjoy the potential benefits of the new space technology; (d) the dangers posed by an extension of the arms race into outer space and the need to ensure that outer space is used for peaceful purposes only.

505. Numerous delegations referred to their countries' increased capabilities in utilizing space technology to solve earth-bound problems. Many countries, including developed and developing countries, emphasized the achievements in the field of telecommunications and the progress that had been made in such areas as remote sensing, meteorological forecasts, navigation and other services. References were also made to plans for satellite systems for direct television broadcasting, domestic and regional communications, and navigation. While most delegations emphasized earth-oriented applications, there was also discussion of

biological and materials research in the space environment, missions to Jupiter and Halley's comet and astronomical studies from space.

506. Many delegations noted that, due to the cost and complexity of space technology and to the global or regional coverage inherent in satellite orbits, international co-operation in space was highly advantageous. It was recognized that co-operation was not a one-sided proposition since potentially it could benefit all concerned. Some delegations pointed out that interational co-operation in outer space was not only expedient but imperative. The hope was expressed that the Conference would itensify international co-operation in space. A number of delegations noted that their countries saw the Conference in the context of the ongoing efforts to promote the new international economic order which space technology, if properly used, could support. The view was also expressed that UNISPACE 82 was related to other United Nations conferences as a continuing forum for the North-South dialogue and that one of its major goals was the lessening of the developing countries' technological dependence on the industrialized nations.

507. The discussion of ways to reduce the technology gap between developed and developing countries focused on the need for transfer of technology through education and training and financial aid of various sorts to defray the cost of expensive foreign technologies and equipment. The view was expressed that in order to reduce the above-mentioned gap, and in addition to stressing self-reliance and mutual co-operation among developing countries, the developed countries with more advanced space technology should assume special responsibilities. Some countries with space capabilities indicated their willingness to give favourable consideration to requests for technical assistance in the form of scholarships for education and training.

508. Some delegations also focused attention on the development of new technologies. It was stated that the needs of users should be put first in the development of new technology, as well as in its application, and that technological development should not be pursued purely for its own sake. The view was expressed that potential commercial demand could help motivate discoveries and applications since space technology was very expensive to develop. Some delegates felt, on the other hand, that a consumer-oriented approach was inappropriate to space technology, which required a more broad-based outlook. In considering the development of new space technology, several representatives noted the need for compatibility and complementarity among the space systems and technologies of different countries.

509. The discussion of international co-operation in the development of technology focused on the complementarity and compatibility among space systems developed by different States and on the unrestricted and equitable use of space technology. Several developing countries suggested that co-operation with the industrialized nations, including technical assistance and the financing of research and training programmes, would enable them to take advantage of the potential of space technology. The view was also expressed that it was important to distinguish between true co-operation and trading and selling of space technology. Countries involved in space technology were urged to make a commitment to co-operate both multilaterally and bilaterally with the developing countries. It was stressed - both by developing and developed countries - that the developing countries should increase co-operation among themselves in order to develop effective and efficient applications of space technology.

510. Attention was also drawn to the advantages of regional co-operation. It was noted that regional co-operation on well-defined projects could yield optimal benefits, since it flowed from common problems and interests. In view of such potential benefits, a proposal was made for the establishment of a Latin American regional space organization. Some developed countries made the point that space applications projects based on operational systems required large investments which, for smaller countries, could not be justified, on a purely national basis.

511. It was noted that remote sensing satellite data had proved very useful for environmental monitoring, geological prospecting, water resource development, agricultural and forest inventories, and air and water pollution surveys. Furthermore, data from meteorological satellites operating within the context of WWW were an integral part of weather forecasting services. The proposed SARSAT and COSPAS systems, both concerned with marine search and rescue, were mentioned as excellent examples of the humanitarian use of space technology.

512. Most delegations noted the usefulness and value of satellite remote sensing and meteorology. It was noted that satellite systems could assist in development surveys, agricultural early warning systems and disaster warning and relief, thereby improving the condition of humanity worldwide. Most delegations felt that such programmes could assist in narrowing the gap between developed and developing countries. Many delegations, however, also pointed to the dangers of the misuse of satellite data for military preparations or for interference with countries' national rights with respect to their territories and natural resources.

513. The need to ensure continuity and compatibility of satellites services was noted by many delegations. Delegations of developing countries, who could be expected to be users rather than suppliers of remote sensing satellites, stressed the importance of those assurances. The importance of appropriate spatial resolution, temporal coverage and data formats was noted. The need for a specific and over-all code regulating the use of remote sensing satellites was strongly expressed by some delegations, especially those of developing nations.

514. Some delegations expressed serious concern regarding the dissemination of data collected by remote sensing satellites. While several developed and developing countries felt that such information should be freely available to any interested State, most delegations felt that the consent of the sensed State should be required before data could be released to a third State organization or third party. Some developing nations felt that the consent of the sensed State must be obtained before sensing, even if the information was not to be disseminated beyond the concerned States; some felt that in no case should the information be available to any State other than the sensor and sensed States. Most representatives expressing an opinion on the point agreed that priority in access to data must be accorded the sensed State.

515. Many delegations observed that the technology and applications of satellite remote sensing and meteorology were developing rapidly and that there was a great need for trained personnel. Many developing countries felt that such personnel should be indigenous and that the technology and applications should be tailored to local needs and capabilities. Several delegations felt that the United Nations should establish a satellite data service to handle all remote sensing data and that regional centres could provide data to this service. Some delegations proposed that such a service should distribute data, while others felt that an information "clearinghouse" for satellite data would be more appropriate. Some

delegations suggested a world-wide system for earth observation, including resource surveys, environmental monitoring and even treaty compliance or other military activity monitoring.

516. In the discussion of telecommunications and the geostationary orbit, most countries felt that decisions should be made internationally in an organized manner so that the geostationary orbit and radio frequency spectrum would be accessible to all without restriction and used in an equitable and efficient manner. While some delegations expressed the view that specialized agencies of the United Nations, such as ITU, were the appropriate bodies to consider technical details relating to the efficient use of the geostationary orbit, several delegations felt that the Conference should provide some general guidelines. Some countries suggested that a specific legal régime under the United Nations or ITU should be established to regulate the use of the geostationary orbit and radio frequency spectrum, while other countries considered that ITU should co-ordinate use of those resources.

517. Some of the equatorial countries expressed the view that they had sovereignty over the sector of the geostationary orbit above their countries. A number of other developing countries agreed that the interests of the equatorial countries should be taken into account. Those countries warned of the possible adverse effects on their interests which might result from unrestricted use of the geostationary orbit. Other delegations did not share those views.

518. While most countries felt that technological progress by the developing countries should be encouraged, some developing countries urged the technologically advanced countries to assume responsibility for adoption of newer and more efficient communication technologies, thereby reducing the congestion of the geostationary orbit and allowing all nations greater flexibility in fulfilling their needs. Some delegations felt that the developing countries should rely on their own combined and co-operative efforts to gradually build up and strengthen their capabilities in space science and technology and to aid in solving the geostationary orbit problems. The view was expressed that a tax or levy should be applied to the use of the geostationary orbit. It was also suggested that removal of inactive satellites would reduce the risk of physical interference between satellites in the geostationary orbit.

519. Some delegations noted the great potential of direct television broadcasting from satellites for educational, medical and social purposes, especially for remote rural regions. Many countries felt that direct broadcasting from satellites should be undertaken in a manner compatible with sovereign rights and with the prior consent of the receiving State. Other delegations felt that the "spillover" provisions of the ITU Convention were sufficient in this regard. It was noted that direct television broadcasting might also be seen as a threat to the cultural integrity of the receiving States. The development of a code or set of principles regulating transnational transmissions by direct broadcasting satellites had preoccupied various bodies, including the United Nations General Assembly, ITU and UNESCO, but the dichotomy between free flow of information and prior consent had yet to be satisfactorily resolved: some countries insisted on the free flow of information across borders, while others insisted upon prior consent by the receiving State.

520. Several delegations noted that domestic and bilateral programmes using direct television broadcasting had already found successful applications and that several programmes for regional direct broadcasting by satellite were planned for the near

future. Many delegations felt, however, that international direct broadcasting should await such guiding principles as would be acceptable to all. The view was also expressed that the demands for protection of political and cultural integrity were not inconsistent with the established human right to transmit and receive information freely, regardless of frontiers.

521. Regarding the question of strengthening international space law, some delegations expressed the urgent need to supplement the 1967 Treaty on Outer Space and to elaborate norms aimed at banning the arms race from outer space. It was also suggested that additional norms should be elaborated covering particular areas of concern, such as remote sensing and direct television broadcasting. Other delegations expressed the view that existing international legal agreements covering space activities, in particular, the Convention and Regulations of the International Telecommunication Union (ITU) covering uses and applications of space technology, were sufficient.

522. During the course of the general debate, the potential danger implicit in the use of outer space for military purposes was mentioned with concern by most delegations, and the international community was urged to give urgent consideration to measures to ban an arms race in outer space. In this connexion, some delegations urged that negotiations be started within the Committee on Disarmament on the proposed treaty on the prohibition of stationing of weapons of any kind in outer space. While many delegations felt that the Committee on Disarmament was the most appropriate forum for discussing such concerns, others stated that the issue of the military uses of space should simultaneously be considered in COPUOS and in its Legal Sub-Committee. A few delegations expressed the view that the current Conference was an inappropriate forum for discussing the question. The view was also expressed that the responsibility for demilitarizing space rested with the two major space Powers.

523. Several delegations cited the need to negotiate an effective and verifiable agreement to prohibit anti-satellite systems. Some delegations stressed the need to resolve the problem of preventing the arms race in outer space as a whole. The view was also expressed that those space activities characterized as essentially defensive or as contributing to the avoidance of war should not be restricted, except in the context of some general or balanced disarmament programmes.

524. Many delegations felt that an arms race in space would be costly as well as dangerous, and it was noted that the redistribution of the vast resources denoted to military purposes could solve many pressing economic and social problems of the developing countries. Finally, the view was expressed that the banning of weapons of mass destruction from outer space was not enough; space technology must be actively used to promote peace.

525. During the general debate, numerous delegations denounced the wrongful use of space technology, such as surveillance satellites, in cases of military conflict, and condemned the aggression committed against Lebanon and the barbarous massacres committed against the Palestinian and Lebanese civilian populations by the aggressor in defiance of international law and morality, as well as the assistance provided to the aggressor in its expansionist policy.

526. Some countries announced a number of initiatives to bring broader benefits of space technology to other countries, particularly the developing countries. Those included, for instance, an initiative for long-term co-operative research efforts

on global habitability, projects for assisting all countries to better anticipate and cope with natural disasters, publication of an aid to obtaining valuable remote sensing data, an international conference on rural satellite communications, the development of a combined low-cost satellite ground station and photovoltaic power system optimized for developing country use, further study of the legal aspects of space activities, promotion of international space flights and increased research on the impact of extended space activities on the near earth environment. A developing country proposed the creation of a regional centre for space applications.

527. With respect to the role of the United Nations system in outer space matters, several countries, including developing and developed countries, called for a strengthening of that Organization's involvement in space activity. Some of them specifically stated their opinion that additional costs could be covered by the regular budget of the United Nations or within existing financial resources, while others urged increasing funding for United Nations space programmes through voluntary contributions from countries in a position to increase their support. The view was also expressed that funds for those programmes should also be sought through the existing channels of the United Nations for technical assistance, such as UNDP. Most countries expressed support for a United Nations co-ordinating role in space activities. The view was also expressed that increased funding through the United Nations system should be used to encourage developed countries' space projects in developing countries.

528. Some delegations proposed the creation of a new international agency for outer space, while others supported the establishment of a centre for outer space within the United Nations Secretariat. Several delegations stated that they saw no need for making any change in the existing United Nations framework; rather, they asked for a rationalization and better utilization of existing United Nations resources dealing with outer space. It was generally agreed that the United Nations should concentrate on programmes for the benefit of developing countries in the development and application of space science and technology, including the establishment of an international space information service.

529. Three of the specialized agencies of the United Nations were represented at the Conference and made statements in the course of the general debate. The Secretary-General of ITU said his organization, like UNISPACE 82, sought to heighten awareness of the potential benefits of space technology. It was concerned with activity at the governmental level in the areas of standardization and regulation and was carrying out certain technical co-operation activities in close collaboration with UNDP. The representative of FAO stated that remote sensing was already providing better understanding and more effective management of renewable resources, particularly in agriculture and forestry and might play an increasingly useful role in monitoring and anticipating natural disasters. The representative of UNESCO dwelt on the potential benefits which satellite communication could provide in the field of education, for which he suggested that certain guiding principles might be formulated which would ensure the free circulation of information to all countries.

530. Statements were also made in the course of the general debate by officials of other United Nations offices which played a role in space activities. The Deputy Executive Director of UNEP considered that it was time to give thought to a global resource data handling service and the dissemination of environmental data collected from space in a standardized and geographically-referenced form

compatible with data already available to countries. The Executive Director of UNIDO said that that organization had been engaged in a programme dealing with technological breakthroughs under which the potentials and implications of advances were being identified. The representative of the United Nations Centre for Science and Technology for Development noted the clear need for the international community to help developing countries build up their capacities in the use of space science and technology for development suited to their needs. The Vice-Rector of the United Nations University hoped that outer space would become a further dimension in the growth potential of the human race and that all mankind would reap its benefits.

531. Among the intergovernmental organizations taking part in the general debate, the Director-General of ESA underlined the exclusively peaceful purposes of that Agency's work in space research and technology and its range of co-operative agreements with many developed and developing countries. The representative of the European Community (EC) said that the Community's activities in space technology were related to the work undertaken at the national level by its members, concentrating on remote sensing and telecommunication. The representative of the Council of Europe said that his organization supported the development of European space programmes, and he endorsed the idea of an international satellite monitoring agency. The representative of the Council for Mutual Economic Assistance (CMEA) stressed the co-operative nature of the Council's work with centrally planned economies, with other developed countries and with developing countries, seeking practical results from each new experiment in space. The Secretary-General of the Pan-African Telecommunications Union (PATU) stated that his organization, in collaboration with ECA and with the assistance of other countries and international organizations, was studying the feasibility of a regional communication satellite system, AFROSAT, as part of a programme for the development and integration of the continent.

532. Non-governmental organizations involved with space research and technology whose representatives participated in the general debate included IAF and ICSU/COSPAR. Statements were also made by representatives of the International Association of Educators for World Peace, the Baha'i International Community and the Universal Esperanto Association, as well as by representatives of the United Nations Council for Namibia, the Afican National Congress of South Africa and the Pan-African Congress of Azania.

533. The Conference particularly examined a proposal to include as annexes to the present report documents A/CONF.101/5 and A/CONF.101/L.3 which contained the position of the Group of 77 concerning the arms race in outer space, direct television broadcasting and remote sensing. Due to the lack of consensus on that proposal, the Conference noted the concerns of the Group of 77 expressed in those documents.

CHAPTER IV

REPORTS OF SUBSIDIARY BODIES AND ACTION TAKEN ON THESE REPORTS BY THE CONFERENCE

A. Report of the First Committee

534. The Conference, at its 1st plenary meeting, allocated to the First Committee item 9 of the agenda as follows:

State of space science and technology

(a) Review and projection of the current and future state of science and technology for space research and applications

(b) Evaluation of the major developments in space science, technology and applications and assessment of the usefulness of these developments so far

35. The Conference requested that the Committee, in its consideration of that agenda item, consider the introduction and chapter I of the draft report of the Conference (A/CONF.101/3).

536. The First Committee met from 9 to 16 August 1982 and held nine meetings, including two meetings on Saturday, 14 August and one on Monday, 16 August 1982, which were added to the six meetings originally scheduled in order to allow the Committee to complete its work.

537. Mr. Robert Knuth (German Democratic Republic) was elected Chairman of the Committee by the Conference at its 1st plenary meeting.

538. The Committee, at its 1st meeting, elected the following other officers:

Vice Chairman: Mr. I. O. A. Lasode (Nigeria)

Rapporteur: Mr. Mahbub Uddin Chaudhury (Bangladesh)

At the same meeting the Committee decided to concentrate on detailed consideration of the introduction and chapter I of the draft report.

539. The Committee, at its 3rd meeting, established an informal working group to consider two paragraphs relating to the geostationary orbit. The working group held two meetings under the chairmanship of Mr. Soegihono Kadarisman (Indonesia) and reported to the Committee at its 5th and 7th meetings.

540. The Committee recommended to the Conference the adoption of the introduction and chapter I of the draft report of the Conference, as amended by the Committee and reproduced in the annex to its report.

541. The Committee was unable to reach agreement on paragraph 13 of the draft report, which was therefore referred to the Conference for consideration in plenary meeting.

Action by the Conference

542. At the 13th plenary meeting, on 21 August, the Conference considered the report of the First Committee, which was introduced by its Chairman, in the absence of the Rapporteur.

543. The Conference took note of the report of the First Committee and adopted the text recommended by the Committee for inclusion in the final report of the Conference.

B. Report of the Second Committee

544. The Conference, at its 1st plenary meeting, allocated to the Second Committee item 10 of the agenda as follows:

Applications of space science and technology

(a) Evaluation of the current and potential applications of space technology, taking into account present and foreseeable national and international programmes in the areas of space research

(b) Examination of the possibilities and mechanisms for enabling all States to benefit from space technology, bearing in mind their various levels of development, varying capacities to absorb new technologies and particular needs and priorities

(c) Examination of the choices for utilizing space technology available to countries at various stages of technological growth and of the difficulties they face in this regard

(d) Examination of the existing infrastructure and scientific and technological development in various countries, especially the developing countries, and of appropriate measure to augment their capabilities to develop space technology and facilitate access to such technology and to participate and co-operate in space activities so as to derive maximum benefit from space technology and its applications

(e) Examination of developments and system configurations appropriate to the use of space technology for education

(f) Discussion of compatibility and complementarity between various satellite systems, including those used for remote sensing, meteorology, communications and navigation

(g) Consideration of the implications of projected developments in the areas of space technology such as earth-orbiting solar power stations, space manufacturing, space transportation and manned space stations; consideration of the implications of the use of the geostationary orbit, the need and possibilities for optimizing that use, as well as of the measures to be taken to that end

(h) Discussion of the nature of, and ways of protecting, the near-earth environment including the upper atmosphere and magnetosphere

545. The Conference requested that the Committee, in its consideration of that agenda item, consider chapter II of the draft report of the Conference (A/CONF.101/3).

546. Mr. Minoru Oda (Japan) was elected Chairman of the Committee by the Conference at its 1st plenary meeting.

547. The Second Committee met from 12 to 19 August 1982 and held 11 meetings.

548. The Committee, at its 1st meeting, elected the following other officers:

Vice-Chairman: Mr. Miguel Sanchez Peña (Argentina)

Rapporteur: Mr. Ahmed Bensari (Morocco)

At the same meeting the Committee decided to consider chapter II of the draft report on a paragraph-by-paragraph basis.

549. The Committee discussed paragraphs 205 and 231 but was unable to reach greement on paragraph 205 and part of paragraph 231, which it therefore decided to refer to the Conference for consideration in plenary meeting.

550. The Committee reached consensus on all paragraphs of chapter II, with the exception of paragraph 205 and part of paragraph 231 referred to above.

551. The Committee therefore recommended to the Conference the adoption of chapter II of the draft report of the Conference, as amended by the Committee and reproduced in the annex to its report.

Action by the Conference

552. At the 13th plenary meeting, on 21 August, the Conference considered the report of the Second Committee, which was introduced by its Rapporteur. Attention was drawn to corrections to be made in the text submitted by the Committee.

553. The Conference took note of the report of the Second Committee and adopted the text recommended by it for inclusion in the final report of the Conference.

C. Report of the Third Committee

554. The Conference, at its 1st plenary meeting, allocated to the Third Committee item 11 of the agenda as follows:

International co-operation and the role of the United Nations

(a) Consideration of reports on the nature and extent of the bilateral and multilateral co-operation in outer space activities

(b) Consideration of reports on the activities of the United Nations, including its specialized agencies, and of other international organizations dealing with the exploration and peaceful uses of outer space

(c) Evaluation of the role of the United Nations, its specialized agencies, other international organizations and programmes of bilateral and multilateral co-operation in order to ensure broad international co-operation on an equal basis

(d) Evaluation of the role of the United Nations in the realization of benefits of space technology for all countries and examination of the need and possibilities for enhancing this role

555. The Conference requested that the Committee base its consideration of that agenda item on chapter III of the draft report of the Conference (A/CONF.101/3).

556. Mr. David K. Andero (Kenya) was elected Chairman of the Committee by the Conference at its 1st plenary meeting.

557. The Third Committee met from 13 to 19 August 1982 and held seven meetings.

558. The Committee, at its 1st meeting, elected the following other officers:

Vice-Chairman: Dr. Djordje Teleki (Yugoslavia)

Rapporteur: Mr. Karol van Kesteren (Netherlands)

559. The Committee, at its 1st meeting, decided to consider chapter III of the draft report on a paragraph-by-paragraph basis.

560. At its 4th meeting the Committee discussed paragraph 419 but was unable to reach agreement on it. It therefore decided to refer that paragraph to the Conference for consideration in plenary meeting.

561. At its 6th meeting the Committee established an informal working group to consider the last four paragraphs of chapter III, relating to the organizational set-up of the Outer Space Affairs Division of the United Nations. Mrs. Eva Nowotny (Austria) was elected to convene this working group, which held one meeting on 19 August. The working group reported to the Committee at its 7th meeting, on 19 August.

562. The Committee reached consensus on all paragraphs of chapter III, with the exception of paragraph 419, mentioned above.

563. The Committee therefore recommended to the Conference the adoption of chapter III of the draft report of the Conference, as amended by the Committee and reproduced in the annex to its report.

Action by the Conference

564. At the 13th plenary meeting, on 21 August, the Conference considered the report of the Third Committee, which was introduced by Mr. Karel van Kesteren (Netherlands), the Rapporteur of the Committee. Attention was drawn to corrections to be made in the text submitted by the Committee.

565. The Conference took note of the report of the Third Committee and adopted the text recommended by it for inclusion in the final report of the Conference.

D. Report of the Credentials Committee

566. At its 5th and 6th plenary meetings, held on 11 August 1982, the Conference, in accordance with rule 4 of its rules of procedure, appointed a Credentials Committee consisting of the following States: Algeria, Angola, Chile, China, Netherlands, Panama, Philippines, USSR and United States.

567. The Credentials Committee convened on 12 August 1982.

568. Mr. Domingo L. Siazon (Philippines) was unanimously elected Chairman.

569. The Committee had before it a memorandum dated 10 August 1982 from the Secretary-General of the Conference on the status, as at 10 August 1982, of credentials of the representatives to the Conference. The memorandum, as orally amended by the Legal Adviser during the meeting (see para. 570 below), indicted that:

(a) Credentials issued by the head of State or Government or by the minister for foreign affairs, as provided for in rule 3 of the rules of procedure of the Conference, had been received in respect of representatives of 63 States, namely: Albania, Angola, Argentina, Australia, Austria, Bangladesh, Belgium, Brazil, Bulgaria, Byelorussian SSR, Canada, Chile, China, Costa Rica, Cuba, Cyprus, Czechoslovakia, Denmark, Finland, France, Gabon, German Democratic Republic, Germany, Federal Republic of, Greece, Holy See, Hungary, India, Iran, Iraq, Ireland, Israel, Japan, Mexico, Mongolia, Morocco, Netherlands, New Zealand, Nigeria, Norway, Panama, Poland, Portugal, Republic of Korea, Romania, San Marino, Saudi Arabia, Senegal, Spain, Sri Lanka, Sudan, Sweden, Syrian Arab Republic, Thailand, Turkey, Uganda, Ukrainian SSR, USSR, United Kingdom, Upper Volta, Uruguay, Venezuela, Yugoslavia and Zimbabwe;

(b) Credentials in the form of a telegram from the head of State or Government or minister for foreign affairs had been received in respect of representatives of two States, namely: Luxembourg and Viet Nam;

(c) Credentials in the form of a letter, note verbale or telegram emanating from a permanent representative, an ambassador, a minister other than the minister for foreign affairs or from a permanent mission, embassy or ministry of the State concerned in respect of representatives of 24 States, namely: Algeria, Bolivia, Colombia, Democratic Yemen, Ecuador, Egypt, Guatemala, Indonesia, Italy, Kenya, Lebanon, Lesotho, Libyan Arab Jamahiriya, Malaysia, Pakistan, Peru, Philippines, Rwanda, Somalia, Switzerland, Tunisia, United Republic of Cameroon, United States and Zaire;

(d) As at 12 August 1982, representatives of 91 States had registered as participants in the Conference. No credentials had yet been received from the representatives of two States, namely: Mali and Qatar.

570. The Legal Adviser stated that since the preparation of the memorandum by the Secretary-General of the Conference, representatives of additional States had registered and some had submitted credentials. Accordingly, the Legal Adviser orally amended the memorandum to reflect the status as at the time of the meeting. The contents of the memorandum, as orally amended, are set out in the foregoing paragraph. The Legal Adviser further explained that the States listed in subparagraph (a) above had submitted credentials in the form required by rule 3 of

the rules of procedure of the Conference; the States mentioned in subparagraph (b) had submitted credentials in the form of telegrams emanating from the authorities referred to in rule 3, while the States mentioned in subparagraph (c) had issued credentials signed by authorities other than those referred to in rule 3; the States referred to in subparagraph (d) had registered delegates as participants in the Conference, but had not yet submitted any credentials. The Legal Adviser stated that the practice was to approve the credentials issued in the form required by rule 3, to approve provisionally those credentials which were not in proper form and to recommend to the Conference that the delegations that had not yet submitted credentials should be permitted to continue to participate in the Conference on the understanding that proper credentials would be submitted as soon as possible.

571. The representative of the USSR stated that his Government did not accept the credentials presented by the delegation of Chile, considering that those credentials had been issued by persons who had usurped power in that country.

572. The representative of Chile stated that he was surprised at the statement by the representative of the USSR, considering that since 1974 Chile and the USSR had been members of COPUOS and no similar problem had arisen. He considered that the Committee was not a political forum and that its task was to examine the form of the credentials.

573. On the proposal of the Chairman, the Committee unanimously adopted the following resolution:

"The Credentials Committee,

"Having examined the credentials of the representatives to the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, referred to in paragraph 4* of the present report,

"Taking into account the different reservations expressed by delegations during the debate,

"1. Accepts the credentials of the 63 States referred to in paragraph 4 (a) above;

"2. Accepts provisionally the communications relating to the representatives of the 26 States referred to in paragraphs 4 (b) and (c) above, pending the receipt of credentials complying with rule 3 of the rules of procedure;

"3. Recommends that the representatives of the two States referred to in paragraph 4 (d) above should continue to participate provisionally in the Conference in accordance with rule 5 of the rules of procedure, pending the receipt of credentials complying with rule 3."

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* Now reflected in paragraph 569 above.

574. The Committee also decided to authorize its Chairman to formulate the report of the Committee with the assistance of the Secretary and to submit the report to the Conference after having shown a draft thereof to the members of the Committee. The Chairman was further authorized to supplement, when introducing the report to the Conference, the information set out in paragraph 569 above so as to reflect any further registrations, credentials and communications received by the Secretary-General after the meeting of the Committee.

575. On the proposal of the Chairman, the Committee decided to recommend to the Conference the adoption of the following resolution:

> "The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space
>
> "*Approves* the report of the Credentials Committee."

Action by the Conference

576. At the 12th plenary meeting, on 20 August, the Conference considered the report of the Credentials Committee.

577. The Chairman of the Committee announced that, since the date of the Committee's meeting, credentials in good and due form had been received from Indonesia, Italy, Pakistan and Switzerland and that credentials signed by authorities other than those referred to in rule 3 had been received from Benin and Kuwait. THe United Republic of Tanzania had registered delegates but had not yet submitted any credentials. The total number of States participating in the Conference was therefore 94.

578. After taking note of that supplementary information, the Conference approved the report of the Credentials Committee.

CHAPTER V

ADOPTION OF THE REPORT OF THE CONFERENCE

579. The Rapporteur-General introduced the draft report of the Conference (A/CONF.101/L.2 and Add.1) at the 12th plenary meeting, on 20 August 1982.

580. The Conference considered chapters I, II and III of part two of the draft report and adopted them with certain amendments.

581. At the 13th plenary meeting, on 21 August, an informal consultation group entitled "Friends of the President", which had been established to consider the paragraphs referred to the plenary by the three committees and which consisted of three countries from each geographical region, submitted proposed texts for three paragraphs to the Conference. The proposed texts were adopted by the Conference for inclusion into the decisions and recommendations of the Conference as paragraphs 13, 14 and 426.

582. At the same meeting, the representative of Brazil introduced a draft resolution expressing the Conference's gratitude to the host country. The Conference adopted the draft resolution by acclamation. The text of the resolution is reproduced in chapter VII below.

583. The Conference adopted the draft report as a whole and authorized the Rapporteur-General to complete it in conformity with United Nations practice, with a view to its submission to the General Assembly at its thirty-seventh session.

584. Following statements by the representatives of Egypt (on behalf of the African States), the Philippines (on behalf of the Asian States), the USSR (on behalf of the Eastern European States), Uruguay (on behalf of the Latin American States), New Zealand (on behalf of the Western European and other States) and Morocco (on behalf of the Arab States), the Secretary-General made a statement summing up the principal results of the Conference. The text of the Secretary-General's statement is reproduced in chapter VI below.

585. The President of the Conference made a closing statement and declared the Conference closed. The text of the President's statement is reproduced in chapter VI below.

CHAPTER VI

CONCLUDING STATEMENTS

A. Statement by the Secretary-General of the Conference

586. After years of preparation, and two weeks of intensive work, of meetings and discussions, consultations and confabulations, negotiations and receptions, we are now at the end of our Conference. By general consensus this was a successful Conference. But what have we achieved?

587. I feel we have achieved a great deal. What is set out in our reports, is only a part - though an important part - of our achievement. In addition, the Conference has created a wide awareness - I hesitate to say a world-wide awareness - about capabilities of man in space technology and its applications and of the potential this holds for our future. The Conference has brought together scientists and statesmen, politicians and policy-makers from almost a hundred countries who have, I hope, developed a better understanding of the many multi-dimensional features of our subject and a great appreciation of each other's point of view. This understanding and the spirit of co-operation are manifest in the fact that all the three Committees have produced consensus reports dealing with topics which are at once complicated and simple. Such issues, you will agree, are often the most difficult to resolve, because concepts and facts are at play in the same arena. We have resolved many and agreed to continue discussing others. I hope that this co-operative, imaginative and business-like spirit of Vienna would be carried far beyond the walls of this beautiful building to all corners of the earth - and beyond, perhaps also into outer space.

588. We had no plans to build a large new administrative structure to further the ends of this Conference and, fortunately, we have not chosen such a simple and easy symbol to mark the success of our Conference. Instead, we have examined in some detail the problems of using space in different ways for the good of all mankind. Our suggestions and recommendations have specificity and yet they are grounded in the global and co-operative framework of man's space enterprise. We have recognized that beyond the adventure, beyond the urge to find out more about the cosmos, there is a whole new agenda here on the ground for various countries, individually and jointly, to ensure that this new happening in human history will have meaning for the largest number of people. We have emphasized that we must proceed, past our concern with widening existing highways, to building of new pathways into wilderness. Our reports recognize that in principle the benefits of space can descend on this earth to every man and woman as democratically as sunlight.

589. Of course, what we have adopted today is not a blueprint for the uplift of humankind, nor even a moderately exhaustive plan of action for future space activities. It could not have been, because we are still groping. Rather, I see our work as a partial road map into the future with many roads and avenues, and many destinations. It is for each country, individually and in co-operation, to decide its goals and to chart its own course to achieve these goals. Several recipes and guidelines are, however, clarified in our reports.

590. And yet there are some common imperatives of the space age. We have to move and prosper with each other and with our earth. We can no longer live off each

other nor can we merely exploit our earth. Our planet, and we ourselves, have, in a sense, become one organism because we influence each other and touch each other, ever so intimately, independent of distance. The time constant for interaction between segments of human society has become shorter than the response time of the human nervous system. We must move from being new neighbours to become neighbourly.

591. During an evening lecture a distinguished speaker wondered whether our venturing out into space is not in response to the basic urge of our gene material, DNA, to spread out into the universe. I hope that the exuberant selfish gene would also recognize that it should not be wiped out here on earth through the same means it has evolved for its expansion. We have expressed our concerns in this regard during this Conference. I hope that our expression will make a difference.

592. I have often been accused, by friends and colleagues, of introducing, according to them, extraneous, philosophic and aesthetic elements into our deliberations and documents. I plead guilty. We do have a new philosophic, aesthetic and simultaneously ethical input into our history. Without recognizing this, our directions might go astray. We have to combine our new technical virtuosity with a new awareness of our connectivity, with each other and with our planet. To a small measure the work of this great Conference makes such an attempt. I congratulate you Mr. President, distinguished delegates, for this achievement.

593. I would like to express my deep gratitude to you and - through you - to the Austrian Government for the excellent arrangements made for this Conference. The co-operation, help and efficiency of all who worked for this Conference have contributed centrally to the smooth functioning of the Conference. The hospitality of your countrymen is of course proverbial and I assure you that we have been made to feel like pampered guests throughout our stay here.

594. Finally, I offer thanks to the staff of my own organization, the United Nations, my distinguished colleagues in the Secretariat, particularly the hard-working and indispensable Executive Secretary, and the offices of the United Nations in Vienna and in New York. Without the devotion and hard work of everyone concerned - the conference officers and interpreters who worked here in the conference hall and in New York, those concerned with production and distribution of documents, the translators both here and in New York and a host of others - we could not have carried out our work as we did.

B. Statement by the President of the Conference

595. After two weeks of intensive work, we are now at the close of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space. Coming as it did a full 14 years after the first Conference, this was by itself a momentous event. But it has assumed far greater importance because of the very rapid progress made in space technology in the intervening years: progress that has drastically altered the possibilities that space technology offers. It has now assumed the form of an important and powerful tool for accelerating economic development, promoting education and communication, and monitoring the well-being of our environment. Equally importantly, the excitement and daring exploits of man in space - through astronauts, cosmonauts and spationauts, as well as through robot vehicles - have fired the imagination and expectations of people everywhere. I

stress expectations, because countries now look to space technology, and therefore to this Conference also, to come up with ways and means of bettering the quality of life.

596. It is in the context of this backdrop that one must view our endeavours over the last two weeks. Have we succeeded in fulfilling the hopes of peoples around the world? Has our Conference created a path or least indicated a direction by which all humanity can share the fruits of these new exploits of man?

597. Personally, looking upon our deliberations here and at the final output - namely, the reports of the three Main Committees - I am indeed gratified by what we have been able to achieve. The recommendations for concrete action, though they may at first seem modest, are well thought-out steps that should set the pattern for a more co-operative and equitable sharing of the benefits from space. They also aim at strengthening indigenous capabilities and developing human resources, which - in the final analysis - is our greatest resource and one that is "renewable".

598. I am also happy about another aspect: the reports of all the three Main Committees were finalized on the basis of consensus. This, I feel, augurs well for future co-operation in this field. I would sincerely hope that this spirit of accommodation, of compromise and co-operation is carried to the day-to-day dealings between our various nations in all fields.

599. However, my happiness about our proceedings is somewhat dampened by the fact that our co-operation here is parallelled by an unprecedented effort to develop and even deploy weapons that would threaten peace in space. While we have successfully incorporated our concerns about this in the report - and for this I am most grateful for the co-operation extended by various delegations in my efforts - I am unfortunately not sure whether these concerns will have an impact on the reality of what is happening. However, I do hope that this Conference, by stressing the peaceful uses of space, by highlighting the need for co-operation as a pre-requisite to mutual benefits, will create a world-wide awareness of the need to ensure that outer space remains a peaceful environment - one that is free of weapons and one in which all peaceful activity is inviolable.

600. The positive achievement of this Conference has been substantial and for this the credit goes to all of you. We should, however, also remember the tremendous efforts made by our distinguished Secretary-General as well as by the Executive Secretary and by the staff of the United Nations, both in the preparations for this Conference and in its smooth functioning. It is also with sincere gratitude that I would like to mention the excellent support that I have received from my colleagues in the Bureau of the Conference, including our distinguished Rapporteur-General and the Vice-Presidents, as well as the Chairman of the three Committees and other officers of the Conference.

601. I hesitate to mention a fellow-countryman, but in all fairness I must recall the very excellent work done by Ambassador Jankowitsch as Chairman of the Preparatory Committee and indeed by the whole Committee.

602. I hope that in addition to your work in the Conference, you were able to spend a little time looking at our city. I hope our efforts to make your stay here as comfortable and enjoyable as possible were fruitful.

603. I wish you all a very pleasant and comfortable journey back to your homes.

604. I now declare closed the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space.

CHAPTER VII

RESOLUTION ADOPTED BY THE CONFERENCE

605. At its 13th (closing) plenary meeting, on 21 August 1982, the Conference adopted the following resolution:

EXPRESSION OF GRATITUDE TO THE HOST COUNTRY

"The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space,

"Having met at the Hofburg Congress Centre in Vienna from 9 to 20/21 August 1982, in response to the invitation of the Government of Austria,

"1. Expresses its deep appreciation to the Government of Austria for its generosity in hosting the Conference in a splendid manner, and for the kindness and efficiency of the Austrian personnel that made the necessary arrangements for and assisted during the work of the Conference, which contributed greatly to its success;

"2. Expresses its profound gratitude to the Austrian authorities responsible for the many special arrangements associated with the work of the Conference in connexion with the technical presentations, space demonstrations, exhibitions, poster sessions, forums and lectures that enhanced the work of the Conference;

"3. Extends its thanks to the Government and people of Austria, as well as to the authorities and people of Vienna, who have been so hospitable to the participants in the Conference."

CHAPTER VIII

ACTIVITIES ASSOCIATED WITH THE CONFERENCE

606. During and prior to UNISPACE 82, a number of special events were organized which provided an opportunity for States, intergovernmental and non-governmental organizations and private interests to present information or demonstrations relating to their interests or accomplishments in the field of outer space activities and to promote greater awareness about the use and potential of space technology.

607. The various activities included: (a) space demonstrations, (b) technical presentations and poster sessions, (c) evening lectures, (d) a forum organized by COSPAR and IAF, (e) exhibitions, (f) activities arranged by and for non-governmental organizations and (g) preparatory and public awareness activities.

608. Each of these activities is described in the following paragraphs.

A. Demonstrations of space applications

609. With the objective of bringing to the Conference some glimpses of the actual applications of space technology in a variety of situations, the Conference secretariat - in co-operation with a number of countries and organizations - arranged a number of demonstrations of space technology. For this purpose, a special large screen and associated projection arrangements were made in the plenary hall, where most of the demonstrations were watched "live" by the delegates.

610. The live demonstrations in the plenary meetings were about 10 minutes long and were generally shown at the beginning of the morning and afternoon meetings during the first week of the Conference. They included: satellite educational television broadcasting; scientific consultations via satellite; remote medical services via satellite; reception and processing of remote sensing data; reception and dissemination of meteorological data; maritime communication and navigation; and video-conferencing (one-way), including addresses by heads of State.

611. Other demonstrations were conducted for the entire two-week period using partly live and partly taped material. These were located in the Seitengalerie, outside the main conference room, and were available for observation or consultation by participants. These demonstrations included world-wide access to technical and scientific data banks, news reports from major press agencies via satellite, and a solar-powered satellite ground station. In addition, satellites were used in direct support of the Conference to provide remote interpretation and remote translation.

612. To facilitate these demonstrations, 18 satellites and 39 ground stations around the world were used. This was made possible only by the application of up-to-date management techniques and the support received from Member States, international organizations and the Austrian authorities. The demonstrations are briefly described in the following paragraphs.

1. Satellite educational television broadcasting

613. Broadcasting satellites have a unique ability to provide television programmes to large areas that are sparsely populated and difficult to reach. One demonstration showed such educational television broadcasting to rural areas of India.

614. Educational television programmes that were broadcast by the NASA ATS-6 satellite to 2,400 villages in India were shown, and the results of the Satellite Instructional Television Experiment (SITE), which had been conducted in 1975/76 were discussed. It had included basic science programmes for students of 6 to 12 years of age, enrichment courses in science and mathematics to teachers during vacation periods and general educational programming to village adults in the evening. The experience from this experiment is being used in the establishment of the Indian National Satellite (INSAT) system, of which the first satellite was launched earlier this year.

615. The transmission was relayed from New Delhi via Fucino, Italy, using an INTELSAT satellite and the OTS satellite developed by ESA.

2. Scientific consultations via satellite

616. Three satellites, PALAPA, INTELSAT and OTS, were used to relay a transmission between two Indonesian universities via Jakarta and Fucino, Italy. What was demonstrated is how a university, confronted with a particular scientific problem (in this case pollution) is able to seek support from specialists in another university via the PALAPA satellite system. "Live" interaction with the Conference - through replies to questions asked from Vienna - was also included.

3. Remote medical services

617. Satellite technology can assist in providing to rural areas medical services that require specialist consultation. This demonstration showed the use of the Canadian Anik-B satellite to permit health practitioners in remote villages in north-eastern Canada to transmit electro-cardiograph, electro-encephalograph and X-ray data to an expert at Memorial University in St. John's, Newfoundland.

618. In addition to using Anik-B, the demonstration used the OTS satellite to relay the transmission to Vienna. Again, interaction with the Conference was also included, through a dialogue.

4. Reception and processing of remote sensing data

619. The value of satellite remote sensing for surveying earth resources has been clearly demonstrated, but applications have been limited by difficulties and delays in obtaining data. This is particularly important in areas such as agriculture and hydrology where rapid access to data is essential. A means of ensuring rapid access to satellite data would be the establishment of a world-wide data distribution system using communication satellites.

620. For immediate access to data, a "quick look" system can be used to relay data in semi-processed form as it is received from the satellite. This was demonstrated by relay of data from the NASA LANDSAT to the ESA ground station network (Earthnet) to Vienna via the OTS satellite.

621. A demonstration of interactive digital image processing was also included, using the German Aerospace Research Establishment (DFVLR) digital interactive image analysis system (DIBIAS) at Oberpfaffenhofen via the OTS satellite. Processing of data from the NASA Heat Capacity Mapping Mission (HCMM) satellite and the NIMBUS-7 coastal zone colour scanner (CZCS) was demonstrated.

5. Reception and dissemination of meteorological data

622. Meteorological satellite data are routinely used throughout the world for weather forecasting. This has been based on the availability of low-cost ground stations and free access to data transmissions from meteorological satellites.

623. Images from the NASA GOES-East and GOES-West satellites and from the ESA METEOSAT-2 were received by a Secondary Data Users Station (SDUS) at the Conference site and displayed. METEOSAT data were received directly from the satellite, while the GOES data were received and reformatted at a ground station in Lannion, France, and relayed via METEOSAT to Vienna.

624. In addition, an APT terminal received and displayed images from the United States NOAA satellites and the Soviet Union's METEOR satellites.

6. Maritime communication and navigation

625. INMARSAT became operational in 1982, linking coastal earth stations with ships and off-shore installations throughout the world, for both routine and emergency communications by telephone or telex.

626. To demonstrate this service, a ship-type terminal was installed at the Conference site in Vienna, enabling the Conference to communicate with ships at sea via coastal earth stations at Goonhilly (United Kingdom), Eik (Norway), Southbury (United States) and Yamaguchi (Japan).

7. Video-conferencing

627. Communication satellite technology allows groups of people to communicate, both by voice and visually, without leaving their offices. This was demonstrated by live addresses to the Conference by the heads of State of Brazil and Sri Lanka, speaking from their own capitals.

628. In addition, the Soviet cosmonauts aboard the Soviet Salyut-7 were shown in their spacecraft in orbit and spoke to the Conference. The signals were relayed from the Dubna earth station near Moscow via the Soviet Union Statsionar-4 satellite to the MOSKVA earth station in Vienna.

8. Remote conference services

629. Through the use of communication satellites, conference services - including simultaneous interpretation of meetings and translation of documents - can be provided from remote locations permitting the most efficient use of personnel and facilities. Communication satellites can provide links for voice, video, text and facsimile transmission.

630. For these purposes, a satellite earth station installed by COMSTAT at United Nations Headquarters in New York was used to communicate via an INTELSAT satellite with an earth station at the Conference site.

631. Simultaneous interpretation into the six official languages of the Conference was also done experimentally from New York using six language channels, two control channels and a video channel. This was done for two meetings of the plenary.

632. The translation of Conference documents was done operationally from New York for the entire Conference. A major advantage of this system was that documents were transmitted from Vienna to New York at the end of the working day and translated in New York during regular working hours due to the six-hour time difference. The translated documents were transmitted back to Vienna in time for the morning meetings the next day.

9. World-wide access to technical and scientific data banks

633. With modern communication systems, an inexpensive desk-top computer can link any user with any data bank. Some of these terminals were available at the Conference site to provide access to the following computer data banks:

(a) Informational Retrieval System (IRS), Frascati, Italy;

(b) National Technical Information Service (NTIS), Washington, D.C., United States;

(c) NASA/GSFC Get Away Special (GAS), Greenbelt, Maryland, United States;

(d) NASA/JSC Payload Integration Library System (PILS), Houston, Texas, United States.

634. The terminal in Vienna communicated via TELENET with the data banks in the United States and via ESA-Quest with several data banks located in the ESA member States. Radio Austria provided the essential local access to these networks via RADAUS NODE. High-density digital data was relayed back from the relevant data bank to Vienna via the OTS satellite.

10. News reports

635. News headlines from around the world were displayed on video units and teleprinters located outside the main conference room. INTELSAT, OTS and INTERSPUTNIK satellites were used to provide access to reports from Reuters, Agence France Presse (AFP), Inter Press Service (IPS), and TASS.

11. Solar-powered satellite earth station

636. Both applications and "spin-offs" of space technology were demonstrated by means of a satellite earth station powered by photovoltaic solar panels which also powered a water pump.

637. The system was developed by the solar energy projects branch at the NASA Lewis Research Centre together with the Bureau of Science and Technology/Office of Education of the United States Agency for International Development.

12. Applications of space technology

638. A "live" transmission from the USSR described the various applications of space technology as used in the Soviet Union. This programme was routed from the Soviet Union to Vienna in the same way as the programme from Salyut-7.

B. Technical presentations and poster sessions

639. At the request of some of the specialized agencies and in order to enhance the technical content of the Conference, a series of technical presentations were organized on 13 August. The agencies concerned and the topics were as follows:

ITU/CCIR: The application of space telecommunications for development (Mr. R. E. Butler)

UNDRO: Satellite applications to disaster management (Mr. L. Walter)

FAO: Remote sensing applied to renewable resources - FAO's role and activities to assist developing countries (Dr. J. A. Howard)

UNEP: Remote sensing policy implications for bio-mass development (seminar chaired by Dr. Noel Brown; other speakers: Dr. Pincas Jawetz, Prof. Harbons Arora, Dr. Michael Gwynne)

ESA: The ESA remote sensing satellite ERS-1 (Dr. D. Lennertz)

In addition to the above, INMARSAT presented a film "Linked - via INMARSAT".

640. Apart from the technical presentations, "poster sessions" were organized to enable interested participants to present technical aspects of national papers and papers presented by participating organizations in the Conference. The following poster sessions were held:

10 August - "Global habitability" - Presenter: Shelby Tilford, NASA Director of Environmental Observations, and Richard Goody of Harvard University (United States)

- "Rural Satellite Program" - Presenter: Ms. Anna Stahmer, AID Rural Satellite Program (United States)

16 August - "Communication Satellite Technology" - Presenter: Dr. Hall Himball (United States)

- "Current Status of LANDSAT 4 Thematic Mapper Imagery and new Landsat Data Indexes" - Presenter: Dr. Vincent Salomonson (United States)

17 August - "Space Activities in China" - Film Presentation (China)

- "Space Telescope" - Presenter: Dr. Ricardo Giacconni, Johns Hopkins University (United States)

20 August - "Canada in Space" - Film presentation (Canada)

641. On 12 August, an International Astronomy Seminar was organized jointly by the United Nations and the International Astronomical Union. The programme included the following presentations:

The Sun and sunlike stars: Prof. M. K. V. Bappu (India)

Solar-terrestrial influences: Prof. R. M. Bonnet (France)

The size, shape and temperature of stars: Prof. R. Hanbury Brown (Australia)

X-ray and gamma-ray astronomy, new windows into our universe: Prof. W. H. G. Lewin (United States)

Space science and cosmology: Prof. M. S. Longair (United Kingdom)

Summary and concluding remarks: Prof. A. G. Massevitch (USSR)

C. Evening lectures

642. The UNISPACE 82 secretariat organized three evening lectures by internationally eminent personalities - Arthur Clarke, Chancellor of the University of Moratuwa in Sri Lanka; Carl Sagan, Director of the Laboratory for Planetary Studies and Professor of Astronomy and Space Sciences at Cornell University in Ithaca, New York; and Oleg Gazenko, Director of the Institute of Biomedical Problems of the USSR Ministry of Health.

643. The broad purpose of the lectures was to give the audience, including the participants to UNISPACE 82 and the general public, a look at space from different perspectives. The lectures covered the practical benefits available from space and also the larger philosophical issues that space encompasses.

644. Arthur Clarke spoke on 10 August on "Space flight - imagination and reality"; Carl Sagan on 12 August on "The exploration of the solar system - retrospect and prospect"; and Oleg Gazenko on 17 August on "Man in space - space exploration from the biological point of view".

D. Background papers

645. A number of background papers were prepared for the information of Member States and as an aid to their preparations for UNISPACE 82. They involved the participation of over 200 scientists, engineers and others from all over the world. Recognizing their long-term value and also in order to make them more widely available, the Conference secretariat arranged to have them published in the form of a book entitled The World in Space (publisher: Prentice Hall). The book was released just before the Conference.

E. Regional and interregional seminars

646. Six regional and interregional seminars were held on space applications and oriented specially towards discussing issues related to UNISPACE 82. Four seminars were held in 1981, in Addis Ababa, Buenos Aires, Toulouse and Djakarta, and the other two were held in 1982 in Quito and Addis Ababa. A summary of the recommendations of those seminars was compiled and circulated to participants in UNISPACE 82 (A/CONF.101/BP/13).

F. Other seminars and meetings

647. At the initiative and behest of the Conference secretariat, a number of seminars and meetings were arranged by various organizations to discuss matters related to the concerns of UNISPACE 82. Among those was a special symposium on the role and impact of space research in developing countries (organized jointly by COSPAR, COSTED and the United Nations in conjunction with the COSPAR meeting in Ottawa in May 1982) and a Stanley Foundation meeting in June 1982 on maintaining peace in outer space. Copies of the report of the latter meeting were made available at the time of the Conference. The Stockholm International Peace Research Institute (SIPRI) had also organized a meeting in Stockholm in November 1981 on "Outer space - a new dimension of the arms race" and a book based on this meeting was made available by SIPRI to delegations at UNISPACE 82. In

March 1982, the Conference secretariat - with financial assistance from the Government of Japan - had organized an international round table on "Alternative space futures and the human condition". A book based on the discussions has been published and was released just before the start of UNISPACE 82.

G. Essay and poster contests

648. In order to promote greater interest and awareness about space technology in general, and UNISPACE in particular, two international contests were organized. One was an essay contest for school children on the theme "How space technology can transform my country and the world", the other was an international poster contest, with the winning entry to be the official poster for UNISPACE 82. The response to both contests was very enthusiastic and large numbers of entries were received. An exhibition of the winning national posters was organized during the Conference just outside the plenary hall. The winning essays from each region were printed (in the original language and with an English translation) and copies were made available to participants in the Conference. Three of the five regional winners, at the request of the Conference secretariat, had provided tapes (two video and one audio) which they read out excerpts or spoke about their essays. These were played in the plenary hall during the Conference.

H. Other public awareness activities

649. A special booklet was published by the United Nations which described the benefits of outer space, derived through various applications, and the role of the United Nations in space. Special postage stamps to commemorate UNISPACE 82 were also issued, along with a brochure that very briefly described the uses of space. Many other countries also issued special postage stamps.

650. Five issues of a newsletter - UNISPACE 82 News - were put out by the Conference secretariat. They included information on various UNISPACE-related activites as well as articles in Arabic, French, Russian and Spanish, though the basic language used for most articles was English.

I. Exhibitions

651. In order to promote greater public awareness about space technology, and especially about its practical uses, the Conference secretariat organized - with the help and co-operation of the concerned Member States and organizations - a series of exhibitions at United Nations Headquarters in New York from February to July 1982. The common theme was "The use of space technology for the solution of earth-bound problems". Six separate exhibitions on that theme were organized, for about a month each, as follows:

February:	International Civil Aviation Organization
March:	India
April:	European Space Agency
May:	Indonesia
June:	Japan
July:	USSR

652. The exhibitions consisted basically of photographs, displays and descriptive material, along with a few models.

653. In Vienna, in conjunction with the Conference, the Government of Austria organized a major exhibition from 9 to 21 August. The exhibition was inaugurated on 9 August by Prof. Yash Pal, Secretary-General of UNISPACE 82. Twenty-five countries and four international organizations took part in that exhibition, which included a large number of models and a very extensive display of space technology, including equipment for space and ground use, and applications. Participating countries and organizations included: Austria, Belgiun, Bulgaria, Canada, Cuba, Czechoslovakia, Denmark, France, German Democratic Republic, Germany, Federal Republic of, Hungary, India, Italy, Japan, Kenya, Netherlands, Norway, Poland, Spain, Sweden, Switzerland, USSR and United States; ESA, EUTELSAT, FAO and INTELSAT.

J. COSPAR/IAF Forum

654. At the initiative of the Secretary-General of UNISPACE 82 and the Conference secretariat, COSPAR and IAF organized a UNISPACE forum in Vienna from 4 to 6 August 1982. The primary purpose was to provide an elaboration of the background papers for the Conference (in the preparation of which these two organizations had played an important role) and to provide a forum for discussions on matters related to the agenda of UNISPACE 82. The Forum was opened by Dr. Hertha Firnberg, Austrian Federal Minister for Science and Technology, and had as its co-chairmen Prof. J. H. Carver (Australia) and Prof. J. Ortner (Austria). Its programme included sessions on the following topics:

(a) Relevance of space science for development

(b) Remote sensing: meteorology, climatology, oceanography

(c) Remote sensing: agriculture, geology, geodesy

(d) Communications: educational uses of communication satellites

(e) Communications satellites: point-to-point, "commerical uses"

(f) Social and economic implications

(g) Management of space: communication frequencies, interactions of space objects

(h) Future space programmes of interest to developing countries.

655. A total of 184 persons from 42 countries participated in the Forum. A highlight was the last session, a round-table discussion in which heads or very senior representatives of nine space or space-related agencies took part. The report of the Forum was circulated to participants in UNISPACE 82 in the form of a background paper, as document A/CONF.101/BP/14.

K. Activities of non-governmental organizations

656. Apart from the activities of the non-governmental organizations organized by COSPAR, IAF and IAU - already mentioned in earlier sections - a group of other non-governmental organizations, called "NGOs at UNISPACE", organized a number of

meetings and discussions throughout the duration of the Conference. This series of meetings was inaugurated by Prof. Yash Pal, Secretary-General of UNISPACE 82, on 9 August.

657. The programme of meetings and the names of the co-ordinators were as follows:

		Session co-ordinators
August 10	Impact of space on the third world	Dr. Rashmi Mayur
August 11	Energy from space	Dr. Peter Glaser
August 12	Space, bioresources and the environment	Mr. Noel Brown Mr. Pincas Jawetz
	Energy from space	Dr. Peter Glaser
August 13	The private sector: key to the development of space	Dr. Klaus Heiss
August 14	Preserving peace in space	Dr. Robert Bowman
August 16	Future developments in space	Dr. David Webb
August 17	Information from space	
August 18	Biomedical aspects of space	Dr. William Douglas
August 19	Legal/political aspects of space	Hon. Edward Finch, Esq.
August 20	Scientific exploration of space	
	Philosophical aspects of space	Dr. Vanessa Merchant
August 21	Closing session	

Notes

1/ See Report of the United Nations Conference on Science and Technology for Development, Vienna, 20-31 August 1979 (United Nations publication, Sales No. E.79.I.21 and corrigenda), chap. VII, paras. 1-7 of the Preamble.

2/ See Official Records of the General Assembly, Thirty-fourth Session, Supplement No. 20 (A/34/20), paras. 79-115.

3/ Ibid., Thirty-fifth Session, Supplement No. 46 (A/36/46).

Annex I

MESSAGES FROM HEADS OF STATE OR GOVERNMENT

SRI LANKA

Mr. J. R. Jayawarada, President

[Original: English]

I send you greetings on the inauguration of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space. I send you also, on behalf of all Asians, our warm good wishes for the success of your deliberations in establishing outer space for all time, as mankind's new frontier to be explored and utilized in the interests of humanity.

It is a signal honour to my country, Sri Lanka, that I have been given this opportunity of representing our region in this inaugural broadcast, appropriately via space satellite. I speak, however, not only as an Asian but as a citizen of our planet.

You are meeting in the twenty-fifth year since the first satellite heralded the space age. Man has since taken his first step on the moon. Two great countries which pioneered space exploration have symbolized the essential unity of the human race by the linking of hands in space. Space technology has taken tremendous strides in the form of unmanned probes to distant planets and the development of reusable space vehicles. Man's knowledge of space does indeed literally and metaphorically encompass a much wider horizon today than it did a quarter century ago. The purpose of this Conference, to my mind, is to ensure that man's understanding of his place in our universe is also commensurate with his knowledge and his skill.

When the first conference on space met in historic Vienna 15 years ago the subject of outer space was, to many of us, particularly in the third world, somewhat distant. It was not, I must hasten to add, for lack of interest. We had too many concerns, too many immediate preoccupations here on earth. People who awakened to every dawning day as a day of anxiety about the family's next meal or about the health of a loved one, or about a roof over their heads to protect them from the elements on earth, could not become partners in this new area of human endeavour about which they had little knowledge.

What might be called the physical conquest of space has added a new dimension to our outlook on life on earth. That single small step on th moon was indeed a giant leap for mankind. In the last two decades the entire world community, developed and developing alike, has come into direct physical contact with the promise as well as the problems presented by man's conquest of space.

You are gathered in Vienna at this Confernece significantly designated as UNISPACE 1982, mandated to promote international co-operation in the exploration of outer space and its uses. This getting together, I woud presume, is not merely for the sharing of knowledge. From his earliest days, civilized man has sought knowledge and shared it through communication. Knowledge is no doubt a desirable end in itself. If it did not, however, result in improving the quality of human life, all knowledge would be barren and all science would be bereft of any meaning to billions of people on earth.

This Conference, I would venture to stress, should be about knowledge in the service of man, about knowledge with understanding. I would wish that the world community could look upon these last two decades of the twentieth century as the end of the era of narrow national rivalries and the beginning of an era of true human interdependence. That interdependence must surely mean that the knowledge of outer space and its potential, accumulated by the international community in the last two and a half decades, is viewed as a pool of human experience, as a tool to be employed in the improvement of people's lives everywhere.

In that vision of international life, the poorer nations which have not directly participated in or directly contributed to the conquest of space cannot remain outsiders, they cannot remain mere spectators of this great adventure which is unfolding before mankind. It is indeed being recognized, although unfortunately not widely enough, that these nations are not really outsiders. As partners in the global economic system, which enabled some nations to advance by leaps and bounds, these poorer nations themselves have contributed to that advance through that partnership. More directly individual scientists and technologists from the developing world have also contributed to the development of the technologies and the mastery of the skills which made space exploration possible.

The developing countries will not be satisfied with remaining mere spectators to the march of progress in space science and space technology. Quite many of them have their own programmes - some highly advanced and some only incipient - in the use and development of space science and space technology. Sri Lanka is no exception. We are committed partners in international co-operation in the use of space communications. We are, however, like many other nations in the third world, only in the initial stages of the use of space technology as we are in many other areas of basic science.

At the same time, like the other developing nations we do not intend to remain at that level. That is why I am happy to have seen the fruition last year of my objective of establishing in Colombo an institute of fundamental studies. The institute will develop before long as a meeting ground of world scientists of repute, who will pool their scientific knowledge and methods not only in the more conventional investigations in physics, chemistry, biology and astronomy but also in serious inquiry into philosophical questions such as the Buddha's view of the physical universe. We consider this Conference very important and very opportune. The importance which Sri Lanka attaches to it is reflected in the high level delegation which is in Vienna to join you in your work.

The development of space science holds not only positive promise. All of us are aware of its pitfalls as well. The potential of satellite technology for destructive uses is the greatest challenge which humanity faces today. We have the word of every astronaut and cosmonaut who looked at planet earth from space, that their first response to this view of our planet was a profound realization not only of its smallness in the vastness of the universe, but also of the oneness of the human condition. The greatest irony of our time is that even with that perception of our human bond, nations could think in terms of using that very same space to deny that bond. It would be man's greatest injustice to man, man's greatest insult to science to view outer space as another arena of conflict, another medium of mutual destruction. On behalf of all the peoples of our world and in the name of all humanity I voice our profound hope that this Conference will succeed in averting that folly.

This Conference presents us with a unique opportunity of strengthening the foundations of human interdependence, of sustaining in action all the noble ideals of all our religions, all our philosophies, all our civilizations. Let us grasp that opportunity of ensuring for our succeeding generations a world in which misunderstandings have been overcome and man is not only the master of his resources but also of his passions. It is our expectation that UNISPACE 1982 will mark the beginning of true interdependence among nations, trust and concord among peoples and peace on our planet.

BRAZIL

Mr. Joao Baptista de Oliveira Figueiredo, President

[Original: English]

The task to which you will be dedicated constitues, literally, the leading edge of human activity. Throughout the history of mankind the contemplation of space has given us matter for religious reflection and has enriched the memory of peoples with celestial myths. It fed the ideas of the first mathematicians and oriented the course of adventurous spirits who went to sea guided by the constant stars. It gave administrators the notion that seasons were associated with the movement of celestial bodies, helping them in the work of sowing and reaping which represented life to their peoples.

Centuries went by and human knowledge expanded enormously. Regarding space, however, our progress was bound to earth, and fenced in by its atmosphere. Exceptional minds applied themselves to the problems of the cosmos and, although limited by the data obtained with optical instruments, transformed our conception of the universe. But they could never take their instruments higher than the mountain peaks and the very air which gives us light filtered and deformed the fruits of their observations. In our time, after the pioneer advances of radioastronomy, the situation has changed radically. The last three decades have seen the birth of a complex and multidisciplinary space science in which are meshed physics and molecular biology, medicine and navigation, metal working and the study of electromagnetic propagation, the ecology of celestial bodies and the chemistry of combustion, all of which and many others comprising an interdependent whole.

This new knowledge and these new techniques already have important effects on our societies. The consiousness that we are all being affected by the first steps of man in space brought to Vienna, 14 years ago, the international community and today brings it together again, at the same place, to evaluate the developments since the first space Conference - to call it by its short name - and to endeavour to trace the future course of international co-operation in the exploration and use of outer space. Great advances have been recorded from 1968 to this date, most of which resulted from the efforts of the more prosperous countries, who are better equipped in science and technology. Other countries, and Brazil is among them, although suffering from the limitations imposed on them by their stage of development, have achieved positive even if more modest results in space science and its applications.

I shall not discourse on the work Brazil has been doing in the field of space. The Brazilian national paper, which was distributed to participants in the Conference, contains a description of our activities. I would like to reiterate, however, what representatives of the Brazilian Government have already said on several occasions, that is to say, that we are firmly disposed to co-operate with all countries - and particularly with developing countries - on all aspects of space science and utilization which may be within our reach and to mention Brazilian experience in remote sensing, satellite communications, computer science for space applications, astrophysics and meteorology as some of the several fields of possible co-operation between Brazil and other countries.

I have referred, although extremely briefly, to the new world of science and technology which space activities are opening to all of us. May I be allowed to say to you that, by the very importance of the subject of this Conference, it cannot be seen or treated in isolation, as a matter for the laboratory, the university or the research institute. Much less can the means of information, communication and for the expansion of knowledge under examination here be the object of a technical discussion detached from the economic, social and political facts of our planet. Nothing will contain a greater element of risk than to pretend that science exists in the abstract, with no influence on human relations or without being influenced by them. The main working document of the Conference touches lightly upon these aspects which I would call political and mentions, in an even more concise fashion, the work which is being done on these questions by the Committee on the Peaceful Uses of Outer Space of the United Nations. Those who follow the activities of the Committee are well aware of the Brazilian stand on those themes. Even so, I believe it necessary to remind the Conference of the importance of some among them and of how they transcend the frontiers of scientific and technological concerns, reaching the core itself of our conceptions of what is the state.

I will mention, first, remote sensing of the earth by means of satellites. This marvellous instrument offers to us a previously impossible knowledge of our natural resources, bringing to our eyes an unprecedented vision of the existence of minerals, of the growth of crops, of the good or bad utilization of forests, of maritime currents and air masses which affect our lives and our subsistence, of the effects of pollution and of urban growth presenting us, in sum, with an almost unlimited variety of useful and important information for a better organized and more productive life. At the same time, this multiple tool affects traditional concepts of security, violating the notion of national privacy and even, as indicatred in your working document, marching towards the violation of individual privacy. Remote sensing impinges on the sovereignty of States over their natural resources and it may prejudice the capacity of countries of negotiating the sale of their agricultural products at fair and equitable prices. This is an instrument both valuable and dangerous. I leave to the reflection of the Conference the necessity of establishment of principles to regulate its use.

The second point of concern to which I ask your attention is that of direct television broadcasting by satellites. This space activity is on the way of becoming reality, offering to the peoples of the earth matchless opportunities for mutual knowledge, cultural expansion and varied leisure. It brings, on the other hand, the threat of cultural aggression, of the transfer of habits and behaviour inappropriate to national realities, in addition to other potentialities which need not be mentioned at this moment. It is possible that in the future all mankind will speak one single language and have the same usages and it is also possible that this will contribute to peace among men. Today, however, nothing is more precious to us than our national culture, based on ethical traditions, on a national history and language, in ways of acting and of being which we identify as our own and which give to the human species that variety which enriches us all. I suggest, therefore, that the Conference think not only on the benefits which we may gather by this means, but on the dangers which we all must avoid by agreement among nations.

Finally, I cannot avoid mentioning the concern of my Government about the growing possibility of the use of outer space for warlike purposes. Even today the lower limits of space are the imperative pathway for engines of destruction during their tests. The existence of these instruments of mass destruction sheltered under the earth's surface or hidden in the oceans is, by itself, a terrible and sufficient threat to all of us. I do not believe that the invention of new weapons and their deployment in space will, in any manner, increase the security of any country. It rather appears to me that the multiplication of armaments has to be stopped and nullified in all environments and that this Conference, honouring its name, can contribute to the continuing of outer space as the last region within the reach of man which is totally weapon free.

In the name of the Brazilian Government and people I present compliments to the President of the Conference and to his Bureau. I wish to all participants a harmonious and fruitful labour that may contribute to peace and progress for mankind.

CHINA

Mr. Zhao Ziyang, Premier of the State Council

[Original: English]

On the occasion of the convening of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, I wish to extend warm congratulations to the Conference on behalf of the Chinese Government and people.

UNISPACE 82 is an important international conference concerning questions of outer space and has received close attention from various countries in the world. It is our hope that this Conference will make positive contributions to the promotion of outer space science and technology in the service of peaceful purposes, to the enhancement of co-operation based on equality between all the Governments and peoples in the field of outer space science and technology and to the furtherance of the economic development and social progress of all countries, developing countries in particular. May the Conference be successful.

INDIA

Mrs. Indira Gandhi, Prime Minister

[Original: English]

The 25 years since man first successfully demonstrated his ability to launch objects into space have seen many notable achievements.

Men and automated spacecraft have landed on the moon. Man-made spacecraft have reached Mars and Venus and explored the outer planets. Through these and other scientific developments, humankind's understanding of the universe, and I hope of itself, has been enriched. Closer to earth, communications satellites, weather satellites and remote sensing satellites are being increasingly used by peoples in their day-to-day activities.

At the same time it is pertinent to ask if such spectacular advances, which in some ways have brought the world together have also contributed to reducing the glaring disparities which divide peoples, the rich and the poor, the haves and the have-nots. The promise of gains from advanced technologies elude the majority of peoples, whose aspirations for a better and richer life remain unfulfilled.

A global conference on space is an opportunity. I urge scientists and world leaders to see the world in its wholeness, as indeed it is viewed from space and, through their collective wisdom, take practical steps to ensure that our differences are not extended into space. Let there be peace in space, so that all humanity can benefit.

On behalf of the Government of India, I send good wishes for a successful conference.

UNION OF SOVIET SOCIALIST REPUBLICS

Mr. L. Brezhnev, Chairman of the Presidium of the Supreme Soviet

[Original: Russian]

I should like to greet cordially the participants in the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space.

Your Conference has been convened on the eve of a momentous date - the twenty-fifth anniversary of the space age, which began with the launching in the Soviet Union on 4 October 1957 of the first artificial earth satellite. This tremendous feat of human genius ranks among the greatest events of world history.

Mankind can be justifiably proud of what has been accomplished over the past 25 years. The conquest of outer space is proceeding with truly cosmic speed: from the first artificial earth satellite and the first orbit around our planet by Yuri Gagarin to the large-scale orbiting complexes and manned space flights lasting several months as well as the long-range expeditions to the moon, Mars and Venus.

Today cosmonautics has also been directly applied to economic tasks of a purely earth-bound nature. It has become the dependable ally of geologists and navigators, agronomists and meteorologists, communications experts and doctors, cartographers and forestry workers.

If one looks into the near future, the question of creating in outer space permanently functioning laboratories on board increasingly large orbiting complexes with rotated crews will be considered. Indeed, the creative potential of man in his daring onslaught of the outer reaches of space is unlimited.

The successful development of international co-operation in the exploration and use of outer space, in which a leading role is played by the United Nations, gives cause for satisfaction. This co-operation is diverse in form and extremely rich in content.

It is particularly gratifying that the first international crews sent into outer space under the INTERCOSMOS programme, which is being carried out by the socialist countries, have already orbited the earth. The citizens of 10 countries together with our cosmonauts have carried out space flights on board Soviet space ships and stations. We are prepared to continue to assist international space flights.

Co-operation in outer space should unite people and promote understanding of the fact that we are all living on the same planet and that a peaceful and prosperous earth depends on us all.

The Soviet Union has consistently maintained that outer space should remain an arena for peaceful co-operation and that the unlimited expanses of outer space should be free from weapons of any type. The achievement of this great and humanitarian goal through joint efforts is both feasible and vitally necessary for the future of all mankind.

I wish the participants in the Conference every success in their work and express the hope that the results of the Conference will serve the cause of strengthening peace, mutual understanding and co-operation and further progress in the conquest of outer space for the good of all the people of our planet.

PAKISTAN

Mr. M. Zia ul-Haq, President

[Original: English]

It gives me great pleasure to extend warm greetings to the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 1982).

Barely 25 years ago the human race, for the first time, succeeded in going beyond the confines of the planet earth and entered the new frontier of outer space. Today, our activities in space have begun to exercise a significant and to a large extent beneficial influence on our daily lives in many diverse ways. Artificial satellites are providing an excellent communications service between distant points on the globe and bringing closer to reality the concept of the "global village". Satellites forecast weather with improved accuracy, and record the over-all situation of crops and other vegetation. They help us survey the natural resources of the planet, map the earth, monitor its environment, aid marine, air and ground navigation and perform search and direct rescue missions for people in distress. The list of benefits, already impressive, will include more and more activities as time passes. There is no doubt in my mind that space applications and technology have a great potential in the service of humanity because they help us to plan better and acquire a greater degree of control over our destiny.

Unfortunately, there is another side to the coin. An estimated 75 per cent of the satellites launched since the first Sputnik had military applications. As the international community attempts in other forums to promote the objectives of disarmament, I hope that UNISPACE 82 will do its best to ensure that the promising new frontier of space does not become an arena for military competition and confrontation.

The outer space Treaty, which prohibited the introduction of weapons of mass destruction in orbit around the earth, and reserved celestial bodies exclusively for peaceful purposes, was a good beginning. I hope and pray that the Conference can reaffirm strongly that outer space will be used only for peaceful purposes, and for the benefit of the entire humanity.

The world is already deriving benefits from the technology of space. One of the principal aims of UNISPACE 82 is to consider ways and means of enabling developing countries to benefit from this technology to raise the standards of living of their peoples. I am confident that in spite of difficulties and limitations, which we all recognize, the gathering in Vienna will have the vision to address itself to its historic task. In the noble endeavour of using the technology of space to solve problems of this planet, Pakistan will play its part in promoting space science for the benefit of all the peoples of the world.

I wish the organizers and participants of the world Conference every success.

BULGARIA

Mr. Todor Zhivkov, Chairman of the State Council

[Original: Russian]

On behalf of the State Council and the Government of the People's Republic of Bulgaria, and on my own behalf, it is my pleasure to extend greetings to this important meeting, convened in order to discuss the present and future status and utilization of space science and technology, international co-operation and the role of the United Nations in outer space matters.

The exploration and peaceful uses of outer space are among the greatest achievements of the scientific and technological revolution in our twentieth century. They are opening up broad avenues for constructive co-operation between States. We shall all soon be celebrating the twenty-fifth anniversary of the birth of the space age, heralded by the signals of the first artificial satellite of our planet. Since then, the exploration and use of outer space has proved to be of great benefit to people.

Your Conference is especially significant because it is taking place during a period of marked aggravation of the international situation, when the threat of nuclear war hangs over the peoples. Space is the common property of mankind. Peace - the most important prerequisite for mankind's existence - is also common property. For this reason, it is vitally important to avert completely the danger of outer space being transformed into a stage for the arms race, not to place there any weapons whatsoever and not to make outer space a source of additional tension between States. The exploration and use of outer space can and must serve only the peoples' well-being and the goals of development and social progress, and promote the preservation and strengthening of peace throughout the world.

By its participation in the United Nations, the People's Republic of Bulgaria consistently and steadfastly makes its modest contribution to the attainment of these goals.

In addition, the People's Republic of Bulgaria is an active participant in the INTERCOSMOS programme for the exploration and use of outer space. This programme encompasses important scientific and technological research, experiments and joint flights, which are a new and substantial contribution to the practical conquest of space in the interests of all countries.

Allow me to wish the Conference success in its work and to express the conviction that it will permit the development of business-like exploration and peaceful uses of outer space, for the benefit of States and peoples.

UNITED STATES OF AMERICA

Mr. Ronald Reagan, President

[Original: English]

This Second United Nations Conference on the Peaceful Uses of Outer Space provides leaders from around the globe with an unprecedented opportunity to chart a course for greater co-operation among nations in exploring mankind's last and endless frontier.

Let us resolve to work together to ensure that the benefits of space continue to contribute to a bright and peaceful future on earth. And let us also chart new pathways to the stars to serve as avenues of peaceful exploration and adventure for our generation and for generations to come.

Annex II

LIST OF DOCUMENTS

A. Basic Conference documentation

Symbol	Title
A.CONF.101/1	Provisional rules of procedure
A/CONF.101/2	Provisional agenda
A/CONF.101/3 and Add.2	Draft report of the Conference
A/CONF.101/3/Add.1	Draft report of the Conference - Note on financial implications
A/CONF.101/4	Objectives of the Conference as approved by the Preparatory Committee and endorsed by the General Assembly
A/CONF.101/5 and Corr.1	Declaration of the Group of 77
A/CONF.101/6	Report of the First Committee
A/CONF.101/7	Report of the Credentials Committee
A/CONF.101/8 and Corr. 1-4	Report of the Second Committee
A/CONF.101/9 and Corr.1	Report of the Third Committee
A/CONF.101/10	Report of the Conference
A/CONF.101/L.1	Report of the Pre-Conference Consultations held at the Hofburg Conference Centre, Vienna on 8 August 1982
A/CONF.101/L.2 and Add.1	Adoption of the Report of the Conference - Draft report of the Conference
A/CONF.101/L.3	Proposal submitted by Mexico on behalf of the Group of 77
A/CONF.101/L.4	Text resulting from the consultations of the "Friends of the President"
A/CONF.101/L.5	Algeria: Amendment to paragraph 25 of document A/CONF.101/L.2/Add.1
A/CONF.101/C.1/L.1	Annotated Programme of Work - Committee I
A/CONF.101/C.2/L.1	Annotated Programme of Work - Committee II
A/CONF.101/C.3/L.1	Annotated Programme of Work - Committee III
A/CONF.101/C.3/L.2	Note by the Secretariat

Information documents

A/CONF.101/INF.1	Information note on the preparation of national papers
A/CONF.101/INF.2 and Corr.1 and 2	List of participants
A/CONF.101/INF.3	United States initiatives at UNISPACE 82
A/CONF.101/MISC.1	List of documents
A/CONF.101/MISC.2 and Add.1-3	List of participants
A/CONF.101/ORGANIZATION	Organization of the work of the Conference - Note by the Secretariat

B. National papers and abstracts

Country	National papers Symbol	Available Languages	Abstract Symbol	Available Languages
ARGENTINA	A/CONF.101/NP/22	(S)	A/CONF.101/AB/22	(A,C,E,F,R,S)
AUSTRALIA	A/CONF.101/NP/46	(E)	A/CONF.101/AB/46	(A,C,E,F,R,S)
AUSTRIA	A/CONF.101/NP/44	(E)	A/CONF.101/AB/44	(A,C,E,F,R,S)
BANGLADESH	A/CONF.101/NP/7	(E)	A/CONF.101/AB/7	(A,C,E,F,R,S)
BOLIVIA	A/CONF.101/NP/54	(S)	A/CONF.101/AB/54	(A,C,E,F,R,S)
BRAZIL	A/CONF.101/NP/43	(E)	A/CONF.101/AB/43	(A,C,E,F,R,S)
BULGARIA	A/CONF.101/NP/27	(E)	A/CONF.101/AB/27	(A,C,E,F,R,S)
BULGARIA/CUBA	A/CONF.101/NP/50	(S,E)	A/CONF.101/AB/50	(A,C,E,F,R,S)
CANADA	A/CONF.101/NP/29	(E)	A/CONF.101/AB/29	(A,C,E,F,R,S)
CHILE	A/CONF.101/NP/18	(S)	A/CONF.101/AB/18	(A,C,E,F,R,S)
CHINA	A/CONF.101/NP/13	(C,E)	A/CONF.101/AB/13	(A,C,E,F,R,S)
COLOMBIA	A/CONF.101/NP/42 and Add.1	(S)	A/CONF.101/AB/42	(A,C,E,F,R,S)
CUBA	A/CONF.101/NP/20	(S)	A/CONF.101/AB/20	(A,C,E,F,R,S)
CZECHOSLOVAKIA	A/CONF.101/NP/8	(E)	A/CONF.101/AB/8	(A,C,E,F,R,S)
ECUADOR	A/CONF.101/NP/19	(S)	A/CONF.101/AB/18	(A,C,E,F,R,S)
EGYPT	A/CONF.101/NP/1	(E)	A/CONF.101/AB/1	(A,C,E,F,R,S)
EUROPEAN SPACE AGENCY	A/CONF.101/NP/37	(E,F)	A/CONF.101/AB/37	(C,E,F,R,S)
(ESA: Belgium, Denmark, France, Germany, Federal Republic of, Ireland, Italy, Netherlands, Spain, Switzerland, United Kingdom of Great Britain and Northern Ireland)				
FINLAND	A/CONF.101/NP/33	(E)	A/CONF.101/AB/33	(A,C,E,F,R,S)
GERMAN DEMOCRATIC REPUBLIC	A/CONF.101/NP/16	(E)	A/CONF.101/AB/16	(A,C,E,F,R,S)
GREECE	A/CONF.101/NP/36	(E)	A/CONF.101/AB/36	(A,C,E,F,R,S)
HUNGARY	A/CONF.101/NP/45	(E)	A/CONF.101/AB/45	(A,C,E,F,R,S)
INDIA	A/CONF.101/NP/6	(E)	A/CONF.101/AB/6	(A,C,E,F,R,S)
INDONESIA	A/CONF.101/NP/11	(E)	A/CONF.101/AB/11	(A,C,E,F,R,S)
ISRAEL	A/CONF.101/NP/56	(E)	A/CONF.101/AB/56	(A,C,E,F,R,S)
JAPAN	A/CONF.101/NP/39	(E)	A/CONF.101/AB/39	(A,C,E,F,R,S)
JORDAN	A/CONF.101/NP/40	(E)	A/CONF.101/AB/40	(A,C,E,F,R,S)
KENYA	A/CONF.101/NP/12	(E)	A/CONF.101/AB/12	(A,C,E,F,R,S)
MALAWI	A/CONF.101/NP/34	(E)	A/CONF.101/AB/34	(A,C,E,F,R,S)

MALAYSIA	A/CONF.101/NP/58	(E)	A/CONF.101/AB/58	(A,C,E,F,R,S)
MONGOLIA	A/CONF.101/NP/28	(R)	A/CONF.101/AB/28	(A,C,E,F,R,S)
MONGOLIA/USSR	A/CONF.101/NP/32	(E)	A/CONF.101/AB/32	(A,C,E,F,R,S)
MOROCCO	A/CONF.101/NP/23	(F)	A/CONF.101/AB/23	(A,C,E,F,R,S)
NETHERLANDS	A/CONF.101/NP/17 and Corr.1	(E)	A/CONF.101/AB/17	(A,C,E,F,R,S)
NEW ZEALAND	A/CONF.101/NP/26	(E)	A/CONF.101/AB/26	(A,C,E,F,R,S)
NIGERIA	A/CONF.101/NP/35	(E)	A/CONF.101/AB/35	(A,C,E,F,R,S)
NORWAY	A/CONF.101/NP/47 and Add.1	(E)	A/CONF.101/AB/47	(A,C,E,F,R,S)
OMAN	A/CONF.101/NP/38	(E)	A/CONF.101/AB/38	(A,C,E,F,R,S)
PAKISTAN	A/CONF.101/NP/21	(E)	A/CONF.101/AB/21	(A,C,E,F,R,S)
PERU	A/CONF.101/NP/15	(S)	A/CONF.101/AB/15	(A,C,E,F,R,S)
PHILIPPINES	A/CONF.101/NP/3	(E)	A/CONF.101/AB/3	(A,C,E,F,R,S)
POLAND	A/CONF.101/NP/31	(E)	A/CONF.101/AB/31	(A,C,E,F,R,S)
PORTUGAL	A/CONF.101/NP/55	(E)	A/CONF.101/AB/55	(A,C,E,F,R,S)
ROMANIA	A/CONF.101/NP/24	(F)	A/CONF.101/AB/24	(A,C,E,F,R,S)
SAUDIA ARABIA	A/CONF.101/NP/52	(E,A)	A/CONF.101/AB/52	(A,C,E,F,R,S)
SENEGAL	A/CONF.101/NP/57	(F)	A/CONF.101/AB/57	(A,C,E,F,R,S)
SRI LANKA	A/CONF.101/NP/10	(E)	A/CONF.101/AB/10	(A,C,E,F,R,S)
SUDAN	A/CONF.101/NP/51	(E)	A/CONF.101/AB/51	(A,C,E,F,R,S)
SWEDEN	A/CONF.101/NP/9 and Add.1	(E)	A/CONF.101/AB/9	(A,C,E,F,R,S)
SYRIAN ARAB REPUBLIC	A/CONF.101/NP/2	(E)	A/CONF.101/AB/2	(A,C,E,F,R,S)
THAILAND	A/CONF.101/NP/5	(E)	A/CONF.101/AB/5	(A,C,E,F,R,S)
UGANDA	A/CONF.101/NP/48	(E)	A/CONF.101/AB/48	(A,C,E,F,R,S)
UNION OF SOVIET SOCIALIST REPUBLICS	A/CONF.101/NP/30 and Corr.1	(E)	A/CONF.101/AB/30	(A,C,E,F,R,S)
UNITED STATES	A/CONF.101/NP/53	(E)	A/CONF.101/AB/53	(A,C,E,F,R,S)
UPPER VOLTA	A/CONF.101/NP/4	(F)	A/CONF.101/AB/4	(A,C,E,F,R,S)
URUGUAY	A/CONF.101/NP/41	(S)	A/CONF.101/AB/41	(A,C,E,F,R,S)
VENEZUELA	A/CONF.101/NP/25	(S)	A/CONF.101/AB/25	(A,C,E,F,R,S)
VIET NAM	A/CONF.101/NP/14	(E)	A/CONF.101/AB/14	(A,C,E,F,R,S)
YUGOSLAVIA	A/CONF.101/NP/49	(E)	A/CONF.101/AB/49	(A,C,E,F,R,S)

C. Background papers

Symbol	Title
A/CONF.101/BP/1 and Corr.1 Add.1	Current and future state of space science
A/CONF.101/BP/2	Current and future state of space technology
A/CONF.101/BP/3	Relevance of space activities to monitoring of earth resources and the environment
A/CONF.101/BP/4	Impart of space activities on the earth and space environment
A/CONF.101/BP/5 and Corr.1	Compatibility and complementarity of satellite systems
A/CONF.101/BP/6	Feasibility and planning of instructional satellite systems
A/CONF.101/BP/7	Efficient use of the geostationary orbit
A/CONF.101/BP/8	Relevance of space activities to economic and social development
A/CONF.101/BP/9	Training and education of users of space technology
A/CONF.101/BP/10	Multilateral intergovernmental co-operation in space activities
A/CONF.101/BP/11 and Add.1 Add.1/Corr.1 Add.2	Role of the United Nations system in space activities
A/CONF.101/BP/12	Role of non-governmental organizations in space activities
A/CONF.101/BP/13	Summary of recommendations made by the regional and interregional seminars of the United Nations Space Applications Programme in connexion with the Conference
A/CONF.101/BP/14	Background paper: Report on UNISPACE Forum

D. Papers submitted by intergovernmental organizations

Symbol	Organization and title
A/CONF.101/BP/IGO/1	Report on the civil aviation interests in the use of outer space. International Civil Aviation Organization (ICAO)
A/CONF.101/BP/IGO/2	Background paper. International Maritime Satellite Organization (INMARSAT)
A/CONF.101/BP/IGO/3	Role of IMCO in the development of space technology for maritime purposes. Inter-Governmental Maritime Consultative Organization (IMCO)

A/CONF.101/BP/IGO/4	Background paper. Arab Satellite Communications Organization (ARABSAT)
A/CONF.101/BP/IGO/5	Background paper. United Nations Office of the Disaster Relief Coordinator (UNDRO)
A/CONF.101/NP/IGO/6	Report on remote sensing applied to renewable resources. Food and Agriculture Organization of the United Nations (FAO)
A/CONF.101/BP/IGO/7	Report of the meeting of the Group of Experts on Satellite Remote Sensing for Natural Resources. Department of Technical Co-operation for Development (DTCD)
A/CONF.101/BP/IGO/8 and Corr.1	Satellites in meteorology, oceanography and hydrology. World Meteorological Organization (WMO)
A/CONF.101/BP/IGO/9	Contribution of the International Radio Consultative Committee to UNISPACE 82. International Telecommunication Union (ITU)
A/CONF.101/BP/IGO/10	Background paper. Committee on Science and Technology
A/CONF.101/BP/IGO/11 (E,F)	Background paper. The European Community (EC)
A/CONF.101/BP/IGO/12 (E,F,R,S)	Satellite systems in support of WMO programmes and joint programmes with other international organizations. World Meteorological Organization (WMO)
A/CONF.101/BP/IGO/13	Background paper. Potential applications of space-related technologies to developing countries (UNIDO)
A/CONF.101/BP/IGO/14 and Corr.1(F)	Background paper. International Radio Consultative Committee (CCIR) - International Telecommunication Union
A/CONF.101/BP/IGO/15	Background paper. International Telecommunication Union. Application of space telecommunications for development service prospects for the rural areas.
A/CONF.101/BP/IGO/16	Background paper. International Telecommunication Union. List of CCIR recommendations and reports of interest to UNISPACE II

E. Papers submitted by non-governmental organizations

A/CONF.101/BP/NGO/1 (E)	Outer space and world order. International Peace Research Association (IPRA)
A/CONF.101/BP/NGO/2 (E)	An international space programme. International Association of Educators for World Peace (IAEWP)
A/CONF.101/BP/NGO/3 (E)	Background paper. Check List - Disaster Warning and Prevention, Emergency Medical Care, Emergency Communications - Prepared by the Sub-Committee on Worldwide Disaster Response, Rescue and Safety of the International Academy of Astronautics

A/CONF.101/BP/NGO/4 (E)	Background paper. Proposition on the Preservation of Peace in Space - Submitted by International Association of Educators for World Peace
A/CONF.101/BP/NGO/5	Background paper. Energy from space for use on earth - Submitted by International Solar Energy Society
A/CONF.101/BP/NGO/6	Background paper submitted by Bahá'í International Community
A/CONF.101/BP/NGO/7	Background paper submitted by International Federation for Home Economics
A/CONF.101/BP/NGO/8	Background paper submitted by the World Association of Former United Nations Internes and Fellows
A/CONF.101/BP/NGO/9	Background paper. Energy from biomass. Submitted by the Society for International Development

F. Documents issued before the Conference

1. Report of the Committee on the Peaceful Uses of Outer Space. General Assembly Official Records: 34th Session: Supplement No. 20 (A/34/20)

2. Report of the Preparatory Committee for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space. General Assembly Official Records: 35th Session; Supplement No. 46 (A/35/46)

   Report of the Preparatory Committee for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space. General Assembly Official Records: 36th Session; Supplement No. 46 (A/36/46)

   Report of the Preparatory Committee for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space. General Assembly Official Records: 37th Session; Supplement No. 46 (A/37/46)

3. Reports of the Advisory Committee

A/CONF.101/PC/1	Report of the Advisory Committee to the Preparatory Committee for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space
A/CONF.101/PC/4 and Corr.1	Report of the Second Session of the Advisory Committee to the Preparatory Committee for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space
A/CONF.101/PC/6	Report of the Advisory Committee to the Preparatory Committee for the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space on its third session

G. Documents of the Pre-Conference Consultation

A/CONF.101/PRE-CONF/L.1 and Add.1	Annotated list of questions
A/CONF.101/PRE-CONF/L.2	Proposed schedule (time table) for the work of the Conference