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

PREPARATIONS FOR THE THIRD UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE (UNISPACE III) BY THE PREPARATORY COMMITTEE

DRAFT REPORT*

Note by the Secretariat

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*The General Assembly, in its resolution 52/56, requested the Secretariat to prepare a draft for consideration by the Preparatory Committee. The Secretariat, by its note verbale dated 11 July 1997, requested member States to provide input for the draft report. Taking into account the inputs provided by 8 States and on the basis of generally available technical information, the Secretariat prepared a first draft for consideration by the Advisory Committee in February 1997. The present document contains the first full text of the draft report prepared by the Secretariat for paragraph-by-paragraph consideration by the Preparatory Committee at its 1998 session. The text was prepared on the basis of comments made by the Advisory Committee at its 1998 session on the text contained in document A/AC.105/C.1/L.218.

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I. BACKGROUND

A. Historical perspective

1. The interest of humankind in space dates back to prehistorical times. To primitive cultures, invisible beings and influences in the night sky were thought to govern events on Earth. Many of the historical monuments fro m thousands of years ago were created to worship the Sun, the Moon or other celestial bodies, providing perceived links between the souls on Earth and the spirits dwelling in the heavens.

2. Assisted by telescopes and other sighting instruments, humans began to increase their knowledge about th e motions of the planets and their understanding of the universe. They started to wonder about their place in the entire scheme of things and to think about the structure, and eventually the origin and the future, of the universe. Th e science of astronomy became one of the most intellectually stimulating branches of the human quest for knowledge and understanding.

3. The human quest for knowledge of the universe w as accompanied by the desire to break free from the confines of the planet and to step out into outer space. Following the inve ntion of gunpowder and fire arrows a thousand years ago in China, the idea of travelling by means of rockets slowly crystallized in the human mind. At the end of th e nineteenth century, some scientists, inspired by scientific fictio n about space travel, dreamed about space exploration and began to work on rocket technology.

4. The development of rockets was accelerated by the desi re to acquire more effective weapons during the Second World War. It was continued mainly through military research and development. Nevertheless, the first rocket t o

leave the planet was not used for military purposes. It was used to launch a satellite for the advancement of science on the occasion of the International Geophysical Year. In October 1957, the successful launch of Sputnik marked the dawn of the Space Age and the beginning of human efforts to ensure the peaceful uses of outer space.

5. During the early years of the space age, the desire to explore outer space was fuelled by the competition between the two space powers, resulting in the rapid pace of human achievements in outer space. In April 1961, Yuri Gagarin became the first human being to orbit Earth. In July 1969, the so-called race to the moon culminated in the successful lunar landing by Apollo 11, when Neil Armstrong and Buzz Aldrin stepped on the surface of the Moon. The competition increased the human capacity to build complex space systems, involving not only the advancement of science and technology, but also the improvement of system management capabilities.

6. Rapid progress in the development of science and technology systems, including management of large-scale scientific enterprises, made it possible to conduct closer observations of the planets, in both the inner and outer solar systems. To date, all the planets in the solar system, except for Pluto, have been visited by spacecraft. An international armada of scientific spacecraft was also sent to study Halley’s Comet on its most recent visit to the solar system, which occurs at intervals of about 75 years. Together with observations made through the Hubble Space Telescope, providing clear images of celestial phenomena, various missions sent to probe different aspects of the universe will continue to provide clues about the origin and the future of the cosmos and of humankind.

7. Significant progress in the development of space science and technology and their applications have enabled humans to exploit this last frontier, outer space. Efforts to utilize the space environment were further strengthened during the post-Apollo period. Space stations and platforms have provided opportunities to conduct various research activities in orbit. Applications satellites have provided the capability to observe Earth from space and facilitated communications around the world, with momentous consequences for the economic and social development of humankind.

8. In the information age, communications satellites have contributed to the expansion of commercial activities, a promising sign for the growth of space industry in other fields. Launch services are being transferred to the private sector, stimulating efforts to provide access to outer space at lower cost. An increasing volume and variety of remote sensing data and higher-resolution imagery are being disseminated by commercial distributors for various uses.

9. Space technology and its applications have also provided the means of obtaining, through the use of Earth observation satellites, essential data for scientific research on the state of planet Earth. Those satellites will assist humanity in assessing the consequences of industrial activities, thus making it possible to take corrective actions to protect the fragile planet.

10. Scientific exploration of outer space, utilization of the near-Earth environment and observation of Earth have enhanced human awareness of the profound interdependence of all people on planet Earth. The global networks created by communications satellites have brought together people around the world, enabling them to freely exchange ideas and discover their cultural diversity. Data and information on the global environment have demonstrated the vulnerability of the planet to human activities and increased awareness of the need to join efforts to protect the planet for future generations.

11. The exploration and peaceful uses of outer space promote mutual understanding through cooperation to solve global problems on Earth and to expand human civilizations into outer space. International cooperation in outer space will mark another milestone in 1998 with the beginning of construction of the International Space Station, a further step towards fulfilment of the dream of living in space and probing ever more deeply into outer space in the future.

12. Through space exploration and exploitation, humanity will continue to search for the origin of the universe and for the means of ensuring the future of human civilizations. Through applications of space science and technology,

humanity will seek to enhance the human condition, preserve the global environment and ensure global prosperity for coming generations.

B. United Nations and the peaceful uses of outer space

13. The United Nations has been involved in space activities since the very beginning of the space age. Following the launch of the first man-made satellite, Sputnik-1, in October 1957, in the midst of the cold war, there was a growing concern in the international community that space might become another field for intense rivalries between the superpowers or would be left for exploitation by a limited number of countries with the necessary resources. In the following year, the General Assembly established the Ad Hoc Committee on the Peaceful Uses of Outer Space, composed of 18 members, to consider the activities and resources of the United Nations, the specialized agencies and other international bodies relating to the peaceful uses of outer space, organizational arrangements to facilitate international cooperation in the field within the framework of the United Nations and legal problems that might arise in programmes to explore outer space.

14. The Committee on the Peaceful Uses of Outer Space was established as a permanent body in 1959, with an original membership of 24 States. Its membership currently consists of 61 States.* Following intense consultations among its members, the Committee agreed in March 1962 to conduct its work in such a way that it would be able to reach agreement without voting.

15. In response to a request by the General Assembly in 1961, the Committee has been serving as a focal point for international cooperation in the peaceful exploration and use of outer space and carrying out its mandates to maintain close contact with governmental and non-governmental organizations concerned with outer space matters, to provide for the exchange of information relating to outer space activities and to assist in the study of measures for the promotion of international cooperation in those activities. The work of the Committee has been assisted by its two subcommittees of the whole, the Scientific and Technical Subcommittee and the Legal Subcommittee, since they were established by the Committee in March 1962. Over the years, those bodies have established working groups on various issues of particular significance.

16. Since the establishment of the Committee and its subcommittees, the practice was to maintain the same offices, elections taking place only on an ad hoc basis when an officer became unable to continue in office. The various functions had been distributed between the Group of 77, the western group and the eastern group. In 1996 and 1997, against dramatic geopolitical changes in the post-cold war period, the Committee reviewed its working methods, including the composition of its bureau. As a result, the Committee agreed to introduce the principles of equitable geographical representation and rotation in the composition of the bureaux of the Committee and its Subcommittees,

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*The original members were: Albania, Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Czechoslovakia (succeeded by membership of the Czech Republic), France, Hungary, India, Iran, Italy, Japan, Lebanon, Mexico, Poland, Romania, Sweden, Union of Soviet Socialist Republics (succeeded by membership of the Russian Federation), United Arab Republic (former name of Egypt), United Kingdom of Great Britain and Northern Ireland and United States of America. The membership was enlarged to 28 in 1961 (by admitting Chad, Mongolia, Morocco and Sierra Leone), to 37 in 1973 (by admitting Chile, German Democratic Republic, Germany, Federal Republic of, Indonesia, Kenya, Nigeria, Pakistan, Sudan and Venezuela), to 47 in 1977 (by admitting Benin, Cameroon, Colombia, Ecuador, Iraq, Netherlands, Niger, Philippines, Turkey and Yugoslavia) and to 53 in 1980 (by admitting China, Greece, Portugal, Spain, Syrian Arab Republic, Upper Volta (former name of Burkina Faso), Uruguay and Viet Nam). As part of the 1980 expansion, Spain and Greece were admitted on the understanding that they would alternate every three years with Portugal and Turkey, respectively. The current membership of 61 was constituted in 1994 (by admitting Cuba, Kazakhstan, Nicaragua, Republic of Korea, Senegal and South Africa, the German Democratic Republic and Germany, Federal Republic of, having been succeeded by the membership of Germany). The practice of rotating membership between Greece and Turkey as well as between Portugal and Spain was terminated as part of the 1994 expansion, and Cuba and the Republic of Korea were admitted on the understanding that they would alternate every two years with Peru and Malaysia, respectively.

shortened the duration of sessions of those bodies and strengthened the agenda of the Legal Subcommittee. The five offices of the bureaux of the Committee and its subsidiary bodies,* each having a term of three years, now rotate among the five regional groups, one office being allocated to each of the following: African Group, Asian Group, Eastern European Group, Latin American and Caribbean Group and Group of Western European and Other States.

17. Secretariat services to the Committee and its subsidiary bodies are provided by the Office for Outer Space Affairs, which consists of two sections: the Committee Service and Research Section and the Space Applications Section. The Office is also responsible for the implementation of the United Nations Programme on Space Applications.**

18. The discussions and recommendations of the Committee have led to the formulation and adoption of the five multilateral treaties and five declarations and sets of legal principles.*** In addition to the progressive development of the legal regime governing space activities, the work of the Committee has contributed significantly to the promotion of international cooperation in the field of space science and technology. Through the exchange of information on developments in space activities, the Committee has provided Member States with opportunities to identify areas for further cooperation. The Committee has also provided important guidance for the implementation of the United Nations Programme on Space Applications, which has contributed to increasing the capability of developing countries in the utilization of space technology and its applications, through its educational and training activities, and has often served as a coordinator or facilitator for cooperation between developed and developing countries, through its technical advisory services.

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*The bureaux consist of: the Chairman, First Vice-Chairman and Second Vice-Chairman/Rapporteur of the Committee; the Chairman of the Legal Subcommittee; and the Chairman of the Scientific and Technical Subcommittee. Currently, U. R. Rao (India), Raimundo Gonzalez (Chile) and Mouslim Kabbaj (Morocco) serve as the Chairman, the First Vice-Chairman and the Second Vice-Chairman/Rapporteur of the Committee, respectively. The chairmen of the Legal Subcommittee and the Scientific and Technical Subcommittee are Dietrich Rex (Germany) and Václav Mikulka (Czech Republic), respectively.

**Following a request by the General Assembly, a small expert unit that had been initially established to render assistance to the Ad Hoc Committee on the Peaceful Uses of Outer Space became a unit within the Department of Political and Security Council Affairs in 1962 to service the Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee. It was transformed into the Outer Space Affairs Division of that Department in 1968 and then into the Office for Outer Space Affairs within the Department of Political Affairs in 1992. Since 1993, when the Office was transferred from New York to the United Nations Office at Vienna, it has also been servicing the Legal Subcommittee, which had previously been serviced by the Office of Legal Affairs.

***The five treaties and agreements are as follows: Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (General Assembly resolution 2222 (XXI), annex), adopted on 19 December 1966, with entry into force on 10 October 1967; Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (General Assembly resolution 2345 (XXII), annex), adopted on 19 December 1967, with entry into force on 3 December 1968; Convention on International Liability for Damage Caused by Space Objects (General Assembly resolution 2777 (XXVI), annex), adopted on 29 November 1971, with entry into force on 1 September 1972; Convention on Registration of Objects Launched into Outer Space (General Assembly resolution 3235 (XXIX), annex), adopted on 12 November 1974, with entry into force on 15 September 1975; and Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (General Assembly resolution 34/68), adopted on 5 December 1979, with entry into force on 11 July 1984. The declarations and legal principles are as follows: Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space (General Assembly resolution 1962 (XVIII), adopted on 13 December 1963; Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting (General Assembly resolution 37/92, annex), adopted on 10 December 1982; Principles Relating to Remote Sensing of the Earth from Outer Space (General Assembly resolution 41/65, annex), adopted on 3 December 1986; Principles Relevant to the Use of Nuclear Power Sources in Outer Space (General Assembly resolution 47/68), adopted on 14 December 1992; and Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries (General Assembly resolution 51/122, annex), adopted on 13 December 1996.

19. The work of the Committee has also led to the convening of three United Nations conferences. As early as 1959, the General Assembly decided to convene an international conference, under the auspices of the United Nations, for the exchange of experience in the peaceful uses of outer space and requested the Committee on the Peaceful Uses of Outer Space to work out proposals with regard to the convening of such a conference. During the following years, the Committee conducted preparatory work for the Conference, and the Conference on the Exploration and Peaceful Uses of Outer Space was convened at Vienna from 14 to 27 August 1968. The Conference was convened to examine the practical benefits of space exploration and the basis of scientific and technical achievements, as well as the opportunities available to non-spacefaring States for international cooperation in space activities, with special relevance to the needs of developing countries.*

20. One of the results of the Conference was the establishment of a post of Expert on Space Applications, whose full-time task is to promote practical applications of space technology. One of the first recommendations made by the Expert on Space Applications to the Committee was the establishment of the United Nations Programme on Space Applications. In the following year, the Secretary-General was requested by the General Assembly to allocate a budget for the implementation of the Programme.

C. The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space

21. In November 1978, on the basis of a recommendation by the Committee, the General Assembly decided to convene the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82).** The Assembly designated the Committee as the Preparatory Committee for the Conference and the Scientific and Technical Subcommittee as Advisory Committee to the Preparatory Committee.

22. The Conference, convened at Vienna from 9 to 21 August 1982*** and attended by 94 Member States and 45 intergovernmental and non-governmental organizations, considered the state of space science and technology, applications of space science and technology, international cooperation and the role of the United Nations. The recommendations and conclusions of UNISPACE 82, adopted by consensus, are contained in the report of the Conference (A/CONF.101/10 and Corr.1 and 2).

23. The General Assembly, in December 1982, endorsed the recommendations of UNISPACE 82, one of the most significant consequences of which has been the strengthening and expansion of the United Nations Programme on Space Applications. The Assembly decided that the Programme should promote greater exchange of actual experiences with specific applications and greater cooperation in space science and technology between developed and developing countries as well as among developing countries, and stimulate the growth of indigenous nuclei and an autonomous technological base in space technology in developing countries. In order to achieve those goals, the Programme was requested to develop a fellowship programme for in-depth training of space technologies and applications specialists and to organize regular seminars on advanced space applications and new system developments for managers and leaders in space applications and technology development, as well as for users. The Programme was also directed to disseminate, through panel meetings and seminars, information on new and

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*Kurt Waldheim (Austria) was elected President and Vikram A. Sarabhai (India) was elected Vice-President and Scientific Chairman of the Conference, which was attended by 78 Member States and 13 international organizations.

**Following his appointment in October 1980 by the Secretary-General of the United Nations, Yash Pal (India) took office as Secretary-General of the Conference 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.

***Willibald Pahr (Austria) was elected President and Carlos Antonio Bettencourt Bueno (Brazil) was elected Rapporteur-General of the Conference.

advanced technology and applications and to provide technical advisory services on space applications projects. An International Space Information Service was also created to facilitate access to data banks and information sources.

24. In 1987, the Working Group of the Whole to Evaluate the Implementation of the Recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82) was established in the Scientific and Technical Subcommittee. The objectives of the Working Group were to improve the execution of activities relating to international cooperation, particularly those included in the United Nations Programme on Space Applications, to propose concrete steps to increase such cooperation and to make such cooperation more efficient.

25. The recommendations made by the Working Group of the Whole since 1987 have focused the attention of the international community on a number of issues of importance to promoting the access to and use of space technology by all Member States, particularly for developing countries. At its 1997 session, in concluding its evaluation of the implementation of the recommendations of UNISPACE 82, the Working Group noted that it had refined or interpreted several of the recommendations to make them more specific and to facilitate their implementation. As a result, significant progress was made particularly in the enhancement of international and regional cooperation in the continued development of worldwide space activities and the promotion of a greater exchange of actual experiences. Concrete results were achieved in the following areas: the organization of a fellowship programme of in-depth training courses and workshops on advanced applications of space science and technology; preparation of a series of technical studies relating to specific areas of space science, space technology and their applications; and the establishment of regional centres for space science and technology education. The work of the Working Group has also led to more appropriate allocations from the United Nations budget for the expanded activities of the United Nations Programme on Space Applications.

26. The Working Group of the Whole has also been instrumental in the conceptual development and planning of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) and contributed effectively to the detailed preparatory work on various matters, including the objectives, form, venue, date, participation, provisional agenda, financial aspects and additional components of the Conference.

II. ENABLING ENVIRONMENT FOR SPACE EXPLORATION AND UTILIZATION

A. New international context

27. Since 1982, when the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82) took place, there have been a number of new developments in space science and exploration and in space technology. Applications and uses of space technology have rapidly forged ahead, with new technologies and techniques spawning both greater use and increased effectiveness of existing applications, as well as creating new applications worldwide. The number of countries with space capabilities has increased, and there has also been a rapid growth in the number of countries that utilize space technology.

28. A major trend, indicative of the success of space technology, is the increasing commercialization of certain applications and the privatization that has emerged. That trend has brought in the entrepreneurial drive and the market acumen of the private sector, giving a further impetus to the growth of space applications. At the same time, the growing market has spurred further initiatives and investments in technology development. The public sector is establishing partnerships with the private sector in various phases of the research and development process, giving leverage to the resources of both partners and promoting commercial activities with strong economic growth.

29. The biggest change, however, has been in the geopolitical context. The world has moved from an era of near confrontation to one of cooperation, with elements of commercial competition. The change in the geopolitical context

goes beyond space, and affects a whole range of relationships between States. It does have an important impact on space, and that is likely to manifest itself through many more cooperative/collaborative projects.

30. There are many areas where collective efforts should be made to achieve common objectives of mankind. One of those objectives is to maintain optimal interactions with nature. Since the beginning of civilization, mankind has lived in a competitive relationship with nature. While human interdependence with the environment is greater than that of any other organism, the relentless pursuit of progress, comfort and security has resulted in constantly increasing stress on the environment, at both the local and global level. Consequently, the life-sustaining environment of Earth is undergoing a more rapid transformation than ever before. The rapid growth of population, with the resulting expansion of human activities, particularly industrial activities, and the increasing demands to meet the basic needs of people, continues to impact adversely on the environment. The consequences of those phenomena include the overexploitation of natural resources and the degradation of both the environment and living conditions. There is a growing worldwide concern for land and coast degradation, air and water pollution, loss of biodiversity and deforestation. Explosive population growth combined with the availability of limited land could cause haphazard urban growth, resulting in the further aggravation of living conditions, exemplified in the proliferation of slums and diseases. Some of the climate changes, such as global warming and depletion of the ozone layer, which could ultimately lead to an ecological crisis affecting the entire biotic species on the planet, are considered to be caused, at least partially, by anthropogenic activities.

31. While humans have developed the capacity to alter the state of the surrounding environment, they are still vulnerable to the forces of nature. The damage caused by natural phenomena to people and the productive infrastructure of countries has steadily risen. Besides human and economic losses, disasters can also destabilize social and political structures. El Niño, an abnormal state of the ocean-atmosphere system in the tropical Pacific, has important consequences for worldwide weather conditions, and the phenomenon could result in global losses of billions of United States dollars ($) and countless human lives. Extreme climate episodes, such as ice storms, floods and drought, could cost billions of dollars in damages per year. Worldwide, more than a billion people are affected each year by vector-borne diseases. Some of those diseases cause chronic suffering and disability.

32. The challenges posed by the need to reduce the negative impact of human activities on the environment and to minimize the damage wreaked by the forces of nature on civilization are being faced by people in all parts of the world. Scientific and technological developments in the twentieth century have increased the human capacity to take collective actions at the global level and to ensure human prosperity into the twenty-first century.

33. Space science and technology have had a profound impact on the day-to-day life of common people. Distances have shrunk and satellite communications have led to the emergence of the global village, where voice, text, graphics and complex instructions can be transferred from one place to another, over large distances, within the shortest possible time. Developments in communications science and technology have changed business, national and international transactions, revolutionized economics and banking, transformed the entertainment industry and touched many facets of day-to-day life of the people. Satellite images have made it possible to detect the onset of calamities, to monitor the changes that are happening on the face of Earth and to gain insight into the complex state of the planet. The prediction of weather and changes in the climate systems has also helped in the implementation of appropriate agricultural practices, disaster relief, damage mitigation and the forewarning of catastrophic climate events.

34. The challenge consists in cooperation at the international level and the sharing of technologies and applications, thus maximizing the benefits accruing from the use of space technology. One critical sphere for international cooperation is in the use of space techniques for environmental monitoring and protection. There is now international recognition of the seriousness of the problems of environmental pollution, soil degradation and deforestation, as well as of the issues associated with global warming. Following the adoption of Agenda 21 at the United Nations Conference on Environment and Development, held at Rio de Janeiro, Brazil, from 3 to 14 June 1992, a number of initiatives have been taken, including the use of space science and technology for monitoring the environment. Given

the imperative demand for immediate action to save the planet from environmental disaster, there is broad recognition of the need to enhance international cooperation for space activities in that field.

35. The evolution of science and technology since UNISPACE 82, the new political climate, reduced public spending and the large number of new participants, including several developing countries and the private sector as major players, require that policy and decision makers in the public and private sectors, particularly in developing countries, take stock of the current importance of space technology. Space technology will have important effects on the quality of life of the average person, both in economic and social terms. There will be significant opportunities for economic and social development arising from the projected trends in the growth and development of the space industry. Space activity will become a world economic engine in the twenty-first century, with many opportunities, in particular for developing countries. It should, however, be ensured that space technology will not become a means of creating a widening gap between developed and developing countries.

36. In summary, the new context provides a positive framework for the continuing development of space technology and its more extensive applications in existing and new fields. At the same time, the increased commercialization and privatization of space activities has brought in new dynamism, new investments and greater market-responsiveness. The new context is also conducive to the further growth of international cooperation in space. The issues dealt with, the discussions held and the recommendations made by UNISPACE III should be placed within that context.

B. Important and growing role of space activities

37. Since the beginning of the space age, space exploration and exploitation have yielded tremendous scientific as well as economic and societal benefits for mankind. Space science provides a wealth of information about the processes that formed the universe, the planetary system, the Sun and Earth itself. Using powerful telescopes, scientists are probing back in time to the very origin of the universe, just moments after the big bang. Humanity is now exploring Mars, Jupiter and Saturn from close range. Current satellites with sophisticated instrumentation will send data back to Earth from which scientists will map the surfaces of the planets and determine the composition of their atmospheres and other geophysical parameters. With such data, energy exchange mechanisms for planetary atmospheric models are being developed and refined. Those models can reproduce extreme or insufficient atmospheric warming which could explain the loss of the atmospheres of planets. Such knowledge is vital, since it is Earth's atmosphere that protects and determines its environment.

38. Space technology and its applications have been widely recognized as one of the major instruments for enhancing human capabilities to understand the environment and manage natural resources and for providing effective communications across large distances and to rural areas. Those capabilities have promoted economic, cultural and social development, particularly for developed countries, and provided the possibility for developing countries to accelerate their development process.

39. Earth observation satellites provide an important and unique source of information for studies of the Earth system. There are currently over 45 satellite missions operating and around 70 more missions, carrying over 230 instruments, are planned for operation during the next 15 years by the world's civil space agencies. Those satellites are providing measurements of many parameters of interest to those studying the Earth system, and the planned missions will provide a significant increase in data and information over that provided by the satellites currently in operation. Data from those satellites are useful not only for scientific purposes, but also for societal and economic purposes, in such areas as land-use mapping, management of renewable and non-renewable resources, disaster management, global health and agricultural and fisheries management. Thus, an extremely valuable tool is already available and will be greatly improved over the next decade. The elements of this tool, however, require international coordination, clear definitions of the problems to which they can be applied and, above all, a much broader awareness on the part of its potential users, in particular, developing countries.

40. Although still considered an emerging technology in commercial terms, remote sensing has evolved from traditional applications such as cartography, hydrology, surveying and monitoring of natural resources to more consumer-oriented applications such as disaster-preparedness, insurance claims adjustments, marketing, delimitation and appraisal of real estate properties and precision farming. Value added services offered by the private sector in converting the satellite images to meaningful information for the user domain is a growing market, with an estimated value of $600 million over the next five years.

41. Satellite communication systems, including those developed nationally by governmental or commercial entities as well as through international organizations such as the European Telecommunications Satellite Organization (EUTELSAT), the International Mobile Satellite Organization (INMARSAT) and the International Telecommunications Satellite Organization (INTELSAT), have introduced improved techniques and new technologies. The emerging new services would provide more efficient solutions, particularly for developing countries, in dealing with issues of regional and global concern, such as enhancing opportunities for education, ensuring access to adequate medical services and increasing the effectiveness of disaster relief operations.

42. Satellite communications will further develop as an economic engine both for developed and developing countries**.** The world market for only launchings and the operation of satellites for fixed communications and broadcasting for the period 1997-2005 is conservatively estimated to total between $60 and $80 billion. The estimated value of ground station, terminal market and end-user services of those satellites for the same period amount to an additional $200 billion to $300 billion. While satellite launchings and operations are limited to spacefaring States and large companies, participation in ground-segment activities is open to a much broader range of actors, including those in developing countries.

43. Meteorological satellites form a truly international network that views the Earth on a continuous basis. Those satellites provide the data for short- and mid-term weather forecasts (contributing to better planning of agricultural strategies and of a host of daily activities), while the advance warning they give on hurricanes and typhoons has dramatically reduced losses in terms of infrastructure and human life in the large number of countries that are prone to such disasters.

44. Satellite positioning systems (Global Positioning System and the Global Orbiting Navigation Satellite System (GLONASS), originally deployed for strategic military purposes, now provide non-encrypted signals, free of charge, for civilian applications such as air, land and nautical navigation. GPS receivers allow pilots, drivers and other users to locate objects to within 100 metres. Through the use of differential global positioning techniques, positions can be determined to within 1 metre. That capability is already resulting in greater safety, lower costs and greater productivity for the end-user. In 1994, GPS services and equipment for mapping and surveying and other applications generated combined revenues of $500 million. Those applications and the benefits derived from their use are expected to grow exponentially in the coming decade.

45. With an estimated $77 in revenues and employing more than 800,000 people worldwide in 1996, the global space industry has become one of the largest industries in the world. Commercial utilization of space hardware, including telecommunications facilities, and the development of infrastructure elements, such as the manufacture of launch vehicles, satellites and ground equipment, currently represent 53 per cent of the industry, with the balance coming from government financing. In 1996, for the first time, commercial revenues surpassed government expenditures.

46. In order to maximize the benefits of space technology and its applications, particularly for developing countries, at least two interrelated general issues relating to the utilization of advanced technology for economic and societal development should be borne in mind. The first issue concerns promoting the technology to be utilized and understanding the associated problems encountered in the use of that technology. The other issue concerns ensuring the effective utilization of the knowledge of advanced technology for sustainable development activities. Consideration of those issues would enhance overall understanding of the technical, technological and managerial issues as well as the policy implications involved in the use of space technology, thus generating greater scientific,

economic and societal returns from space exploration and exploitation, which have already been confirmed in many areas of human endeavour.

III. THIRD UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE (UNISPACE III)

A. Genesis of and preparations for UNISPACE III

47. At its 1992 session, the Committee on the Peaceful Uses of Outer Space noted a proposal that a third UNISPACE Conference should be organized in 1995, preferably to be held in a developing country. That proposal was made with a view to consolidating the momentum provided by activities conducted on the occasion of the International Space Year during 1992 and to evolving follow-up actions and mechanisms further to broaden the scope of international cooperation as well as to promote increased participation of all developing countries in space activities. Based on the recommendation of the Committee, the General Assembly in its resolution 47/67 of 14 December 1992, recommended that Member States might discuss during the 1993 session of the Committee, the possibility of holding a third United Nations Conference on the Exploration and Peaceful Uses of Outer Space.

48. At its 1993 session, the Scientific and Technical Subcommittee, through its Working Group of the Whole, noted the above recommendation of the General Assembly. The Working Group noted that there had been considerable advances and changes in space technology and applications since 1982, as well as many changes in the geopolitical and economic situations affecting space programmes around the globe, and recommended that it could be useful to address the potential for a third UNISPACE conference. In this regard, the Working Group also recommended that the Committee, in addressing the question of such a conference as recommended by the General Assembly, consider the objectives and goals of the conference, as well as organization, venue, timing, financial implications and other matters. The Working Group noted the proposal that a third UNISPACE conference should be held in a developing country in the near future. The Working Group also noted the suggestions that it could be held in 1995 and that the Working Group could serve as a Preparatory Committee for such a conference.

49. At its 1993 session, the Committee on the Peaceful Uses of Outer Space noted that the most important step was to define a set of sharply focused objectives for such a conference and that the goals set for such a conference might also be achieved through other means, such as intensification of work within the Committee.

50. During the following years, various ideas and proposals were submitted by member States, the Chairman of the Committee as well as the secretariat, upon requests by the Committee and its subsidiary bodies. Those ideas and proposals concerned, *inter alia*, the objectives and agenda of UNISPACE III and various means of achieving the objectives of UNISPACE III and their financial implications.

51. On the basis of the recommendations of the Subcommittee, the Committee at its 1996 session agreed that a special session of the Committee (UNISPACE III), open to all States Members of the United Nations, should be convened at the United Nations Office at Vienna in 1999 or 2000. The Committee agreed with the Subcommittee on the set of objectives and also agreed that all efforts should be made to limit the cost of UNISPACE III to keep it within the existing resources for the Committee and its secretariat by reducing or curtailing the duration of the sessions of the Committee and its subsidiary bodies during the year of UNISPACE III. Those agreements of the Committee were endorsed by the General Assembly at its fifty-first session. Based on the recommendations of the Committee, the Assembly, in its resolution 51/123, also requested the Committee and the Scientific and Technical Subcommittee to act as the Preparatory Committee and Advisory Committee for UNISPACE III, respectively, and the Office for Outer Space Affairs to act as the executive secretariat.

52. Following intense work within the Working Group of the Whole, which was requested by the Advisory Committee to assist its work at its 1997 session, consensus agreement was finally reached on the agenda of

UNISPACE III. At that session, the Advisory Committee made a number of additional recommendations concerning the date, participants, additional components and financial aspects of UNISPACE III. At its 1997 session, while endorsing those recommendations, the Preparatory Committee agreed upon the procedure to prepare the draft report of UNISPACE III.

53. The General Assembly, in its resolution 52/56, agreed that the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) shall be convened at the United Nations Office at Vienna from 19 to 30 July 1999 as a special session of the Committee on the Peaceful Uses of Outer Space, open to all States Members of the United Nations.

B. Purpose and objectives

54. The purpose of holding the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space is to review and highlight the significant advances of space science and technology that have taken place since 1982 with a view to promoting their greater use, particularly by the developing countries, in all areas of economic, social and cultural development. At the same time, the Conference would provide a unique forum in which States Members of the United Nations, organizations of the United Nations system, intergovernmental and non-governmental organizations with space activities and the space-related industries in the private sector, could be involved in developing a blue print for international cooperation in space-related activities for the beginning of the next century. Such a gathering would bring together, for the first time, all interested parties and relevant actors.

55. The UNISPACE III Conference, which is convened under the theme “Space benefits for humanity in the twenty-first century”, will aim at achieving the following primary objectives: promoting effective means of using space technology to assist in the solution of problems of regional or global significance; and strengthening the capabilities of States Members, in particular developing countries, to use the applications of space research for economic and cultural development. The other objectives of UNISPACE III are as follows:

(a) To provide developing countries with opportunities to define their needs for space applications for development purposes;

(b) To consider ways of expediting the use of space applications by Member States to promote sustainable development through the involvement of a larger number of developing countries in international research programmes such as the International Geosphere-Biosphere Programme;

(c) To address the various issues related to education, training and technical assistance in space science and technology and their applications aimed at the development of indigenous capabilities in all States;

(d) To provide a valuable forum for a critical evaluation of space activities and to increase awareness among the general public regarding the benefits of space technology;

(e) To strengthen international cooperation in the development and use of space technology and applications.

IV. HARNESSING THE POTENTIAL OF SPACE AT THE START OF THE NEW MILLENNIUM

A. Protecting the environment

1. Status of scientific knowledge of Earth and its environment

(a) Status: environmental and Earth sciences

56. In the twenty-first century, the planet Earth will face the potential hazard of rapid environmental changes, including warming of the climate, rising sea level, deforestation, desertification and land degradation, depletion of the ozone layer, acid rain and a reduction in biodiversity. Such changes would have a profound impact on all countries, yet many important scientific questions remain unanswered.

57. The Sun is a variable star that provides all energy for living things on Earth. That energy is also the principal driving force of the atmosphere and ocean circulation systems and the climate of the Earth. The energy from the Sun comes in the form of radiation, for instance, the visible illumination that is necessary for plant photosynthesis, and of energetic particle streams. To understand the influence of the Sun on the Earth environment, it is necessary to trace the flow of radiation and charged particles from the Sun and to determine its effects on the coupled magnetosphere-ionosphere-atmosphere of Earth, especially the stratospheric ozone layer.

58. The ultraviolet (UV) irradiance of the Sun is the dominant energy source for the Earth atmosphere. Small changes in the atmosphere (for example, in total ozone) can produce dramatic differences in the solar radiation reaching the Earth surface. Increasing UV radiation is known to cause increases in the occurrence of skin cancer and can affect microbiological systems by damaging or altering their genetic structure.

59. In order to determine solar influences on global change on Earth, it is critical to monitor the total and spectral distribution of solar irradiance, middle and upper atmosphere structures and composition over many solar cycles, solar wind, the energetic particle input into the Earth magnetosphere and coronal mass ejections from vantage points far from Earth.

60. The Earth magnetosphere and atmosphere are highly coupled to the atmosphere and heliosphere of the Sun. Variations in the solar atmosphere, including flares and ejection of charged particles from its corona, and their interaction with the Earth magnetosphere and upper atmosphere are governed by physical processes that are only partly known.

61. The variable interaction of the Sun with the Earth magnetosphere, ionosphere and upper atmosphere can create potentially damaging environments for space assets that provide weather forecasts, telephone and other forms of communication, television, navigation and other important services. An example of a casualty of space weather is the recent failure of ANIK-E2, a communications satellite, after being bombarded by high-energy electrons triggered by the Sun.

62. The possibility of unprecedented global climate change exacerbated by human activity is a subject of considerable international concern. That concern has been expressed through the Framework Convention on Climate Change (FCCC). For several years the Intergovernmental Panel on Climate Change (IPCC) has been issuing periodic scientific assessments of global climate change and its possible impact. IPCC estimates that global surface air temperatures will increase significantly over the next 100 years. The likely consequences of such warming include changing patterns of precipitation and temperature, a rise in the sea level and altered global distribution of fresh water. The impact on human health, the vitality of forests and the productivity of agriculture is likely to be significant.

63. Global climate is a consequence of complex interactions between the solar energy input to Earth, the atmosphere (and atmospheric composition), the oceans, the hydrological cycle, the land surface and vegetation, the cryosphere (snow and ice fields, ice sheets and glaciers) and the geosphere (including continental topography and tectonic changes, volcanic eruptions and the rotation of Earth).

64. The past history of Earth demonstrates that the climate has changed many times through very cold and warm periods as a result of orbital changes of Earth, solar fluctuations, volcanic eruptions or other natural factors. The current concern is that human activity could be an equally strong factor in causing climate change, at a rate much

more rapid than that experienced before. Thus, the adaptation time for humans and plant and animal life to a changed environment might be too short.

65. Recent climate history shows that there has been a global warming of about 0.5 degrees centigrade over the last 100 years. Corresponding changes have been observed in the rise of the sea level in coastal areas. The warming is thought to result from increasing concentrations of greenhouse gases such as carbon dioxide (CO_2), injected into the atmosphere during the burning of fossil fuels, methane (CH_4), emitted by an expanding agriculture and a growing number of livestock, oxides of nitrogen, caused by fossil-fuel burning (for example, by airplanes and automobiles) and possibly fertilizers, as well as chlorofluorocarbons (CFCs), used in air-conditioning. CFCs also destroy the ozone layer, thereby allowing increased UV-B radiation to penetrate the atmosphere.

66. Ozone is the only greenhouse gas that strongly absorbs solar radiation in the UV part of the electromagnetic spectrum in the stratosphere. Stratospheric ozone protects the Earth surface from harmful solar UV-B radiation and plays an important role in controlling the temperature structure of the stratosphere. Thus, reduction in stratospheric ozone can modify surface temperature.

67. Stratospheric ozone depletion is now evident all around the world, except over tropical latitudes. The Antarctic ozone hole is the most conspicuous manifestation of ozone depletion, which has recently accelerated in the Arctic winter and spring. There is compelling evidence that ozone depletion can be ascribed to the increased atmospheric burden of human-made chlorine and bromine compounds such as CFCs, hydrochlorofluorocarbons (HCFCs), halons and methyl bromide. International regulations have been established to phase out the productions of CFCs, halons, HCFCs and methyl bromide, and they will begin to diminish by the end of the century. However, the decrease will be slow and it will be necessary to observe stratospheric ozone to determine whether the recovery from depletion will take place as expected.

68. Technological advances over the past several decades have contributed substantially to improvements in transport systems, agricultural food production and distributions systems, water availability and power generation and distribution, in addition to recent enhancements in computerization to meet the needs of the information age. In retrospect, such progress has been achieved at considerable cost to the environment. Many technological advances are known to have had a negative impact on the physical environment and the health of human, animal and plant life. The dilemma therefore consists in maintaining sustainable economic, social and technological development without further undermining the integrity of the environment.

69. Pollution of the atmosphere, water and soil exemplifies the impact of technological change on the global environment. Atmospheric pollution most visibly manifests itself as smog and acid rain that damages vegetation, acidifies the soil and leads to health problems. Industrial effluents, advanced agricultural methods and other human activities pollute rivers, lakes and even the oceans, particularly in coastal areas. Population growth, overgrazing and the dominant use of wood as a fuel source are leading to deforestation, soil erosion, degradation and desertification, which are in turn contributing to the loss of biodiversity.

70. Natural causes having adverse effects on the global environment include forest fires, volcanic eruptions, earthquakes, tsunamis, hurricanes, cyclones, typhoons, floods, drought and phenomena such as El Niño.

(b) Issues and objectives

71. The observational requirements, arising from the need to understand more fully the Earth system and initiate corrective steps based on that increased understanding, are wide-ranging and involve many different measuring techniques and associated data-processing systems. Satellites are capable of providing the synoptic, wide-area view required to put *in situ* measurements in the global context needed for the observation of many environmental and climatic phenomena.

72. To improve understanding of the influence of the Sun on the Earth environment, it will be necessary to pursue the following issues and objectives:

(a) Continued observations and long-term monitoring of solar spectral irradiation;

(b) Modelling the dynamics of the Sun and its fluctuations;

(c) Assessing the interaction between solar fluctuations and the Earth climate;

(d) Quantifying, through observations and models, solar influences on both short-term (seasonal to interannual timescales) and long-term (10-30 year) climate change.

73. To improve understanding of the relationship between the radiation of the Sun and the Earth environment and between charged particle fluxes and the Earth environment, it will be necessary to pursue the following issues and objectives:

(a) Investigating solar system plasmas and the electric current systems and magnetic plasmas associated with them;

(b) Improving the observation and understanding of the physical processes governing the Earth thermosphere, magnetosphere, ionosphere and upper atmosphere;

(c) Developing a detailed, theoretically grounded understanding of the physical processes that constitute the Earth-Sun connection and improved forecasting of space weather;

(d) Improving the observations and understanding of solar variability;

(e) Characterizing the dynamics, properties and structure of the solar wind as it interacts with the local interstellar medium to form the heliosphere.

74. To improve understanding of global climate change, it will be necessary to pursue the following issues and objectives:

(a) Characterizing and documenting long-term climate variability and trends through systematic global observations of the climate system and the external forces that affect it;

(b) Understanding the nature of key parameters giving rise to change in the climate system and identifying the causal factors of observed climate variations and feedback processes that govern the response of the climate system;

(c) Assessing the predictable aspects of long-term climate variability and changes, including their regional impact, through the combined application of observation and global models.

75. To improve understanding of change in the ozone layer and its effects on the environment and human health, it will be necessary to pursue the following issues and objectives:

(a) Characterizing the global distribution of ozone, chemically active trace constituents and related meteorological parameters;

(b) Understanding the processes responsible for the chemical transformation of trace constituents and the role of aerosols in affecting atmospheric chemistry;

(c) Quantitatively modelling the trace constituent composition of the troposph ere-stratosphere system through the combined application of observations and global models.

76. To improve understanding of technological effects on the environment and human health, it will be necessary to pursue the following issues and objectives:

(a) Monitoring atmospheric/tropospheric pollutants, aerosols and other chemical species;

(b) Observing and monitoring the discharge of rivers into inland lakes and coastal zones;

(c) Understanding the interaction between the by-products of technology and the environment and modelling their impact;

(d) Observing and monitoring natural effects on the global environment.

2. Environment and natural resources and remote sensing

(a) Status: environment and natural resources and applications of remote sensing

77. Human activity has altered the condition of Earth by reconfiguring the landscape, by changing the composition of the global atmosphere, and by putting stress on the biosphere. There are strong indications that natural change is being accelerated and distorted by human intervention. In its quest for an improved quality of life, humanity has become a force for change on the planet, building upon, reshaping and modifying nature in unintended and ofte n unpredictable ways.

78. Development decisions require accurate and comprehensive information, for instance on soils and land use , water resources and agricultural and other resources. Such information would make possible an evaluation of their potential uses and interdependencies and their likely responses to different types and levels of use. Crop or stock suitability, irrigation methods and run-off pote ntial are typical parameters that need to be assessed for a given series of locations with particular climates, soils, ecosystems and alternative land uses.

79. Present-day applications of satellite data are widespread and cover research and operational and commercial activities. Those activities are of interest both in the global context and in the regional, national and local context, where Earth observation data are successfully applied in support of a range of different application areas. Several applications involve weather-related phenomena, disasters or the management of Earth resources. The relevance of remote sensing in those areas is described below.

Applications in weather forecasting

80. The weather at any given location is a result of comp lex interactions between local, regional and global aspects of atmospheric circulation and dynamics, which in turn are affected by the interactions of the atmosphere with the oceans, the land surface and vegetation and the cryosphere.

81. Since many weather phenomena are directly related to the economy and well-being of society, weathe r forecasting has been a crucial requirement of societies around the worl d for centuries. Weather forecasts are currently generated by global models. Using the output from global models, h igh-resolution regional models are run to provide more specific local details of weather systems and precipitation forecasts.

82. Major emphasis is being placed on the development of seasonal to interannual prediction capability because of the lead times required for the management of natural and industrial resources such as agriculture, water supply and energy production and distribution. Accurate forecasting of weather systems is of particular importance i n

preventing or reducing damage due to natural disasters. All the models require global observational data for their daily initialization.

83. *In situ* and space-based observations are made globally approximately every three hours and transmitted to processing centres to enable weather forecasts for periods of 24 hours to about a week. For longer periods, extended range forecasts are also made. For predictions on the seasonal to interannual timescale to capture phenomena such as El Niño, atmosphere-ocean coupled models need to be used. They require substantially more observations of the Earth system for their initialization and time integration.

84. Future satellite missions will make improved and better calibrated observations of the above-mentioned and other parameters. Examples of the satellite missions are INSAT-2E, ADEOS (Japan), EOS-AM/EOS-PM (United States), NPOESS (United States/Europe). SeaWifs (United States), ENVISAT (European Space Agency (ESA)) and others. The instruments will also collect data on the concentration and distribution of greenhouse gases and on ozone chemistry, which are needed by climate change models. The ENVISAT mission is highly oriented towards monitoring the environment and the satellite will carry 11 instruments designed to measure key parameters related to the atmosphere, land and oceans.

85. Ongoing satellite missions make or help derive key global observations of atmospheric structure and dynamics, sea-surface temperature, surface parameters, precipitation, land-surface characteristics and selected atmospheric chemical species via geostationary and polar-orbiting platforms. Examples of those satellites systems are GMS, GOES, GOMS, INSAT and METEOSAT and the METEOR and NOAA-AVHRR series of meteorological satellites, the Earth observing series of satellites including Fengyun (China), IRS (India), LANDSAT (United States), SPOT (France), as well as the TOPEX/POSEIDON (United States/France) ocean circulation mission. Recently, ERS-1 and -2 of ESA, JERS of Japan and RADARSAT of Canada have made it possible to map the Earth surface through clouds or at night in the locality concerned, while providing new information on geological features, topography, sea ice, deforestation, bathymetry, coastal zones and agricultural assessment. Areas in which radar satellites are particularly effective include determination of global wind and wave fields at high spatial and temporal resolution over ocean areas, as well as of global ocean dynamics and climatic instabilities.

Applications in disaster management

86. Every year, there are hundreds of natural disasters that afflict populations in many countries on all continents. In 1996 alone, there were 180 reported natural disasters, of which 50 were major, requiring international assistance. In the last 10 years, there were 64 very large disasters with extremely serious consequences, such as the floods that occurred in China in 1991 and 1996, hurricanes Andrew, Luís and Marylin, and the European-Mediterranean floods of 1997. The economic losses are estimated at $400 billion.

87. Through the implementation of effective public policies and assisted by scientific and technological developments, there has been a decrease in the number of fatalities worldwide. Possibly the most notable example of such a use of technology is provided by the early warning given by meteorological satellites in the case of typhoons and hurricanes.

88. An increase in economic losses is due to an overall increase in population and urbanization, placing more people and their structures at risk, and the increased interdependence of trade and economies. The adverse effects are to some extent offset by technological trends such as increased understanding of hazardous phenomena and enhanced communication capabilities. Among environmental trends, there appears to be a change in atmospheric and meteorological patterns, most notably as a result of short-term phenomena such as El Niño. On a longer timescale, climate change could ultimately trigger numerous environmental disasters around the world.

89. While developed countries suffer greater economic damage in absolute terms, the impact on developing countries is more severe in relative terms. The gross national product (GNP) lost as a result of natural disasters is estimated to be 20 times greater in developing countries than in developed countries.

90. Disaster management includes the following elements:

(a) Disaster mitigation, which involves hazard mapping, risk assessment and presentation of information for the elaboration of land use legislation;

(b) Disaster preparedness, which involves forecasts and early warning;

(c) Disaster relief, which includes action taken to mitigate the effects of the disaster after it occurs, such as assessment of the damage and delivery of health care, food and other supplies;

(d) Disaster rehabilitation, which involves long-term measures that begin during the relief phase.

91. Space technologies can play important roles in early warning and management of the effects of disasters. However, an operational disaster management support service that uses the capabilities of space systems can only be achieved through the joint use of satellite communications and remote sensing images, including services and other products of space systems, with other non-space sources providing ground information.

92. As natural disasters often destroy or severely disrupt terrestrial telecommunication networks, satellites have found a vital role to play in supporting or making possible disaster management activities, including the emergency gathering and dissemination of news and the provision of backup communications for the continuation of government and business activities.

93. Telemedicine applications are increasingly used in emergency and disaster situations. The World Health Organization uses mobile satellite communications for epidemics control, most notably in Africa, as part of its Rapid Epidemic Response Kit to combat diseases such as river blindness or fast-spreading health hazards such as ebola. Slow-scan video communications for medical consultations are also possible via moderate-speed satellite data links, and were used, for example, after a recent major earthquake in Armenia.

94. Images from meteorological and Earth observing satellites provide essential data for hazard mapping, risk assessment, early warning and disaster relief and rehabilitation. Such data are particularly useful when combined with ground-obtained data and information and integrated into geographic information systems (GIS) for analysis and modelling of complex scenarios.

95. Navigation and positioning satellite systems are another promising tool for disaster prediction, warning and relief activities. With ground positioning receivers and through repeated observations, it is possible to determine relative motions of parts of Earth to within a few millimetres. That could make it possible to assess and map earthquake risk and predict volcanic eruptions and landslides. The use of optical or radar images for steroscopic viewing are also useful for that purpose.

96. A sinking ship, a fallen airplane or even a person lost in the wilderness represents a different type of disaster. They are distress situations in which receiving immediate assistance is the difference between life and death. The International Search and Rescue Satellite System (COSPAS-SARSAT) is an international search and rescue system based on receivers on board meteorological satellites that relay signals from transmitters activated in distress situations to a network of ground stations. The signals are processed to determine the geographical location of the transmitter. Since 1982, COSPAS-SARSAT has saved the lives of several thousand people worldwide. Canada, France, Russian Federation and United States provide the space segment for the system, which is supported on the ground by many countries.

97. The international community, recognizing the need for a global effort to reduce the impact of natural disasters, proclaimed the International Decade for Natural Disaster Reduction (IDNDR), beginning in 1990 (General Assembly resolution 44/236). As the Decade reaches its conclusion, there is evidence that enormous synergy has been established in the disaster management community throughout the world. The Office for Outer Space Affairs, in cooperation with ESA and the IDNDR secretariat, has organized regional workshops designed to raise awareness, among policy makers and managers of civil defence and protection bodies, of the usefulness of space technology in support of disaster management.

Applications in management of resources

98. Satellite remote sensing offers several advantages over alternative means of data collection, such as airborne and ground surveys. The advantages relate to the lower cost of data acquisition, the speed and relative ease with which satellite images can be obtained and a high frequency of coverage, strengthened by the recent advent of high-resolution remote sensing satellites. While remote sensing makes a significant contribution to fulfilling information needs, its role is complementary to other means of spatial data acquisition.

99. The archived remote sensing data represent a valuable source of consistent information that permits retrospective (time-series) studies, such as determining the origin of marine pollution or the rate of depletion of a specific resource. Archives of satellite image can now be readily consulted from remote locations, as a result of the growth of information systems and the Internet.

100. GIS is used not only as a database for the storage and retrieval of spatial information, but also as an interactive management tool for analysing alternative strategies for resource allocation. The digital format of images and the synoptic coverage of remote sensing satellites facilitates processing of the images into products meeting a variety of needs. Such a characteristic allows the elaboration of value-added GIS-ready products meeting the specific needs of various groups of users from the same set of source images, thereby encouraging economies of scale.

101. Maps are needed for a wide range of planning and development activities. However, in developing regions and even in some developed countries, such maps are scarce or outdated, partly because of the high cost of preparing them using traditional approaches. The availability of satellite remote sensing images is modifying the way in which maps are prepared and subsequently used. The images themselves are ortho-rectified, annotated and used as maps. Such maps provide more information content and are more readily understood by a wide variety of end-users.

102. The wide perspective of satellite images has allowed geologists to map subtle regional geological features (such as faults, lineaments and geomorphological or lithological contacts) that would not otherwise be easily observed from the ground. The mapping of such features facilitates the exploration for minerals as well as for groundwater, both of which are key resources for development.

103. In agriculture, remote sensing is used to supplement conventional sources of information in establishing agricultural statistics and determining areas of arable land. Optical imagery with low to high spatial resolution from multiple dates as well as radar imagery is used in the identification of crops. Radar imagery is particularly useful in areas such as the humid tropics and northern Europe, where frequent cloud cover may obscure the land surface.

104. Monitoring of crops on individual farms using high-resolution imagery helps to identify areas under stress because of lack of water, in need of fertilizers or affected by diseases, long before the plants begin to show visible evidence of such a state. That facilitates optimal distribution of water, thereby making savings possible as well as improving crop yields. It also helps to avoid excessive application of fertilizer, with its potentially harmful effects on the environment.

105. Multi-date satellite imagery of crops is used in conjunction with other information such as meteorological and soil data, to develop models for forecasting yield several weeks before harvesting. That application can be of

considerable value to developing countries. Forecasts are useful in making timely arrangements for the storage, import, export and efficient local distribution of agricultural produce. Low production forecasts (for example, as a result of drought) would allow time for remedial measures to be implemented. Such is the basis for programmes such as the Famine Early Warning System of the Food and Agricultural Organization of the United Nations (FAO), which benefits a number of countries in Africa.

106. The onset of drought in a given year can be predicted by comparative analysis of the trend in satellite-derived vegetation indices for that year relative to the trend in a normal year. Early warning has allowed authorities in some developing countries to mitigate the effects of drought through redistribution of food supplies for humans and fodder for livestock. The FAO Artemis early-warning system for Africa is based on that capability.

107. Remote sensing data in combination with other information are used to analyse the associations, in time as well as in space, between patterns of landscape elements that are critical to disease transmission and the spatial distribution of infectious diseases. Such analyses allow the development of remotely sensed predictors of disease risk that can be applied to larger areas.

108. Coastal zone management benefits from satellite information on parameters such as water quality, suspended sediment and sea surface temperature. These can be used to monitor river outflow and track oceanic features. Oceanographic applications include provision of accurate information on likely fishing grounds (based on sea surface temperature), ocean wave forecasting for ship routing, measurement of the sea floor topography for off-shore exploration and oil-slick pollution monitoring. Radar satellites also permit improved sea-ice and iceberg monitoring for offshore activities and ship routing in polar regions.

109. Rising worldwide demand for potable water to supply the increasing world population, has heightened the need for assessment and management of water resources. Remote sensing satellites provide data on several key hydrological variables (for example, rainfall, soil moisture, evaporation and snowfall) using a scale that is appropriate for assessment. A satellite-based approach to assessment of water resources is especially important in regions of the world where adequate hydroclimatological networks do not exist.

110. A number of international activities are being carried out to utilize satellite data to assess and monitor conditions on Earth, such as DIVERSITAS, the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP), the World Climate Research Programme (WCRP) and global observing systems, including the Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS) and the Global Terrestrial Observing System (GTOS). The Committee on Earth Observation Satellites (CEOS), consisting of a number of national space agencies and space-related international organizations, has also initiated discussions with other organizations, including the International Group of Funding Agencies for global research, to develop an Integrated Global Observing Strategy (IGOS) aimed at providing an overarching strategy for Earth observations, allowing organizations involved in the collection of data to extend their contribution and assisting user groups, particularly those from developing countries.

(b) Issues and concerns

111. Among the major information needs for many developing countries are those required to support decision-making in important sectors such as natural resources (including agriculture, forestry, minerals, water and fisheries), the environment, human resources (including education and health services) and prevention and mitigation of natural disasters. Successful remote sensing applications in those sectors have resulted in a number of direct and indirect benefits to society.

112. An issue relating to the use of Earth observation data concerns managerial decisions involving the necessary financial commitments. The wide variety of satellites offering data with diverse formats and calibration details, with each satellite requiring specific technical upgrading for data reception, the associated access fee and the hardware and software add-ons for data product generation require financial commitments. Standardization of reception

hardware and data-processing software tools is an area where cooperative and commercial activities can play a major role. There is also a need to address the increasing number of ground receiving stations in a cooperative framework to ensure the availability of all data to all countries with minimal investments. Such availability is linked to prices of data and policies for sharing data and information.

113. Another issue faced by users of Earth observation data, particularly those in developing countries, is the quantity and location of the data. An abundance of data does not necessarily mean the data are available in a timely manner in all situations, since locating them may be a problem. Even if data are available, their usefulness depends on proper interpretation and analysis. Given the plethora of data available, without sufficient experience it is often difficult to select the right data to maximize the benefit to be derived from the data sets. Other related issues are the storage and archiving of data, linked to a disposal policy over time, the obsolescence of hardware and software and data-pricing policies, all of which pose constraints to a broader use of the data.

114. Commercialization of remote sensing has gained importance over the past few years. It reduces governmental subsidies and attracts private investments. The willingness of society to pay for remote sensing information services is related to the perceived benefits from the use of the technology, which could be measured in terms of reduced time or investments or of accurate information not available through other means. While prices of raw and processed data as well as analysed information continue to decrease, with more commercial entities involved in data distribution, the cost of acquiring satellite data and analysed information is still too high for some developing countries. In order to allow all countries concerned with the protection of the environment to obtain necessary data and information, international efforts should be made to further reduce the price of satellite data and analysed information.

115. Another issue involves the final use by policy and decision makers as well as by programme managers of the information derived from satellite data. Earth observation satellites provide essential data on conditions on Earth, allowing experts in the remote sensing field to assess the regional and global environment. While such data can provide evidence of the seriousness of environmental problems caused, for example, by poor management of land and water resources and by pollution, such information from satellites needs to be turned into specific actions to solve the persisting problems. Data from Earth observation satellites can also give early warning of natural disasters, but specific actions should be taken to prevent and mitigate the effects of such disasters.

116. The continuity of satellite data is essential to increase the credibility and value of the information provided by satellites. Policy and decision makers as well as managers of programmes concerned with environmental and developmental problems need to know that they can depend, on an operational basis, on the information derived from the data. The successful use of data in terms of quality of the final product and of a cost-benefit analysis is an important milestone that would eventually lead to its routine use in planning and management activities. Further efforts should be made to enhance and ensure access, on a continuous basis, to various sources of satellite data and to demonstrate its usefulness.

117. There is also a need to explore ways and means to further coordinate international ongoing efforts to make scientific observations of Earth. A number of international initiatives have already been taken to examine various aspects of the global environment. To maximize the use of resources allocated to the monitoring of the Earth environment, it may be useful to review information needs that have not been met by any ongoing monitoring initiative and to consider integrating some of the activities implemented within the framework of various initiatives. To integrate some of the initiatives, it is crucial to ensure the compatibility of the data exchanged.

118. To improve understanding of weather phenomena and their effect on the environment and human activities, it will be necessary to pursue the following objectives:

(a) Developing remotely sensed observations and using them together with *in situ* observations to monitor, describe, and understand climate system variability on all time scales ranging from a few days to months, seasons and interannual periods of fluctuation;

(b) Ensuring that the observations thus collected are in a form conducive to integrated data assimilation by forecast and prediction models. A primary aim is to improve the capability to predict socio-economically important weather and climatic events;

(c) Improving the coverage (in surface area and in terms of additional parameters and variables that are needed) for the calibration and validation of current and planned satellite and remote sensing observations;

(d) Improving remote sensing data retrieval algorithms so that the derived geophysical parameters are more representative of direct measurements;

(e) Improving the input of globally observed satellite measurements directly into global models.

119. The potential contribution of space techniques to disaster management is theoretically well accepted. However, civil protection authorities and other concerned bodies do not yet make extensive use of the techniques. To improve the utilization of space techniques and technology in disaster prevention and management, it will be necessary to conduct the following types of activity, which might initially be achieved through pilot projects:

(a) Identification of the data products corresponding to the requirements of the user (civil protection authority), concerning, for instance, information content, delivery time, means of dissemination and support, as well as formats;

(b) Establishment of a user request procedure;

(c) Consolidation and validation of the answering procedure by data providers;

(d) Validation of the procurement, interpretation and distribution of data and products through emergency simulation exercises;

(e) Establishment and validation of products and services for prevention, crisis and post-crisis activities in relation to the user requests;

(f) Validation of the overall pilot project activities in close cooperation with the users.

(c) Specific action programmes and schedule

120. The establishment of an integrated global observing strategy such as that initiated by CEOS should be further pursued and supported. The establishment of a system that combines current and planned space capabilities with those on the ground should involve international bodies and national agencies and organizations and needs to be user-driven. A systematic assessment of user needs and the capability of the satellite instruments for meeting those needs is required. Commitments would be needed from space agencies to meet the resulting requirements and also from the users to maximize the use of satellite-derived inputs into their modelling and decision-making processes.

121. As one of the steps towards an integrated global system, the United Nations should support the initiative of CEOS and DLR (Germany) to develop a CEOS information locator system on the Internet, which users in developing countries could use to find information about Earth observation data. The system should provide for the easy and inexpensive location, collection and sharing of data, as well as the interoperability and managing of the users' own data. The possibility of converting such a network information database to a structured international framework for cooperation, combining satellite data with ground-based or other data, should be explored.

122. Decision makers everywhere must optimize their human and financial resources to deliver the product for which they are responsible. Whether more efficient modern technologies are utilized depends on a decision maker

being aware that a modern technology, such as remote sensing, can improve the quality of the results or the cost of the final product. A second factor is being aware of whether the alternative can deliver better results than the technologies that have been used in the past.

123. The Office for Outer Space Affairs, in cooperation with relevant departments of the United Nations system, the specialized agencies, space agencies and value-added companies, should initiate a programme to promote the use of Earth observation data for planning and managing programmes and projects by user institutions in developing countries. The programme could identify ongoing national and regional projects in the areas of natural resource management, environmental monitoring and sustainable development that could benefit from the use of optical, infrared or radar data and improve their effectiveness.

124. The ultimate goal would be an improved policy, decision and management process in participating institutions on the basis of timely and accurate information derived from satellite data. The programme would strengthen the capability of institutions to use satellite-obtained data in support of projects and programmes in areas of economic and social improvement. The selection criteria for participating projects would include a funding guarantee for all non-remote-sensing aspects and the capability, either by themselves or through a cooperation arrangement with a local institution, to utilize satellite data. Participants would report to their decision makers the results of their use of satellite data, including a cost-benefit analysis.

125. A needs assessment conducted by the Office for Outer Space Affairs and its partners would identify the type and coverage of satellite images required by each participating project. Those images and the software packages necessary to process them would be acquired for each project. A short training course to acquire hands-on experience with the actual images and software that they would receive would be organized for those who work on the projects.

126. The training courses to be organized, one per developing region per year, could be included in place of one of the yearly training activities of the United Nations Programme on Space Applications. The capabilities of the regional centres for space science and technology education could also be used for that purpose. Additional costs due to the specialized materials and possibly travel expenses for expert lecturers needed by the courses would be minimal.

127. The costs involved for the United Nations would be primarily in terms of staff work-months that could be covered within existing resources of the Office by a rearrangement of priorities in work assignments with modest additional costs. The time-frame for the activity would be three years. In consultation with the participating institutions, the Office would report to the Scientific and Technical Subcommittee on the progress made.

128. The Office for Outer Space Affairs, in cooperation with ESA and the IDNDR secretariat, has organized regional workshops on the use of space technology in support of disaster management. Such workshops, designed for policy makers and managers of civil defence and protection bodies (held in China in 1991, in Zimbabwe in 1995 and in Chile in 1996) made regional recommendations on the need to introduce the use of space technology into disaster management plans and operations. Once policy and decision makers have been sensitized to the value that space technology could have in their planning and implementation activities, they will take steps to incorporate it into their programmes. However, they face the difficulty of determining the most cost-efficient and reliable way of doing so.

129. The Office for Outer Space Affairs, in cooperation with other relevant United Nations entities, the IDNDR secretariat, institutions having experience in using space technology for disaster management and private industry, should initiate a project to provide technical assistance to policy makers and managers of civil defence and protection bodies of developing countries in examining ways of utilizing space technology. Such an activity would build on the experience and accomplishments of previous activities and on work done at the regional level through the preparatory meetings for UNISPACE III and during UNISPACE III itself.

130. The ultimate goal would be for civil defence and protection institutions to begin to utilize space communications and Earth observation technology in all aspects of disaster management. The activity would strengthen the capability of institutions and promote their participation, in an incremental manner, in international initiatives such as an eventual global disaster monitoring system.

131. The project would involve organizing working meetings, on a regional basis, of civil defence and protection managers with providers of space technology and services to define areas where common efforts are advisable (for example, regional databases) and where individual actions are necessary. On the basis of those specific needs, the activity would provide technical assistance to acquire the technology and know-how, leading in some cases to pilot projects to demonstrate and test the technology. The working meetings could be organized within the framework of the United Nations Programme on Space Applications and that of the regional centres for space science and technology education.

132. An additional consideration would be that IDNDR will culminate in 2000 with a meeting which, among other things, will stimulate new actions to achieve the goals of the Decade. The project would ensure that any disaster-related recommendations made by UNISPACE III are considered and taken into account in the recommendations adopted at the final event of the Decade, and that some specific actions, such as the initiation of pilot projects are included. The costs involved for the United Nations would be primarily in terms of staff work-months that could be covered within existing resources of the Office with modest additional costs. The time-frame for the activity would be three to four years. In consultation with the participating institutions, the Office would report to the Scientific and Technical Subcommittee on the progress made.

133. Assessments are required continuously, to guide rational and effective decision-making for environmental policy formulation, implementation and evaluation at local, national, regional and global levels. To improve the global capability for keeping the environment under continuous review, urgent action is required in the following fields:

(a) Investment in new and better data collection, in the harmonization of national data sets and in the acquisition of global data sets;

(b) Increased understanding of the linkages between different environmental issues as well as of the interactions between environment and development;

(c) Enhanced capabilities for integrated assessment and forecasting and analysis of the environmental impact of alternative policy options;

(d) Better translation of scientific results into a format readily usable by policy makers and the general public;

(e) Development of cost-effective, meaningful and useful methods for monitoring environmental trends and the impact of policies at local, national, regional and global levels.

134. To increase the awareness of policy and decision makers concerned with the protection of the environment, it would be useful to establish a comprehensive list of distributors of raw and processed data from Earth observation satellites as well as analysed information.

135. To further coordinate ongoing and planned initiatives relating to Earth observation, it would be useful to prepare a comprehensive list of such initiatives taken at national, regional and global levels. To minimize duplication of efforts, participation in any of the ongoing and planned initiatives should be open to all countries that can make contributions to the achievement of the goals of those initiatives.

136. To enhance the knowledge and skills of scientists from developing countries, relevant training courses and workshops should be developed and conducted.

137. The conception and execution of joint projects between spacefaring countries and developing countries should be encouraged and facilitated.

138. An appropriate mechanism should be evolved for synergistic cooperation and coordination between the Committee on the Peaceful Uses of Outer Space, with its secretariat, the Office for Outer Space Affairs, and other international bodies working in the space field, including the United Nations Environment Programme, the Global Environment Facility, FAO, particularly on critical issues such as global warming, climate change and sustainable development, and with CEOS on the coordination of satellite missions.

B. Facilitating and utilizing communications

(a) Status: communications and broadcasting

139. The economic growth rate of the developing regions will be significantly accelerated by affordable telecommunication services. Satellite communications systems reduce the need for terrestrial infrastructure and shorten the time required to establish basic and advanced communications in rural areas. Broadband satellite services are ideally positioned to allow those regions to leap directly into modern infrastructures. As such, satellite communications could also be the key technology to bring developing countries to participate in the process of building up the Global Information Infrastructure (GII).

140. In the last decade, satellite communications and broadcasting have changed significantly in terms of capacity service offerings, lower space segment and ground equipment costs. The technology has progressed rapidly from small, low-power satellites with low-gain antennas to large complex platforms having high transmission power, precise pointing, a very high degree of frequency reuse and longer design life. Ground terminals evolved from 30-metre antennas to small and even hand-held units. Along with the advance in technology has been the progressive emergence of new telecommunications services and applications.

141. Optical fibre technology has vastly increased the capacity and cost-effectiveness of land lines, especially for high-capacity and interactive use. However, satellite systems still have advantages over fibre-optic systems. Those advantages include: (a) mobility—mobile users cannot be connected to the fibre network directly; (b) flexibility—a terrestrial infrastructure is extremely expensive to restructure; and (c) possibility for rural and remote connections—it is not cost-effective to deploy high-capacity fibre networks in areas with low-density traffic and difficult topography. Thus, satellites and wireless technologies will be important in the future implementation of GII.

142. Newly proposed or enhanced services via satellite include voice, data, video, imaging, video tele-conferencing, interactive video, digital audio and video broadcasts for entertainment and other uses, multimedia and global Internet access. A wide range of applications are planned, including distance learning, corporate training, collaborative workgroups, telecommuting, telemedicine, electronic commerce, wireless backbone interconnection (that is, wireless local area network and wide area network), direct-to-home video and satellite news-gathering, as well as the distribution of music, software, scientific data, and global financial and weather information. Satellite-based systems are also indispensable for disaster prevention and emergency relief communications services. Those capabilities make it possible, particularly for developing countries, to find solutions to problems of global and regional significance and to support development.

143. Satellite systems are uniquely suited to strengthen the development and extension of distance education. Through such advanced broadband applications as the Internet and two-way interactive videoconferencing, local elementary and high schools, universities, libraries, corporations, work sites and multi-purpose information centres can select courses from a wide range of subjects to create or supplement their own curricula.

144. Widespread access to medical facilities for both critical and preventive care is limited in many countries because of geographic constraints and other factors. Satellite technology has tangible applications in telemedicine that could help to extend access to health-care professionals throughout the developing world. Recognizing the powerful link between medical care and satellite communications, several international health organizations already exchange health and medical information for research, education and other purposes.

145. Communications for rural areas is a key element in development efforts. In rural and remote areas, where resources for education and health services can be suboptimal, access to advanced telecommunications capabilities could lead to the development of shared resource centres or community access points. Equipped with satellite terminals, the multi-purpose community centres could serve as principal access points for broadband communications. In many instances, those centres could be located within schools or hospitals and shared by multiple users.

146. Satellite communications are also vital in disseminating timely information on improved agricultural practices, agricultural products, prices of commodities, integrated pest management, public assistance measures, banking and credit services—most of which are directly relevant to the development of rural areas and hence should be treated as matters of the highest priority. Nevertheless, in spite of relatively low costs, in many instances the setting-up of space communications segments for rural communities will still be commercially unattractive. In such cases, there is a need for the intervention of government agencies to establish rural communication services, because the societal benefits to be derived far exceed the direct cost of providing the services.

147. Recent technological developments have enabled the development of a new type of satellite communications systems that are small and relatively inexpensive to manufacture. The new systems are generally known as Global Mobile Personal Communications by Satellite (GMPCS). They were designed to overcome incompatible cellular standards and poor local line quality.

148. GMPCS represent a new possibility in personal telephony, including global mobile faxing, messaging data and even broadband multimedia, providing connectivity via small, hand-held phone sets, computer terminals or laptops. They are based on constellations of satellites capable of providing telecommunication services directly to end-users anywhere in the world.

149. It is anticipated that more satellites will be launched in the next 10 years than all that have been put in orbit over the past 30 years. Nearly 800 of the projected 1,100 communications satellites over the next 10 years will be for mobile systems. During the last five years, the worldwide growth rates for mobile telephony have hovered at an astonishing 50 per cent per annum, and some countries are now actually doubling their mobile subscriber base every year.

150. Apart from enhancing the way in which business is conducted, the satellite communications sector is in itself of utmost significance to the world economy. The world market for satellite communications is distributed between a space segment (satellites, launchers and control stations insurance), a ground segment (end-user terminals and networks) and services. With the expansion of direct-to-home television and digital audio broadcasting services and the introduction of personal communications and multimedia services, the ground segment will grow by millions of users per year. The total global market for satellite communications over the coming 10-year period can be estimated at over $600 billion.

151. Over the next decade, the worldwide telecommunications industry and, in general, the information industry, will continue to undergo massive change. Privatization of the governmental telecommunications sector and the deregulation of relevant legislation, coupled with the liberalization of trade in information technology products that resulted from agreements concluded by the World Trade Organization in 1997, will open up new markets and

increase market demand. Those factors are fuelling demand for telecommunications infrastructure, and satellites will often be the most cost-effective solution to meet the needs of growth, particularly in developing countries.

(b) Issues and concerns

152. The revolution in information technology combined with that in communications has led to a tremendous increase in the capacities for information collection, storage, processing, retrieval and distribution. While that has had a great many positive effects, it can also widen the gap between those that use the technology and those that do not in terms of the amount and timeliness of the information to which they have access. Fortunately, there is evidence that the same technological tools can be used to actually narrow the information gap. Steps need to be taken to address the issue of the information gap between countries and also within each country.

153. One vital necessity, in order to reduce the information gap, is universal access to communications and information sources. That involves ensuring access to broadcast signals and to telephony. Technology can, today, provide television signal and telephone connectivity to any person on Earth, practically irrespective of his or her location. Methods of translating that possibility into reality are an important issue that needs immediate worldwide attention.

154. Access to a low-cost bandwidth will be a factor as essential to economic development in the twenty-first century as cheap power was to the industrial revolution in the twentieth century. It is estimated that to meet such a challenging task globally by terrestrial means, 25 years and $1,000 billion to $3,000 billion would be needed to connect the globe with fibre optics. This is where new satellite communications technology could be most useful, in particular, in rural areas with low-density traffic of less than 200 subscribers per square kilometre, and may be the means through which developing countries could have ample, low-cost access to high-density broadband telecommunications links.

155. Radiocommunications systems are the fastest-growing sector of the telecommunications industry. Other radio-based services such as paging, subscriber radio and television delivered by satellite and global positioning systems are also enjoying rapid growth in many world markets. With increasingly sophisticated systems for navigation, air and maritime safety, new laptop-computer-based mobile data systems, proposed services such as GMPCS and dozens of other new applications still being developed, the allocation of radio frequencies in the electromagnetic spectrum has become a pressing issue. The issue has led to a fundamental review of the planning and coordination framework of the International Telecommunication Union (ITU). The review resulted in the adoption of important decisions at the World Radio Communications Conference of 1997.

156. While the issue of coordination and allocation of geostationary orbit frequency and space resources by ITU needs to be fully supported, consideration needs to be given to a more efficient and equitable distribution of spectrum-orbit resources, taking into account possible technological innovations, in order to ensure the use of such resources by developing countries.

157. Many developing countries have a large need for external funding to provide basic telecommunications to accelerate their socio-economic development. The current forms of investment and assistance in this critical sector are clearly inadequate. The World Bank itself estimates that by the year 2000 the developing world will need at least $12 billion annually to ensure growth in the telecommunications sector, while $30 billion annually would be required to satisfy demand. The level of funding that might be anticipated from international public assistance would be on the order of $2 billion to $3 billion. That is clearly an area where private sector investment should be promoted.

158. In addition to preparing for the Global Information Infrastructure, it will be critical to develop a local information infrastructure to meet the needs of the diversity of users within a country. Related to the local information infrastructure is the issue of determining appropriate technologies in which countries should invest.

159. One of the major problems faced by many developing countries is not one of just acquiring technology for long-distance communications, but what is sometimes called the “last-mile” problem—the lack of reliable electricity, illiteracy, social inequities, terrain conditions, adverse environmental conditions for sophisticated equipment or simply lack of awareness of the technology. Those issues are to a large extent not directly space-related, but need to be carefully considered on a case-by-case basis.

160. The establishment of priorities is an issue to be considered in investing in information and telecommunication technologies, including satellite-based technologies. While the immediate returns on investment in information and telecommunication technologies may not be readily apparent to hard-pressed administrations concerned with limited resources, the long-term positive impacts of a proactive strategy may be considerable. Within that context, developing countries must make difficult decisions. Providing access to information and telecommunication technologies for certain sectors of society, particularly to benefit illiterate and rural populations, is a particularly important but costly challenge.

161. Another issue to consider in establishing priorities to invest in space, or any other type of telecommunications, is that those who will benefit from the services and those who will deliver them (for example, educators) need to be involved early in the process. Well-designed plans would include an education and training programme for all parties involved.

162. Technology and communications limitations in underdeveloped regions are only one reason for the concentration of computers and Internet services in developed countries. There can be political, cultural and even religious reasons for avoiding links into a worldwide, open communications network.

163. The proliferation of low Earth orbit (LEO) communication satellites, designed to provide high-quality global personal communications services, have advantages over geostationary satellites in that such satellites would not have the associated problems of long propagation delays and high-latitude coverage limitations. Moreover, it would be possible to reuse the frequency spectrum and to provide radio positioning services, and the efficiency of spectrum use would be maximized. However, LEO satellites usher in a new technology element, and the need to maintain multiple technology services could pose difficulties for developing countries.

164. Radio is the most ubiquitous communications device in the world. There are over 2 billion radio sets in the world and over 100 million sets are sold every year. A leading company in the space industry is attempting to bring low-cost but high-quality digital radio broadcasting to 3.5 billion people, relying on a digital audio broadcasting system that works by routing a radio signal through a very small aperture terminal up to a geostationary satellite. The satellite retransmits the signal, which is picked up by millions of portable radio receivers.

165. The new global digital radio broadcasting infrastructure being created will enable broadcasters and advertisers to reach underserved, emerging markets in Africa, Asia, Latin America and the Caribbean and the Middle East. With a new type of radio needed to receive programmes from satellites, people in those areas will be able to receive digital sound broadcasting of unprecedented quality and diversity.

(c) Specific action programmes

166. Investment by the private sector in telecommunications is growing. However, to further mobilize the private sector to invest in telecommunications services in developing countries, a legislative and regulatory framework should be established to allow the emergence of a stable, predictable and transparent telecommunications market conducive to rational economic decision-making. That is an initial action which governments wishing to promote such investments should undertake.

167. Once the necessary legislative and regulatory framework is established, in addition to promoting national investment, developing countries may consider inviting the private sector of developed countries active in satellite communications to invest in the establishment of solid telecommunications infrastructure.

168. Some other specific actions to be taken are recommended below:

(a) A plan should be evolved to provide, within reasonable walking distance of every village or habitation on Earth, a telephone or data communication facility and a radio or television set for reception of satellite broadcasts;

(b) Developing countries should be assisted in assessing how space technology can help meet their information and communication needs;

(c) The sharing of experience between countries about the use of satellite broadcasting and communications for educational and development purposes should be facilitated;

(d) The feasibility of international and regional cooperative systems for satellite-based broadcasting and communications for development should be studied;

(e) The possibilities of cooperation with the private sector in setting up a chain of viable, self-supporting communication centres or "information shops" all over a country, where users can go to get access to vast databases via a modem and a satellite terminal, should be explored.

C. Improving and using position/location capabilities

(a) Status: navigation and position/location using satellites

169. Global Navigation Satellite Systems (GNSS) are space-based radio positioning systems that provide 24-hour three-dimensional position, velocity and time information to suitably equipped users anywhere on or near the surface of Earth, and sometimes off the surface of Earth. There are currently two global navigation satellite systems, GPS (United States) and GLONASS (Russian Federation), both operated by the military. GNSS use satellites as reference points to calculate positions accurate to within metres or, with advanced techniques, to within a centimetre. Since their inception, the use of signals from those two existing military satellite navigation systems has been offered free of charge to civilian users.

170. Satellite navigation and positioning services are used largely, but not only, in the field of transport. New applications, however, have emerged in a wide variety of fields. The future of global navigation systems is to a large extent unlimited, as new applications will continue to be created as a result of technological evolution. The social and economical benefits of the navigation signal are enormous. Even if transport is currently generating most of the interest around satellite navigation, other sectors, in particular traffic management and agriculture, will account for most of the revenue in the short and medium term.

171. GPS receivers have been miniaturized and their costs drastically reduced, making the technology accessible to virtually everyone. GPS technology has matured into a resource that goes far beyond its original design goals. GPS receivers are now used by scientists, sportsmen, farmers, soldiers, pilots, surveyors, hikers, delivery drivers, sailors, dispatchers, lumberjacks, firefighters and people in many other professions in ways that make their work more productive, safer and easier. GPS equipment is being built into cars, boats, planes, construction equipment, movie-making gear, farm machinery and even laptop computers.

172. The advantages that a global satellite navigation system would offer include simplification through the use of a single system which could meet all users requirements and operate worldwide 24 hours/day. A space-based system will also provide improved accuracy of position and velocity measurements which will lead in turn to a reduction of waiting times, fuel savings, better environmental protection and a reduction in the number of accidents.

173. With a view to developing its use, Europe has decided to implement an initial Global Navigation Satellite System (GNSS-1) together with system augmentation, and to initiate parallel preparatory work towards a follow-up system (GNSS-2). However, the future development of the market depends, at least partly, on the acceptance by the airline industry of GPS as a navigation aid. That will be influenced to a great extent by the guaranteed open access for civilian users, which is currently limited, at least formally, by the fact that the military retains the option of degrading the civilian signal if considered necessary for national security purposes.

174. The European contribution to GNSS-1, referred to as European Geostationary Navigation Overlay System (EGNOS), is based on the use of navigation payloads on geostationary satellites and will meet civil aviation primary navigation requirements for all phases of flight from en route to non- precision approach, down to category-1 landing. The system should be operational by the end of 2000.

175. The second generation GNSS, namely GNSS-2, is expected to be under civilian control, tailored to the long-term needs of civil user communities and designed for improved navigation performance, while still retaining GPS/GLONASS backward compatibility. The system will have to be designed to serve the needs of civil users in the time frame 2005-2020, and it is anticipated that the demand for improved integrity, accuracy and availability will increase.

(b) Issues and concerns

176. With the availability of high-resolution images from satellites, precision of locations is required to sub-metre levels. Currently, through sophisticated techniques involving repeated measurements, such precision is achievable from the positioning satellite systems. Establishing user-friendly, precise transformation and linkages between the images, GPS observations and their input into GIS databases will be a critical need in the coming years.

177. A major technical issue associated with the use of GPS is the fact that cross-correlating between the datum that GPS employs to the national datum, would require the establishment of a geodetic network based on GPS observations. That becomes very relevant when satellite images, particularly high-resolution images, need to be referenced to national map bases. The cross-correlation and establishment of a different geodetic network means additional investments—both in resources and time.

178. Although some governments have already approved the use of GPS in aviation, the performance of GPS and GLONASS does not meet all requirements of civil aviation in all countries and needs to be enhanced through the implementation of system overlay or system augmentation.

179. A number of political and economic problems also need to be resolved before any new type of a satellite navigation system can be deployed on a global or regional basis. To overcome those problems, the current GNSS-2 initiative will have to focus more on a clear definition of its mission, operational structure and cost-benefit ratio than on the technologies to be applied.

(c) Specific action programmes

180. A large degree of regional and global cooperation is essential to achieve a seamless multimodal satellite based radio navigation and positioning system throughout the world. In this context European entities have started coordination contacts with several countries and organizations with two objectives. First, to examine the possible extension of the EGNOS coverage to other countries or, alternatively, to ensure its compatibility with other regional augmentation systems. Secondly, to study forms of cooperation in view of the implementation of a second generation system.

181. Further international coordination and consultation is necessary to ensure compatibility between existing and planned navigation and positioning systems while maintaining open access to the satellite signals. At the same time, the technical issues related to using the positioning signal in Earth observation applications requires work by groups of technical experts.

D. Furthering knowledge and building capacity

(a) Status: space science and space exploration

182. The ability to develop space science or even use space technology depends critically on the availability of human resources with appropriate knowledge and skills. Space research and education address both the understanding of basic space sciences as well as the fundamentals that lie behind the use of space technology for various applications. In a complementary role, training addresses how a technology is used. Thus research, education and training are the cornerstones for furthering knowledge and are part of overall capacity-building.

183. Perhaps the primary benefits of the new age of discovery relate to the impact made on the way in which humankind views its own global habitat in the context of the solar system and the universe beyond. The recognition that human beings are not the centre of the universe but are part of a greater natural order represents a dramatic change in human attitudes towards the world around them. The new appreciation of the interdependence of human beings and their natural environment has inspired a vast expansion of interest in, and study of, the natural environment, including other planets, stars and the universe as a whole.

184. The runaway greenhouse phenomenon on Venus, caused by an excess of carbon dioxide in its atmosphere, has led to an understanding of the dangers of carbon dioxide build-up on Earth and the resulting global climate change. The antiseptic surface of Mars, without any sign of life or organic material because there is no ozone layer to protect it, provides a bleak description of what might happen if the ozone layer of Earth is destroyed. The finding of aerosols in the atmosphere of Venus and the observation of how they interact with the molecules there have led to increasing knowledge about what happens when aerosols are introduced into the atmosphere of Earth. Asteroid and comet impacts on Earth and on other planets have profoundly influenced the evolution of those planets. All of those discoveries have important global significance for Earth.

185. In addition to the many basic research areas indicated in section A above, dealing with protecting the environment, further knowledge needs to be developed in several other space-related areas. For instance, there is a need for further understanding of the orbital debris environment (including the size range of debris, its composition and its distribution by orbital altitude) to assess the debris hazard to spacecraft in all orbits and to enable decisions to be made on mitigation measures to reduce future hazards.

186. The importance of studies on near-Earth objects (NEO) received an important impetus with the discovery of the iridium anomaly at the K/T (cretaceous-tertiary) boundary. No other event has so clearly demonstrated the influence of minor objects on the evolution of terrestrial life. The introduction of studies based on the fossil record has broadened the interdisciplinary and international nature of planetary science, encompassing fundamental concepts of Earth history, mammalian evolution and contemporary natural hazards both on Earth and in space.

187. The impact of comet SL-9 fragments into planet Jupiter in 1994 and the recent discovery of asteroid 1997 XF 11 reminded the international community of the estimated 1,700 suspected NEOs larger than 1 kilometre in diameter that have not yet been discovered with astronomical telescopes. Some space agencies have already taken initiatives in the detection and characterization of NEOs by acquiring data from spacecraft and ground-based observations and creating an inventory of NEOs. There are also non-governmental organizations aiming at coordinating activities for the detection of NEOs at the international level.

188. Promoting scientific literacy worldwide is one of the great challenges for the new millennium. Much of the quality of life and economic growth now depends on scientific and technical awareness and the ability to incorporate new knowledge and devices into the economy and lives of individuals.

189. The study of space science and planetary exploration is critical to further knowledge in the above-mentioned areas. In a broader sense, it can make very important contributions to the future well-being of humanity, for the following reasons: (a) it is a basic element of education; (b) it leads to and facilitates international cooperation; (c) it leads to technological development; (d) it promotes the participation of young scientists and engineers in space-related fields; and (e) it enhances understanding of the past and develops a vision for the future.

190. Within space science, astronomy has long been a pace-setter in encouraging education in science and the development of scientific literacy, in communicating science and mathematics to the public, and in motivating children to learn those subjects. Through the World Wide Web, other Internet services and the mass media, the findings of space science and planetary exploration as well as the economic and social benefits that eventually derive from them can now be made more readily available to all people.

191. In terms of education, the space sector will always need young graduates in space-related fields from all levels of university education in a wide range of disciplines, including science, management, law, engineering, economics, architecture, communication, medicine and finance. Space agencies, commercial firms, and international organizations involved in space emphasize that many young specialists should complement their training by acquiring the tools that will enable them to increase their efficiency in an interdisciplinary, international and, consequently, intercultural environment.

192. A strong and well-developed conventional system of education, from primary to university levels, can provide a good foundation for introducing or carrying forward work related to space science and technology. A number of space agencies and institutions prepare, on a continuing basis, audio-visual material to strengthen the contents of science, technology and mathematics of existing curricula at all educational levels. Many of those institutions organize training courses on various subjects. Some of them are also involved in providing adequate educational support for teachers.

193. A large amount of educational materials, essentially covering all aspects of space science and technology is being continuously developed. Examples of institutions that prepare such materials include the Brazilian National Space Research Institute (INPE), th Centre national d'études spatiales (CNES) (French National Centre for Space Studies), ESA, the German Aerospace Research Establishment (DLR), the United States Aeronautics and Space Administration (NASA), the National Space Development Agency of Japan (NASDA), the Russian Space Agency (RSA) and several other space agencies. Although this material is developed primarily to meet national needs, through cooperative arrangements, much of it is benefiting a large number of countries.

194. Educational material is also developed by other institutions including international organizations such as CEOS, the Committee on Space Research, the Council of Scientific Unions, the International Astronautical Federation, the International Astronomical Union, The Planetary Society, organizations in the United Nations system, and other professional scientific organizations throughout the world that promote the benefits of space science and technology.

195. In addition to education and training of human resources, capacity-building involves developing experience and practice in conducting research programmes or operational applications of selected technologies. That involves setting policies, establishing institutional frameworks and physical infrastructures, ensuring funding support for the chosen activities and access to external sources of data and information, as well as establishing technical cooperative links with institutions having expertise in the selected areas of research or applications.

196. Experience indicates that as education in the basic disciplines becomes more widely available, the transition from such education to space applications can be brought about by project work, by on-the-job training and experience, by workshops and by joint project partnerships.

197. The Office for Outer Space Affairs, through the United Nations Programme on Space Applications, has undertaken an initiative aimed at establishing regional centres for space science and technology education, affiliated to the United Nations, located in developing countries. The centres are based on the concept that by pooling limited material and highly qualified human resources, developing countries could have education and training centres, of an international-level quality, in which to prepare indigenous personnel in the use of space science and technology, particularly those applications relevant to national development programmes such as remote sensing and the use of geographic information, satellite meteorology, space communications and basic space science.

198. The Centre for Space Science and Technology Education in Asia and the Pacific, affiliated to the United Nations, was established in 1995. The first node of the Centre is hosted by ISRO and offers short-term training courses and nine-month education courses, followed by a one-year follow-up project, in remote sensing and GIS, satellite communications, satellite meteorology and the global climate and in space science. By the end of 1998, the Centre would have completed four courses and have about 80 students as part of its alumni. The Centre envisages becoming a nerve centre in the Asia-Pacific region by undertaking specific research projects, consultancy services to the member States in the region and providing high-quality education in areas of space science and technology development.

199. Brazil and Mexico were selected as host countries for the regional Centre for Space Science and Technology Education in Latin America and the Caribbean, affiliated to the United Nations. The agreement establishing the Centre has been signed by the two Governments and was subsequently ratified by their respective parliamentary

bodies in 1997. The process of establishing such a centre, in Morocco and Nigeria for the French-speaking and English-speaking countries of Africa, respectively, is nearing completion and plans for a similar centre in western Asia are being finalized.

200. In the case of central, eastern and south-eastern Europe, discussions among Bulgaria, Greece, Hungary, Poland, Romania, Slovakia and Turkey led to the establishment of a network of space science and technology education and research institutions. Experts from those countries agreed to work with the Office for Outer Space Affairs to undertake a study on the technical requirements, design, operation mechanism and funding of the network.

201. In support of the centres, the Office for Outer Space Affairs brought together a group of research and education specialists and requested them to prepare international-level curricula in the areas of remote sensing and GIS, satellite meteorology, satellite communications and basic space sciences. The curricula prepared by that group were further sent for peer review to individuals representing a broad geographical and scientific cross-section. The curricula are intended to provide a benchmark for the centres.

(b) Issues and concerns

202. Strengthening and supporting the activities of the regional Centres, established at the initiative of the United Nations, calls for concerted effort by various agencies towards sustaining, *inter alia,* their educational activities, infrastructure development and the institutional and organizational framework.

203. The development of human resources has to be supplemented by the development of adequate physical infrastructure. The first step in developing physical infrastructure is to define needs, and that depends upon the overall needs of the country concerned and the defined or likely role of space science and technology in meeting those needs.

204. While the needs and possibilities will vary from country to country, experience indicates that it is best to begin with the infrastructure required for applications, for example, computers and equipment for analysis of remotely sensed imagery, and then to move on (if required) to data reception facilities. Such an approach also helps to produce the quickest returns from investment in such infrastructure and helps to develop and expand local skills.

205. Financing of physical infrastructure is an area where international assistance may be needed. Multilateral agencies can play a major role in providing such financing and in ensuring the inclusion of space-related infrastructure in development projects, for example, by including a satellite broadcasting component in an education project. Efforts should be undertaken at the national level to create awareness about the need to integrate such infrastructure facilities providing support to elements of other larger projects in the development field.

206. Potential users of space technology, for instance managers of civil protection services, often need technical advice in identifying the type and appropriate level of technologies to include in their programmes. The risks involved for the decision maker are that the chosen technological solution might be insufficient for the problem, and therefore a failure; or that it might have been much more than was required, therefore resulting in a poor cost-benefit ratio. Such a situation is particularly likely to occur in many developing countries.

207. The efforts made by space agencies in observing NEOs could be further strengthened by coordinating activities with non-governmental organizations and individual researchers at the global level. Efforts should be also strengthened to provide the general public with accurate information on NEOs.

208. There are limited opportunities foreseen in the programmes of the major space agencies for continued capabilities of the type supplied, for example, by the International Ultravidet Explorer satellite mission, which ceased operation in 1997. Groups of international scientists participating in a series of United Nations/ESA workshops on basic space science made that observation and recommended the establishment of a world space observatory. Such

a facility would extend well beyond the defined programmes of the major space agencies and the scientific requirements would possibly be more efficiently addressed on a cooperative basis.

209. Space-related organizations with educational activities are increasingly turning to the Internet, and particularly the World Wide Web, for their outreach. But the Web is not yet worldwide, and Internet access is still limited in some developing countries. While there are programmes that aim at enlarging electronic access for developing countries, printed materials continue to be a requirement.

210. Political and financial support for the development and use of space science and technology is enhanced by improving public awareness, understanding and appreciation of the benefits derived from space. Although every institution involved in space conducts activities of dissemination of information to the public, the results are not fully satisfactory. Higher priority needs to be given to such activities.

211. Operating with less formalism and fewer constraints, and with more limited agendas, non-governmental organizations can serve both as advocates and as team builders for international cooperation, both at the level of working scientists and at the level of the general population. Emphasis should thus be placed on the potential of non-governmental organizations to serve as catalysts in education and public information.

(c) Specific action programmes

212. The Office for Outer Space Affairs, jointly with each regional centre for space science and technology education associated with the United Nations, should lead an international effort that would include space agencies, the specialized agencies of the United Nations system, inter-governmental and non-governmental organizations and the private sector, to build up the quality of education programmes and the long-term viability of the centres.

213. The ultimate goal would be for the centres to receive the recognition, particularly among the developing countries, of their value in preparing human resources that can support economic and social development programmes, such that a self-sustaining funding mechanism that is primarily supported by the region, but also by other donor countries, international organizations and private industry could be established. The awareness-raising efforts by alumni, strengthened by their own enhanced accomplishments, would be a key element towards achieving that goal.

214. Possible action in direct support of the education programmes would be the following:

(a) Promoting the establishment of cooperation agreements between the centres and the type of entities mentioned above. The educational areas and form of cooperation would involve an arrangement, at the university level, on a mutually acceptable basis, whereby researchers and lecturers could be exchanged; technical advisory support could be provided for graduates conducting pilot projects in their home countries; and short-term courses and workshops designed to develop capabilities of the participants beyond the basic introduction level could be organized;

(b) Promoting the acquisition by the centres of audio, visual and available on-line educational materials;

(c) Assisting the centres in achieving a significant representation of regional and international lectures;

(d) Assisting the centres in directing some of their activities to areas of regional and international concern;

(e) Establishing a fellowship fund or mechanism to support the participation of individuals from the regions in the education and training programmes of the centres.

215. Other actions to support the build-up of infrastructure and operation of the centres could include the following:

(a) Assisting the centres in preparing cost-sharing proposals to funding institutions for initial operations;

(b) Assisting the centres in establishing contacts with industry that would lead to partnerships in areas of common interest;

(c) Assisting the centres in designing an effective means of disseminating information about their accomplishments, at the regional and international levels, so as to build up the requisite support to ensure their long-term viability.

216. In addition to the Office and the centres, the participants in this activity would be those institutions which indicate interest in any modality of cooperation with the centres. Some of the cooperation activities which the Office already conducts, as for instance with ESA, ISPRS and The Planetary Society, might be redirected and others with new co-sponsors would be added.

217. The costs involved for the United Nations would be primarily in terms of staff work-months which could be covered within existing resources of the Office with some modest costs. The time-frame for the activity would be three years. In consultation with the participating institutions, the Office would report to the Scientific and Technical Subcommittee on progress made.

218. The United Nations has been effective in distributing information and enhancing communications for scientists and educators in developing countries. It could lead initiatives to distribute educational material capturing the latest information and results from space exploration. The support of national space and science agencies, educational organizations and non-governmental organizations for the development and distribution of the material is crucial.

219. Interested countries could provide expertise and participate in missions and other space activities, not only through educational programmes, but also by contributing to and developing space mission databases, instruments and components, by providing co-investigators in scientific or engineering teams, and by manufacturing or production efforts. For this purpose, the various “Announcement-of-Opportunity” invitations to participate in research or pilot projects which are regularly issued by space agencies should be widely disseminated.

220. In addition to its emphasis on space applications, the United Nations could develop programmes of information and training, based on the results of and activities in space science and planetary exploration, for the benefit of developing countries. Workshops and symposia to assist scientists in responding to opportunities to participate in a space mission, as well as to benefit educators and others interested in the broader issues related to space science and planetary exploration, could be convened under the framework and within the resources of the United Nations Programme on Space Applications.

221. Major projects and programmes could have a person assigned as international coordinator to solicit international contributions from spacefaring and non-spacefaring countries alike. Workshops and symposia for scientists and educators from developing countries should continue to be organized to facilitate their participation in space science missions and benefits. Such workshops should examine and build upon the results of previous events.

222. A global NEO watch network, with the involvement of non-governmental organizations, individual researchers and amateur astronomy groups, including those in developing countries, could be established. The space agencies which already have activities to observe NEOs could play a leading role in establishing such a network and could consider providing assistance in improving existing astronomical telescope facilities in developing countries and in establishing the network.

223. The Office for Outer Space Affairs, within the framework of the Programme on Space Applications, could organize international meetings of leading researchers in the fields of astronomy, planetary science, astrophysics, palaeontology, astronautics and space law on NEO on a regular basis, for example, one every two or three years. The meetings on NEOs could also serve in the future, as necessary, as a forum for engineers, legal experts and policy makers to consider technological, legal and political issues in developing a strategy to protect the Earth in the case of likely collisions with NEOs.

224. The development and implementation of a World Space Observatory could be achieved by the year 2005, in a joint effort by space agencies and organizations in the industrialized and developing countries. Necessary financial resources could be raised through the establishment of an International Space Science Fund.

E. Information needs and the global approach

(a) Status: information systems for research and applications

225. Information systems are fundamental tools for organizing, handling and integrating data through appropriate algorithms, and generating output in the form that is most suited to the intended user group. Information technology includes a cluster of advanced technologies in the field of computing, software, micro-electronics, telecommunications, databases and networking. Thus, Information Technology, in this wide sense includes not only information-relevant processing technologies but also telecommunications and electronic information transfer technologies. The emergence of space technology as a potent tool for information gathering and for rapid and reliable communications over large geographical spreads and to remote areas has been a major contribution to the information-technology sector.

226. The changing scenario of the information technology industry and the proliferation of computers has changed the scope of information processing, whether in terms of applications or for technology support. Computers are currently not only able to process text and numbers, but also digital maps and images, both by themselves and along with tabular data, and to merge them together to provide a new perception—the spatial visualization of information.

227. Information infrastructures have become an essential element of the development of any country. In the global sense, the concept of GII is being conceived on the basis of the vision of open connectivity and information access. The thrust of GII is open access, universal service, a flexible regulatory environment, competition and private investment. The fundamental principle underlining a national information infrastructure (NII), is the "right to know" and the "right to information" tenet. The right to information of public domain data, consumer data, citizens rights, universal access and financial data underpin the need for developing NII.

228. Information systems are the core of national and global information infrastructure. While it is not essential to organize multiple information systems for the global and local level, what is needed is an abstraction and exchange mechanism for the aggregation of information from lower levels to higher levels. Many countries have national infrastructures for information where the access to information is recognized as a basic right. Many developing countries are yet to establish information infrastructures and lack the recognition of access to information as a basic resource for development. The essential existence of databases as prime tools for decision-making and development needs to be strengthened further with concrete examples of the cost-benefit ratios of organizing information systems in a systematic manner.

229. For effective planning and development, a variety of data on physical and natural resources, human resources, social practices and economic aspects are required. Databases organized around GIS cores are essential elements of the information systems, and the emphasis in the future will be on organizing spatial databases using GIS. Space images will be the most important form of inputs for the GIS databases, as they record the continuum of the changes in the environment. The modelling and integration capabilities of GIS allow quick and reliable analyses of "what-if" scenarios of real and possible situations and generate visualizations of queries that users specify.

230. An important asset of the systems is their data handling capacity. First, they allow the input of data of different origin, content and format. Secondly, they offer to the operator wide flexibility in manipulating the data and displaying it in a user-appropriate form. Finally, they permit the integration of data in a value-added product, the information content of which is higher than the individual items of data and is customized to meet user needs. The power of those tools depends not only upon their technical characteristics, but also upon the quality of input data, and in particular on the capability of keeping the database up-to-date by including new data. Earth observation from space provides a coherent, objective and regular source of input data for information systems.

231. Information systems are therefore of value for monitoring purposes, to observe an event and for planning and prevention activities. They are valuable tools for both research work and application activities, and eventually in decision-making.

232. Information systems are also needed for education and training. Without an adequate transfer of know-how from developed to developing countries and institutions, it is almost impossible to think about sustainable development. All levels of training need to be considered and ensured for technical specialists, data interpreters, students and professors, decision makers and project managers. Furthermore, on-the-job training and course follow-up activities are necessary.

233. With the advent of the World Wide Web, the location of prime databases on the Web has posed a demand for Web compliance of databases and for a universal and wider access. That has again brought in the new technology syndrome calling for standardization and for low-cost tools.

234. As various new information systems have been developed, the protection of intellectual property rights has become one of the most debated issues, as reflected in the discussion of international action to ensure world intellectual property protection for databases. Various legislative initiatives have been proposed regarding intellectual property rights.

(b) Issues and concerns

235. An important step in solving problems of global and regional significance is to identify the issues relevant to major global problems and concerns such as ozone depletion, coastal changes, climate change, extreme weather phenomena, reduction in biodiversity, desertification, deforestation and land-ocean-atmosphere interactions, in particular the El Niño phenomenon, in which space technology could contribute to the understanding and solution of the problems. At the local or national level, the emphasis would be on using high-resolution satellite images to provide solutions for more mundane issues of direct relevance to the local people—crops, water, land use, urban growth, routing of facilities, pollution etc. A common issue for all those problems is the need to have integrated information systems, in a distributed manner but linked through powerful networks to be able to serve as the “backbone” for national developmental and global research activities.

236. For most of the research and developmental application needs related to environmental issues, the sources of information are the same, namely field observations, ground measurements, remote sensing data taken by airborne and space-borne sensors, ancillary inputs from archives and databases, and additional information based on experience and from statistics. However, although many data products are being created by government, university and other research groups, the products are often difficult to find, fragmented and poorly documented, or they are unavailable in a suitable medium or an easily readable format.

237. The issue of metadata for data access, search and exchange is a key issue if information access is to be universal. Development of information locator engines for easy search and access and getting to the right information is also essential.

238. As policy makers are turning their attention to designing a sustainable development approach to management of the problems of Earth and its resources, data and information are urgently needed in a readily accessible and easily understandable form. Recognition of the usefulness of spatial information (information in map form) for decision-making and its inputs for spatial area-based planning and development is, with a few exceptions, lacking in developing countries. Such a situation needs to be corrected to improve the decision-making process.

239. Specific actions are needed to establish an all-encompassing infrastructure consisting of:

(a) *Databases*. The key elements of the infrastructure are the databases and developing databases for different purposes and users (private, public, scientific, and government) are the major tasks to be accomplished towards a systematic development of the infrastructure. In most countries, the effort will be in converting the massive amounts of analogue data to computerized databases;

(b) *Network*. The basic element in the operation of an information system is the backbone on which information travels from one point to another. With rapid advances in technology, network configurations are evolving to provide high bandwidth connectivity using fibre optics and various technologies to reach data transmission rate capacities of up to 100 megabytes per second (Mbps), communication networking of up to 2 Mbps with very small aperture terminals (VSATs) and high-speed satellite broadcast delivery. Therefore, the network backbone will have to be a mix of satellite and terrestrial communications. The advantage of satellite communication is its regional reach and its ability to serve miniature hubless VSATs and direct-to-home delivery of information services;

(c) *Standards*. Standards for databases (formats, exchange of data and interoperability) and networks (gateways and protocols, communication equipment and software) are an important element of information systems. Standards enable applications and technology to work together. Although users must be involved closely when standards are developed, the final product should be user-friendly. The adoption and use of standards also require resources. The adoption of standards can be slow, partly because those who reap the benefits of standards often are not those who have borne the costs of creating and implementing them. Governments can encourage the adoption of standards by requiring their use;

(d) *User interface*. With regard to design of the information systems, much depends upon the type of user who is intended to have access to the system and the upper-end level of applications or services available on it. For some applications, the penetration will have to reach the household level and the capabilities will include on-line access of video applications, such as for education programmes using the Internet.

240. When discussing the compilation of data and their inclusion in information systems for the benefit of human development, the two key issues to be considered are that user requirements must be defined first, and that there should be continuity with respect to both data and services.

241. Another issue concerns the protection of intellectual property rights. With the increasing sophistication of data-processing techniques used in observation systems, more organizations, including commercial organizations, will be supplying the observation systems, data-reduction capability and value-added products. The intellectual property issues relating to environmental information are complex and changing, requiring careful policy attention. Consideration should be given to the possibility of developing a set of appropriate measures to protect intellectual property rights without constraining opportunities to make the resulting data and information available not only for the primary uses, but also for all other beneficial purposes.

(c) Specific action programmes

242. To reach its full potential for operational applications in territorial, environmental and disaster monitoring, satellite remote sensing must ensure the high revisiting rate needed for applications in support of sustainable

development. That could be achieved through coordination of orbital parameters between satellite operators in order to ensure a high revisit capability. Such coordination could be facilitated through CEOS, with active assistance from the Office of Outer Space Affairs.

243. The availability of clear and up-to-date information on technical issues and application results is essential to derive full benefit from the use of space science and technology. Participation in thematic workshops and conferences and access to the international e-mail network and the Internet should also be supported.

F. Spin-offs and commercial benefits from space activities—promoting technology development and exchange

(a) Status of commercial and spin-off activities

244. Space activities incorporate some of the most important areas of high technology: computer software and hardware development, sophisticated electronics, telecommunications, satellite manufacturing, life sciences, advanced materials and launch technology. Space activities also involve some of the most significant issues of international trade and policy: global markets, gaining access to remote areas, government-subsidized competition and international standardization and regulation.

245. Products and services derived directly from space technology as well as indirectly from the large number of its spin-offs contribute in many ways to improving the quality of life of society. Some benefits are provided directly by the technology, as in the case of telemedicine, tele-education, and emergency communications. Other benefits are found in thousands of spin-off products that have resulted from the application of space-derived technology and are used in such fields as human resources development, environmental monitoring and natural resources management, public health, medicine and public safety, telecommunications, computer and information technology, industrial productivity, manufacturing technology and transportation.

246. The commercialization of space activities has been a highly positive development, with commercial systems providing services that the public sector can no longer afford. Through numerous joint ventures, including ventures involving companies from developing countries, commercial systems and services have eliminated the concept of nationality in some space activities. That is particularly the case with regard to constellations of communications satellites, which depend on the international private sector to provide the financial investment and to manufacture, operate and market the satellites and services; it also applies to remote sensing and other areas.

247. Satellite telecommunications is the most mature segment of the space market. According to some studies, from 262 to 313 communications satellites are to be placed in geostationary orbit between 1996 and 2006, with an estimated market value of $24 billion to $29 billion. To estimate the full potential market, the corresponding figures for low-Earth-orbit and middle-Earth-orbit satellite constellations for mobile telephony and multimedia applications would have to be added.

248. The commercial market between 1987 and 1996 amounted to 36 satellites launched on average each year. The estimated market between 1997 and 2006 is expected to be 110 satellites launched per year. The total market value for launching services from 1997 to 2006 is estimated at $33 billion, of which $21 billion correspond to geostationary satellites. Firm contracts that have already been signed account for 55 per cent of the $21 billion, with another 6 per cent being considered as a captive market. That leaves 39 per cent of the expected market still open for international competition.

249. Next to telecommunications, remote sensing and geographic information systems may be among the most significant commercial applications. With the launch of 20 new remote sensing satellites expected by the year 2002, data-collection capabilities will increase considerably. The new systems will provide users with higher spectral and spatial resolutions. That will be combined with an increase in cost-effective computing power and data compression capability. At the same time, applications will be more adapted to specific user needs and more user-friendly.

250. GIS will become an essential tool for analysing data as well as presenting information for market and geopolitical analysis and for diverse applications such as environmental studies and disaster management planning. It is projected that the GIS market could reach $5 billion in sales by the year 2000.

251. Commercial activities for the provision of information services will emerge as a key sector for private investments, with the anticipated demand for information growing between threefold and fourfold. Development of value added to satellite images, their input into GIS databases, modelling and integration for scenario analysis and recommendation of specific actions will be major elements for involvement of the private sector. Commercial remote sensing satellites are planned to offer high-quality data and services to specific user segments. The commercial viability of the data services and their cost is still to be determined.

252. In 1997, the various segments of the yearly worldwide civil Earth observation market have been estimated as follows: $580 million to $620 million for the satellites, including both meteorological and remote sensing spacecraft; $230 million to $250 million for satellite launches; $60 million for sales of raw data; $280 million to $300 million for terrestrial equipment for receiving, storing and processing satellite data; and $830 million to $850 million for data distribution, processing and interpretation services and value-added products and services. Most users of data and services are currently in the government and public sectors, followed by private companies and universities. Within the next 10 years, depending on the development of some promising market segments (such as real estate, utilities, legal services, insurance, precision farming and telecommunications), the market is expected to grow by a factor of three to five.

253. Since 1993, the market for GPS equipment alone has gone from about $0.5 billion to $2 billion in 1996, and is expected to reach between $6 billion and $8 billion in 2000. Civil ground applications, already at almost 90 per cent of the total market, will keep increasing (automotive navigation systems, geodesy, GIS, precision engineering and emerging fields such as precision agriculture). The success is due to the dramatic increase in the accuracy of GPS and to the steep drop in prices of equipment. GPS is thus becoming an enabling technology fuelling the market by offering accurate, real-time positioning data to be integrated with other types of information.

254. The use of GPS has become a true spin-off and its future growth will rely more and more on the consumer market. In fact, the GPS services are expected to complete the transition from a stand-alone device to a standard feature integrated into a variety of multifunctional products such as wireless personal communication devices, leading to a mass consumer market with an average selling price per receiving unit of about $100.

255. Not all developments of space technology find their applications on Earth. Still being developed, space manufacturing involves the use of the near-zero gravity and vacuum environment of space for the production, processing and manufacture of materials for commercial purposes. That is a very broad definition which includes such industrial and research activities as: the zero-gravity production of medical supplies, metal alloys, plastics or glass; the processing and analysis of organic matter; and the study of the physiology and behaviour of humans, animals and plants in the unique environment of space.

256. New materials will become possible simply because the absence of gravity allows for the creation of perfectly even and consistent mixtures of materials with vastly different masses and densities. Those alloys would have physical properties that could not be duplicated on Earth and could lead to the production of much faster computers, smaller and much more powerful batteries that could power future electric cars, as well as many other new products.

257. Many ideas and strategies have been proposed and in some cases implemented in order to create space markets. They include space advertising and space burial services that are already commercially available. Tourism in space may also prove to be a viable market for new space industries, if the costs of the space infrastructure are drastically reduced and the safety levels increased.

258. Space might also provide an optimum location for orbiting platforms that can be used to transmit energy via optical mirrors and microwave technology. Solar energy or energy from remote sources on Earth could then be directed to the locations where it is needed.

259. Space technology now represents an immensely valuable bank of know-how that is used by thousands of companies worldwide to bring new products, processes and services to the world market at more competitive prices. Such indirect effects of space technology applications, which in the past were considered as by-products of research and development, are increasingly considered as primary effects and as a meaningful element of an industrial policy. Non-space industrial sectors are more demanding of new technology, new processes and new materials to remain competitive in their fields. The origin of much of the new spin-off technology can be found in space industry.

260. Technology transfer and spin-off (that is, products and processes that have emerged as secondary applications of space technology) programmes developed by national and international space agencies now demonstrate a market-oriented approach based on demand and well identified market segments. Thus, space technology no longer appears as a luxurious product and process, but as a reservoir of potential solutions for industry.

261. The simultaneous acquisition, adaptation and assimilation of high-technology knowledge, while perhaps desirable, are not always feasible. Many countries try to overcome that difficulty by adopting different strategies depending on their political and socio-economic environment and stage of economic development. Scenarios for technology development and exchange vary from questions of “What kind?” and “Where?” to “How much?” Accordingly, many countries are developing strategies not only for applying foreign technologies, but also for initiating the necessary process of securing technological training and self-reliance. Developing countries in particular face constraints in their efforts to move ahead in the high-technology area of space, mainly because of the limited financial resources available, lack of access to basic facilities, lack of knowledge about the technology and limited educational training facilities.

262. The transfer of technology encompasses all activities that culminate in the permanent adoption of new techniques by the recipient. So far as space and space-related technologies are concerned, some of the areas of greatest importance for developing countries involve technologies that are already considered as operational technologies in developed countries, the use and development of information technologies being two such areas. The technologies are related to computers, fibre optics, satellites and telecommunications and facilitate, through the use of electronic networks, the rapid transfer, processing and storage of all forms of information and data. Today, those technologies foster globalization by increasingly underpinning all production and service industries. Notable among the priority development and application areas for developing countries are small-satellite technology and the provision of health and education services and support for agriculture.

(b) Issues and concerns

263. The Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interests of All States, taking into Particular Account the Needs of Developing Countries, adopted by the General Assembly in its resolution 51/122, provides a sound basis for the promotion of technology development and exchange.

264. While space provides a whole new realm of opportunity and a vast potential market for industry and businesses, it is still perceived by many as a final frontier rather than an economic market ripe for expansion. However, a fundamental requirement for the above and many other innovative spin-offs to become reality is the reduction and minimization of development costs, thus making economy and efficiency a primary concern. For instance, in order to stimulate the commercialization of the potential market for manufacturing in space, the cost of developing the basic space infrastructure must be reduced dramatically. Governments would also have to play a role in promotion, giving incentives and aiding the development of a private-sector presence in space, making it just another place to do business.

265. A successful transfer of space-related technologies and spin-offs from research and development institutions to industry requires the availability of appropriate methods and infrastructures, as well as clearly defined government policy and support on the matter. The requirements include the following: establishment of organizational structures, dedicated to technology transfer and commercialization, at national space agencies or in other government bodies in charge of technological development; stimulation of marketing mechanisms focusing on widespread promotion of technologies and spin-offs; development of financial and tax incentives encouraging innovators, entrepreneurs and investors; and creation of relevant education and training networks.

266. A major concern is insufficient global access to the technology related to acquiring environmental data and information. Enhanced access would, *inter alia*, contribute to the national implementation of international agreements and protocols, facilitate the formulation of national environmental strategies having a global dimension, and generally improve policy planning and environmental management.

267. Technology transfer from spacefaring countries to developing countries could be promoted by providing more training opportunities for scientists and engineers of developing countries in utilizing off-the-shelf technologies. Such opportunities would be sufficient for the scientists and engineers from developing countries to understand the direction of space technology development, which would facilitate the decision-making process in their countries, in particular with regard to prioritizing the space-related research and development activities to be pursued.

268. A favourable environment in the recipient countries needs to be created to allow the transfer of technologies to become permanent. Such an environment includes trained human resources in sufficient numbers, appropriate infrastructure and institutional arrangements, a suitable policy framework, long-term financial support and opportunities for the involvement of the private sector in technology transfer initiatives. That would enable space technology applications in developing countries to become truly operational and fully integrated into development activities.

269. Although several cooperative, mainly bilateral, programmes exist between developing countries for the transfer of space technology, current mechanisms for fostering south-south cooperation in technology development and transfer are insufficient. Mechanisms through which donor organizations may finance technology-transfer projects at the regional level, such as regional information networks, are not sufficient because of policy constraints which heavily favour bilateral agreements.

270. Providing such opportunities to developing countries may also expand market opportunities for the space-related industry of spacefaring countries. A noteworthy example is that of some developing countries that have made agreements with commercial entities for the transfer of small satellite technology.

271. Problems experienced by developing countries in the area of space technology exchange and spin-offs may be summarized as follows:

(a) Limited access to information;

(b) Low number of specialized training centres;

(c) Less efficient national technology transfer infrastructures;

(d) Lack of qualified suppliers;

(e) Lack of appropriate funding and investment opportunities.

272. Apart from training of human resources at the basic level of science and technology and fostering South-South cooperation, the regional Centres for Space Science and Technology Education should include specific training to contribute to the building of local expertise and ultimately to the success of technology-transfer programmes.

(c) Specific action programmes

273. The effectiveness of current mechanisms needs to be enhanced to improve collaboration between countries on development issues as well as on global environmental problems. An effective, pragmatic and affordable approach to technology exchange, consistent with the Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interests of all States, taking into Particular Account the Needs of Developing Countries, should be developed. The technology to be transferred should be appropriate for local conditions and arrangements should include provisions for periodic updating. The transfer must combine both know-how and an understanding of the fundamental principles upon which the technology is based. Where appropriate, agreements should take into account the need to protect intellectual property rights.

274. Given the current geographic distribution of space activities, the benefits derived from space through the commercial use of space technology applications, technology transfer and spin-offs, are more concentrated in developed countries and in a few of the technologically more advanced developing countries. However, space systems are neutral from a geographic point of view and are used more by the less developed countries and regions, thereby making a greater impact on their social, economic and human development.

275. Taking into account the importance of adequate access to space technologies and applications relevant to sustainable development programmes in developing countries, as well as mutual commercial benefits available to both providers of technology and its recipients and users, international cooperation in the area of space technology transfer and spin-offs should attract the particular attention of Member States. In that connection, the proper legal frameworks and international agreements being developed by United Nations bodies and agencies, covering such issues as intellectual property rights, trade marks, copyright, foreign licensing and export control regulations, are essential to foster international cooperation in the area of space technology and spin-offs.

276. In order to attract investments, vital for the success of technology transfer projects, the political will and commitment of national leaders for the introduction of new technology should be apparent. Political, social and economic stability would also greatly enhance the possibilities of foreign investment in emerging markets. Incentives to encourage both foreign and local investors should be given to stimulate the adaptation of technologies acquired from abroad to meet local needs.

277. The Office for Outer Space Affairs could initiate a technology outreach programme on space for university educators (TOPS) aimed at the promotion of the successful transfer of space-related technologies by enhancing the capability of university educators in developing countries, in particular the least developed countries, to integrate relevant aspects of space technology in the curricula of their institutions. Through its multiplier effect on students, TOPS would lead to a broader local awareness of the benefits of space technology in addressing local concerns in the medium to long term, thus contributing to the creation of a local environment that is more conducive to the permanent transfer of space technology.

278. The effectiveness of many specialized training courses in space technology is often compromised by the reality that after receiving training, university educators in many least developed countries lack access to “seed” financial support for undertaking practical demonstration exercises to highlight the operational utility of space technology in solving local problems. The aim of TOPS would be to provide such university educators with access to limited financial and technical support (not exceeding $10,000 per grant) for the local implementation of practical activities relating to space technology that would serve to enhance the learning experience of their students.

279. TOPS would be aimed initially at the network of university educators from least developed countries in all regions who have participated in specialized space-technology training courses (such as the United Nations International Training Course on Remote Sensing Education for Educators) or from the regional centres for space science and technology education. TOPS would also maintain a site on the World Wide Web through which educators could establish contact with each other to share experiences, with technical advisors on space-technology

issues and with institutions that are willing to assist or otherwise participate in the space-technology demonstration activities being carried out by members of the network. Access to support under TOPS would be through applications from university educators to be selected according to merit on a competitive regional basis. The estimated annual cost of TOPS would be approximately $200,000 (corresponding to 20 awards of $10,000 each).

G. Promotion of international cooperation

(a) Status of international cooperation

280. The General Assembly, by its resolution of 52/122, adopted the Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries. The adoption of the Declaration not only marked another achievement by the United Nations in the development of the international legal regime governing space activities, but also reaffirmed the commitment of Member States to promoting international cooperation in the peaceful uses of outer space for the benefit of all countries.

281. The fading away of cold war tensions during the last decade has dramatically altered the way in which the spacefaring countries of the world conduct space activities. Valuable resources that once were subject to rival strategic considerations are now being used to foster greater cooperation. The rapidly changing world economic landscape has provided the context and impetus for closer cooperation between States moved by a new sense of urgency about long-neglected global problems.

282. International cooperation has created a mindset whereby all those involved in space activities have come to recognize both the advantages of working together to identify common goals and the need to optimize existing resources, financial and otherwise. With budgets for space programmes in major spacefaring countries shrinking and a general skepticism among the general public about the relevance of a number of space activities, it has never been more critical in the history of the space age to stimulate and encourage international cooperation.

283. Conserving the environment, the advent of the information age and continued exploration of the solar system are just some of the important global issues in relation to which space technology can play a leading role in the coming years, and many multilateral mechanisms already exist to promote greater international cooperation, particularly with a view to assisting developing countries. Other activities may require the creation of such mechanisms, but there are a multitude of obstacles preventing greater cooperation. Without continued efforts at international cooperation, smaller countries and developing countries may never build up an adequate scientific and educational base for sustainable space technology and application programmes. Many national space activities, such as satellite communications and broadcasting, require international coordination in order to function successfully.

284. In order to enhance international cooperation, consideration should also be given to further strengthening successful mechanisms for cooperation which already exist. There are already various mechanisms of international cooperation, such as intergovernmental mechanisms, quasi-governmental/private organizations,* ad hoc inter-agency mechanisms,** transnational industrial activities*** and international non-governmental organizations.

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*Quasi-governmental/private organizations are those which may involve some or substantial governmental ownership or other influence, but operate in accordance with business principles. An example of such organizations is INTELSAT. EUMETSAT, EUTELSAT Inmarsat and INTERSPUTNIK are also modifications of the basic INTELSAT model.

**Examples include CEOS, the Inter-Agency Consultative Group for Space Science (IACG) and the Space Agency Forum (SAF).

***There are various modes of transnational industrial cooperation, such as joint ventures, merger and acquisition, strategic or tactical alliances and foreign direct investment.

Intergovernmental mechanisms include bilateral cooperation, currently taking place between developing countries,* and multilateral cooperation, involving intergovernmental mechanisms, including the establishment of a permanent institutional mechanism, such as the Committee on the Peaceful Uses of Outer Space and ESA, the establishment of an ad hoc mechanism, such as the series of space conferences of the Americas held in Latin America and the Caribbean, and project-by-project cooperative mechanisms, such as the International Space Station. While international efforts should continue to be made to explore new and innovative mechanisms for cooperation that would best meet the needs of participating countries, some of the successful mechanisms should be further promoted. For each country, it would become crucial to have the best portfolio of options for international cooperation, in order to maximize scientific and technological, economic and social, as well as industrial, returns from space activities.

285. International space law as developed by the United Nations through the Committee on the Peaceful Uses of Outer Space reflects the importance that is attached to international cooperation by the international community in the use and exploration of outer space. So far, five treaties and five sets of legal principles on matters relating to the peaceful uses of outer space have been elaborated through the United Nations. Each instrument lays great stress on the notion that the domain of outer space, the activities carried out therein and whatever benefits might accrue therefrom should be devoted to enhancing the well-being of all countries and all mankind, and each includes elements elaborating the common idea of promoting international cooperation in outer space activities. The concept of international cooperation also received significant attention in General Assembly resolution 51/122. Clearly, the role of international space law in promoting international cooperation in space activities is extremely important.

286. Beyond the work of the United Nations in the area of space law, many States have adopted national legislation governing their activities in outer space as well as their goals for international cooperative ventures. Other intergovernmental organizations, particularly those within the United Nations system, are also contributing to the legal regime governing international cooperative activities. Among them are the International Telecommunication Union, the World Intellectual Property Organization and the International Atomic Energy Agency.

(b) Issues and concerns

287. As with many other instances of technology transfer and cooperative projects, a primary issue is that the recipient should have the capability of sustaining or maintaining the technology long after the donor has gone. Educating and training scientists and others in the user community is essential to ensure that the technology is used to its fullest extent.

288. Environmental monitoring appears to be the most promising discipline for the pursuit of greater international cooperation. It is now universally accepted that Earth is a unified system, with events in one area of the planet potentially affecting another. Thus, it is currently beyond the resources of any single agency or country to undertake the comprehensive programmes required to understand the science of the Earth system in all its aspects. In addition, objective scientific data is required in order to make sound decisions and credibility depends on international participation in the scientific process.

289. The growing role of private industry in space activities and the parallel decline in government funding for space programmes are aspects of another issue reflecting overall economic trends. In that connection, it is important to recognize the private sector as a potential partner in future activities by identifying potential projects that could benefit from its participation and to encourage its involvement.

290. Greater involvement of the private sector is linked to the cost factor of many space activities, which has two aspects: first, the cost of acquiring necessary data or technology; and secondly, the cost of pursuing space activities themselves. For most developing countries, the mere acquisition of expensive data sets is an insurmountable barrier

*A recent example is the cooperation between Brazil and China to develop remote sensing satellites.

to greater participation in space activities. As more private firms enter the data provision service, market forces should drive down costs and make the data more widely affordable.

291. In terms of project costs, especially for large, human space exploration missions, no longer can a single country pay such a huge bill. The international space station provides an example of 15 States pooling resources to share the technological and financial burdens of a project that will have wide-ranging benefits for all humanity.

292. Access to data is still another related concern, especially of developing countries. Access is sometimes restricted because of, ironically, commercial considerations. Commercial applications of Earth observation data or advanced technology satellites that could benefit commercial firms may require a State to consider restricting data availability to international participants, thereby reducing international participation. National security concerns, especially in light of the high-resolution capability of current remote sensing satellites, are another reason for narrowing data access. Information acquired by such means may have strategic value and security implications, particularly if the information is commercially available to third parties without the consent of the State under satellite observation.

293. Throughout its history, the Committee on the Peaceful Uses of Outer Space has dealt with some of the above-mentioned matters and other current issues, such as remote sensing, direct broadcasting and the use of nuclear power sources in outer space. The results of its work are embodied in the five treaties and five sets of principles governing the peaceful uses of outer space. Recently, however, the programme of work undertaken and the number of topics discussed by the Legal Subcommittee, the legal and regulatory arm of the Committee, have been reduced. The items that do remain on the agenda continue to be debated with no end in sight. Although a new agenda item has been introduced for the 1998 session of the Legal Subcommittee, calling for a review of the status of the existing legal instruments on outer space, international space law has not necessarily kept pace with rapidly changing space technologies. New, highly technical issues, such as space debris and the use of nuclear power sources in space, as well as the issue of reinforcing intellectual property rights, pose many challenging legal questions and may require the elaboration of common standards and practices to ensure that space activities are carried out in a systematic and orderly fashion. Such complex issues call for creative and flexible solutions.

294. Space applications activities are conducted for development purposes by various organizations within the United Nations system. Those activities have been coordinated through the work of the Inter-Agency Meeting on Outer Space Activities, to avoid unnecessary duplication in planning future endeavours and to explore possibilities of carrying out ongoing and planned activities through joint inter-agency efforts. However, the current inter-agency mechanism involves certain limitations on efforts to further enhance the coordination of activities, particularly those already approved by the States members of the organizations concerned, if the coordination involves changes in the mandated activities.

(c) Specific action programmes

295. Support for various programmes is often dependent upon how much and what type of information about them is available. In many countries, the general disinterest in, or even skepticism about, a number of space activities that has been observed among the population at large and government leaders may be attributed to the inadequate dissemination of information about the practical benefits of many space technologies. Better information about those benefits would probably increase the level of interest in making more extensive use of space technology applications in development programmes.

296. To that end, leaders within the space community of space faring countries, including policy advisers and heads of space agencies, should stress to their Governments the value of international cooperation to obtain the practical benefits of space technology in support of domestic economic and political objectives. As a related element, advisers and heads of agencies should recommend that serious impediments to international cooperation should be lessened and eventually removed.

297. In order to further enhance political support for international cooperation in space activities, there should be a multilateral political consensus on common space goals at the highest decision-making level. To that end, consideration should be given to strengthening the efforts to include a space item on the agenda of a multilateral meeting of heads of State, such as the summit meetings of the seven major industrialized countries (Group of Seven) and the Russian Federation* and Summit of the Americas, or a ministerial-level meeting. A similar approach could be also taken to increase political support for international cooperation among legislators. Consideration could be given to convening ad hoc multilateral meetings of legislators who are advocates of space activities to discuss common goals to be pursued in space endeavours. Such meetings could be organized by a group of interested space agencies, and the cost of attending the meetings should be covered by the participants.

298. Education and training efforts need to be strengthened and supported. For developing countries to make full use of space technology, they will need to develop national capabilities rather than relying on foreign experts and suppliers. Many bilateral exchanges and multilateral programmes, such as the centres for space science and technology education being established in all regions of the world with the assistance of the United Nations, are offering scientists and other users an opportunity to build up, in their own countries, a foundation of human resources equipped to use and further develop acquired technologies.

299. Appropriate existing international mechanisms should be used to explore the further development of space technology applications that have a high potential for success and that contribute to meeting global needs. Where such a mechanism does not exist, one should be established and consideration could be given to new forms of cooperation. Such applications include but are not limited to:

(a) Cooperative telecommunications efforts, especially those of benefit to developing countries, using existing facilities and satellite capabilities;

(b) A new navigation satellite system, based on user fees, in the event that the free use and availability of the Global Positioning System is discontinued;

(c) A disaster mitigation system, using scientific, Earth-observation, data-collection and mapping satellites coupled with a near-real-time data fusion and distribution system;

(d) Commercially sustainable system for Earth observation system.

300. National space agencies should share information with each other on their processes for selecting and funding prospective space science projects, thus removing an impediment to expanded space science research.

301. The existing mechanisms are still limited in their ability to define and coordinate the needs of the user community in Earth environmental monitoring activities. Accordingly, those mechanisms should be strengthened in order to facilitate the coordination of needs in that field between satellite operators and users with a view to providing, in a more effective manner, a unified set of data requirements to help in designing and operating future Earth observation systems.

302. Matters pertaining to space law permeate virtually all aspects of international cooperation. Unfortunately, most States have yet to ratify or sign the various legal instruments governing space activities elaborated within

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*Precedents already exist for having space issues on the agenda of the Summit meetings of the Group of Seven, resulting in the creation of a framework for political support for certain space activities. Earth observation issues were discussed at the summit held in 1982 at Versailles, giving birth to the activities of CEOS. The United States invitation to participate in the space station programme was on the agenda of summit meetings held in 1984 in London and in 1985 at Bonn.

the framework of the United Nations. The intention of Member States to review the status of the existing legal instruments is a first step towards promoting wider adherence to the treaties and principles and should at least stimulate discussion on the various shortcomings of the existing body of space law. Subsequently, the international community may also realize the need to elaborate new technical standards and recommend practices that take into account the many technical developments in the space activities of today.

303. In addition to strengthening the functions of the United Nations in developing the legal framework governing space activities, the role of the United Nations in promoting international cooperation in the peaceful uses of outer space could be further enhanced by the following actions:

(a) Enrichment of the work of the Scientific and Technical Subcommittee through:

(i) Inclusion of the following issues in its work by expanding the scope of its consideration of some of the existing agenda items or adding new agenda items:

a. Disaster warning, prevention, mitigation and relief through the use of space technology and its applications;
b. Manned space activities, including developments in international cooperation concerning the International Space Station;
c. International cooperation and coordination in the development and operation of the Global Positioning System;

(ii) Strengthening the partnership with industry by organizing during its annual session a one-day industry symposium to provide Member States with updated information on commercially available products and services as well as ongoing activities of space-related industries and to provide opportunities for managers from space-related industry to express any concerns that they may have and to make suggestions;

(b) Enhancement of coordination of space activities within the United Nations system through:

(i) Eestablishment of an ad hoc intergovernmental advisory group consisting of the chairmen of the intergovernmental bodies responsible for the space-related activities of the organizations within the system to meet for one day to review inter-agency coordination and inform the respective intergovernmental bodies of any substantial recommendations of the Inter-Agency Meeting on Space Activities;

(ii) Mmore critical review of inter-agency coordination by the above-mentioned intergovernmental bodies, in order to provide guidelines to enable the secretariats responsible for implementing the space activities to identify areas in which coordination efforts should be strengthened;

(c) Strengthening of the outreach activities of the United Nations Programme on Space Applications through:

(i) Organization of a public forum each year, to be held in various countries and regions in collaboration with interested non-governmental organizations, to inform the general public of past, ongoing and planned space activities as well as the future direction of such activities, with the programme being developed by the Office for Outer Space Affairs in collaboration with the non-governmental organizations and the host country, and speakers being provided by interested space agencies;

(ii) Invitations designed to encourage the participation of youth in activities of the Programme;

(iii) Promotion of interest in space science and technology among young scientists and engineers;

(iv) Establishment of an international space corp, consisting of approximately 10 members, including astronauts and other space scientists and engineers, which would have one mission per year to each of the regions of Africa, Asia and the Pacific, Latin America and the Caribbean, eastern Europe, western Europe and North America, involving the organization of a one- or two-day programme for youth, in collaboration with an interested host country.

V. THE SPACE MILLENNIUM: VIENNA DECLARATION ON SPACE AND HUMAN DEVELOPMENT

(*Elements that could be considered for inclusion in the Vienna Declaration on Space and Human Development are presented below.*)

304. Human consciousness, from its inception, has looked at the Sun as the life-giver, and at the star-filled night sky with wonderment. Innate curiosity about the stars and the solar system led to the science of astronomy, and centuries ago, the first “space scientists” were beginning to understand the physical laws dictating the movement of celestial objects.

305. From those beginnings, space science progressed slowly through the years. The twentieth century, and especially the last four decades since the beginning of the space age, has seen a phenomenal acceleration in the progress of space science and technology. Scientists have conquered gravity, and humankind has—quite literally—left its mark on the dusty surface of another celestial body: the Moon.

306. Today, space science has assumed an important and visible role in many areas of human activity. It has made a vast contribution in improving and expanding telecommunications and broadcasting; it has assumed growing importance in environmental monitoring and protection, in natural resource management and in meteorological forecasting and climate modelling; and it is of critical importance in position location and mobile communication. It is, therefore, a major contributor to the well-being of humanity and specifically to economic, social and cultural development.

307. Space science is also contributing to peacekeeping and confidence-building measures between States through satellite-based monitoring and surveillance systems. That has made it possible to verify various arms-control agreements and has, therefore, indirectly facilitated the signing of such agreements.

308. The vast potential of space science is slowly unfolding, as new technologies are developed and ever-newer applications become operational. At least some actual field experience is now available for a vast number of applications of great importance to national and individual development.

309. As humanity approaches the end of the second millennium and the start of the third, it is faced with new and unprecedented challenges, some of which threaten its very survival. While fears of a nuclear holocaust have receded, possibilities of environmental catastrophe have arisen. The process of development has itself created serious new problems. Meeting those challenges and solving the new problems require international cooperation and the tools of advanced technology. Space technology can play an important role, both in solving the problems and in furthering sustainable development.

310. The United Nations and other organizations within the United Nations system will continue to serve as major promoters of international cooperation to face those challenges and solve the emerging problems with the effective use of space technology and its applications. The private sector also has the potential role in promoting and accelerating the development and applications of space technology. The United Nations, international

organizations and the private sector will play a crucial role in achieving the goals and taking specific action s agreed to by the Conference.

311. As humanity prepares to enter the next millennium, UNISPACE III unanimously sets the following goals for early attainment (*major goals and specific action programmes contained in the present report and agreed upon at the Conference to be listed below in a summary form*):

a. . . .

b. . . .

c. . . .

. . .

312. UNISPACE III, taking cognizance of the new international context, recognizes the vital importance of the goals enumerated above. It notes that sustainable development, in all its facets, will require the achievement of those goals within a reasonable time-frame, and that space technology and its applications will be a majo r contributor to ensuring the overall health of the planet and the development—even survival—of humanity.