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COMMITTEE ON THE 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 ADVISORY COMMITTEE FOR UNISPACE III

Draft report for the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space

Note by the Secretariat

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INTRODUCTION

1. The General Assembly, in its resolution 52/56, paragraph 23, agreed that the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) should 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. In paragraph 24 of that resolution, the Assembly requested the Office for Outer Space Affairs of the United Nations Secretariat, acting as the executive secretariat for UNISPACE III, to carry out the tasks recommended by the Committee on the Peaceful Uses of Outer Space, acting as the Preparatory Committee for UNISPACE III, in the report on the work of its fortieth session (A/52/20). [1]

2. One of the tasks to be carried out by the secretariat was defined by the Preparatory Committee at its 1997 session, when it agreed that, to develop the report for the UNISPACE III Conference, the secretariat would provide an initial draft in time for the 1998 session of the Advisory Committee (A/52/20, para. 157). The Advisory Committee and the Preparatory Committee at their 1998 sessions would provide comments on the draft of the report, on the basis of which the secretariat would provide a revised version in order to assist the Advisory Committee in finalizing the draft report in February 1999. Those arrangements would also allow for a short meeting of the Preparatory Committee prior to the UNISPACE III Conference, consistent with the pattern of meetings as indicated by the Preparatory Committee (A/52/20, para. 151), in order to finalize any outstanding issues on the draft report.

3. The initial draft report has been prepared by the executive secretariat for the Conference, and will be revised in accordance with paragraph 2 above, in time for the June 1998 session of the Preparatory Committee. The report is an initial draft prepared on the basis of the provisional agenda for the Conference, contained in document A/AC.105/672, annex II.

I. SCOPE OF THE DRAFT REPORT

4. In its final form, the report would consist of two main parts: a technical part that would build the foundation for the deliberations of the Conference and a second part that would contain the proceedings of the Conference, including its recommendations and plan of action. The technical part would identify the major global issues and provide a brief description of their environmental, economic and social impacts, as well as highlighting specific areas where space technology could provide solutions. It would also identify the major ongoing international programmes, the various actors who are or could be involved in them and the current and near-future capabilities of the technology that could be used.

5. The final draft report, which is to be provided to the Conference, would be developed in an evolving manner on the basis of input by the Advisory and Preparatory Committees. Through the preparatory work of those Committees, the final draft report will contain proposals on possible recommendations and an outline of the plan of action, approved by the Preparatory Committee, for consideration by the Conference.

6. The contents and structure of the draft report would be designed to achieve the following:

(a) To establish the current importance of space activities, directly and indirectly, for the world economy, the environment and the well-being of society;

(b) To identify the main global problems and various international programmes that address those problems as well as some of the activities and projects that are being conducted or planned;

(c) To identify existing international frameworks and conventions within which the objectives of the Conference could be met;

(d) To present a summary of the state of space science and technology as well as the development trends, including the increasing role that the private sector is playing;

(e) To identify the issues within specific global problems, as well as opportunities for enhanced development, where space technology could be of assistance, including an identification of possible roles for the private sector;

(f) To propose specific actions in the areas of capacity-building and in promoting international cooperation;

(g) To identify global objectives and specific recommendations for action at the national and international levels to achieve them;

(h) To present a plan of action along with proposed strategies to implement the recommendations.

7. In preparing the draft report, the Office has drawn material from a wide variety of sources of current information, in particular from the reports of some of the organizations mentioned in the provisional agenda for UNISPACE III. In identifying the global issues and ongoing and planned international activities and programmes, the report contains information from the reports of United Nations Environment Programme, Food and Agriculture Organization of the United Nations, World Meteorological Organization, Committee on Earth Observation Satellites, International Decade for Natural Disaster Reduction and International Geosphere-Biosphere Programme. It also contains information drawn from contributions to the background papers of the Conference submitted by national and international organizations, from scientific and technical journals, and from the Internet home pages of relevant institutions. The present draft report contains, for consideration by the Advisory Committee, some elements of issues and concerns that could be considered at the Conference. The various subsections of the draft report will be updated and developed further to reflect the balance in importance that is indicated by the Advisory and Preparatory Committees.

II. DRAFT REPORT

A. Primary objectives of UNISPACE III

8. The primary objectives of the UNISPACE III Conference would be:

(a) To promote effective means of using space technology to assist in the solution of problems of regional or global significance;

(b) To strengthen the capabilities of Member States, in particular developing countries, to use the applications of space research for economic and cultural development.

9. Other objectives of the UNISPACE III Conference would be:

(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; and

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

B. Global problems

10. A large number of global problems are related to the degradation of the global environment, especially during the past few decades. Other global problems concern the provision of health and education services to societies, and particularly to those in sparsely populated rural areas. Previously unknown risks to human health are becoming evident from the cumulative effects of a whole range of chemicals, particularly the persistent organic pollutants. The effects of climate variability and change are already increasing the incidence of known public health problems and leading to new ones, including a more extensive reach of vector-borne diseases.

11. Land degradation and the need for efficient land management are global concerns. The limited availability of arable land and the loss of land to urban expansion are particularly important concerns to small island States. The degradation of drylands, placing some l billion people in 110 countries at risk, is an urgent global problem, particularly in developing regions. In highly industrialized regions, reducing soil contamination and combating acidification are priorities.

12. With regard to forests and biodiversity, the impact of development activities and the advance of the agricultural frontier are of concern in developing regions, while forest and biodiversity conservation receive major attention in the North. The decade from 1980 to 1990 witnessed a decline of some 2 per cent in the world's forests and wooded land. In Europe, air pollution (including acid rain), pests, diseases and forest fires were the main causes of forest degradation.

13. Every day, 25,000 people die as a result of poor water quality, and water-borne diseases still represent the single largest cause of human sickness and death worldwide. Some 1.7 billion people, more than one third of the world population, are without safe water supply. In addition, an estimated one quarter of the world population will suffer from chronic water shortages at the beginning of the next century.

14. Coastal degradation is another global concern. About 60 per cent of the world population lives within 100 kilometres of the coastline, and more than 3 billion people rely in some manner on coastal and marine habitats for food, building sites, transport, recreation and waste disposal. Around one third of the coastal regions of the world are at high risk of degradation, particularly from land-based sources of pollution and infrastructure development.

15. All major cities in the world suffer urban air-quality problems. Acid rain and transboundary air pollution, once problems only in Europe and parts of North America, are now becoming apparent in parts of the Asia-Pacific region as well as parts of Latin America. Despite coordinated action worldwide, damage to the ozone layer continues faster than expected, with the next 10 years predicted to be the most vulnerable.

16. All regions express concern over global warming. The rapidly rising demand for energy to fuel economic development, particularly in Asia and the Pacific, where a 100-per-cent increase in energy use is predicted for the period 1990-2010, and in Latin America, with a predicted energy growth of 50 to 77 per cent, as well as other development-related issues worldwide, will aggravate those problems.

17. The polar regions, representing the largest remaining natural ecosystems on Earth, are also increasingly coming under stress, particularly from long-range pollutant transport and deposition. Their crucial role in climate regulation and the vulnerability of their fauna and flora warrant special attention.

18. Over the last 30 years, the damage caused by natural phenomena to people and the productive infrastructure of countries has steadily risen. Economic damage has more than tripled from $40 billion in the 1960s to $140 billion in the 1980s. There are strong indications that this trend will continue. Besides human and economic losses, disasters can also destabilize social and political structures. Information is needed to develop maps showing the risk of potential hazards in order to prepare plans for prevention, mitigation and relief operations, and to issue early warnings of impending events or to monitor their evolution.

19. Worldwide, mosquitoes are the most important vectors of disease. It is estimated that 2.3 billion people are at risk from malaria and that between 300 and 500 million clinical cases are reported each year. Lymphatic filariasis affects a further 900 million people and, though generally not life-threatening, causes chronic suffering and disability. In Africa alone, 50 million people are at risk of contracting human trypanosomiasis (sleeping sickness). Tsetse flies are also a vector of animal trypanosomiasis that infects cattle and is a major constraint on livestock production in Africa.

20. El Niño, an abnormal state of the ocean-atmosphere system in the tropical Pacific, has important consequences for worldwide weather conditions. The 1997-1998 El Niño phenomenon could surpass a similar event of the period 1982-1983 which claimed nearly 2,000 lives and resulted in global losses of an estimated 13 billion United States dollars ($). In spite of significant progress made, the scientific community is not yet able to make long-term predictions of the occurrence of El Niño. Better prediction of extreme climate episodes such as ice storms, floods and droughts could save the world billions of dollars in damage costs by enabling water, energy, transport and emergency response managers, as well as farmers, to plan and avoid or mitigate losses.

C. Importance of space activities

21. The world population, currently estimated at about 6 billion, is expanding at the rate of 250,000 per day. Increasing recognition of the importance of determining the global impact of human actions on the Earth system which sustains it, coupled with the reality of a growing population, has led to international concern about the deterioration of the environment and the quality of life of present and future generations. There is also a growing preoccupation with the impact of processes and phenomena such as desertification and other disasters on societies, particularly on those of the poorest developing countries. Such concerns have highlighted the need to gain a better understanding of the stresses that are being placed on the Earth system. This is a global endeavour in which all countries need to participate.

22. 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. 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.

23. Space exploration is providing a wealth of information about the processes that formed the universe, the planetary system, the Sun and the 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.

24. At the same time, the use of space technology has become of crucial significance to everyday life in economic, social and cultural terms. The use of satellites is inseparably linked to globalization, both as a result of and as a driving force behind the process, as well as to the opening of the international market place. Satellites provide the means for voice communications, broadcast of television news and home entertainment, the high-speed transfer of data and, increasingly, business communications.

25. With an estimated 77 billion United States dollars ($) 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.

26. Satellite communications are by far the most widespread application of space technology. Practically every country utilizes satellites for communication either through direct ownership of the satellite or, more commonly, through leased capacity on national or international satellites. Communications will further develop as an economic engine. 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.

27. Satellite positioning systems (NAVSTAR 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.

28. 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.

29. 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.

D. New context

30. 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.

31. 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.

32. 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.

33. 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, 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.

34. 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.

35. 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. On the other hand, space technology could also become a means of creating an ever-widening gap between developed and developing countries.

36. In summary, the new context is conducive to the further growth of international cooperation in space. It also 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 issues dealt with, the discussions held and the recommendations made by UNISPACE III should be placed within that context.

E. The space millennium: Vienna Declaration on Space and Human Development

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

38. 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.

39. 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.

40. 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.

41. 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.

42. 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.

43. 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 requires 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.

44. As humanity prepares to enter the next millennium, UNISPACE III unanimously sets the following goals for early attainment (to be completed at a later stage):

a. . . .

. . .

45. The further elaboration of those goals, their translation into specific activities and tasks, as well as their realization, will require close international cooperation, in which the United Nations system has a major role to play. The United Nations, through the Committee on the Peaceful Uses of Outer Space, has already been a major catalyst and promoter of international cooperation in the field of space science and technology. It has helped in the development of international space law and, through the United Nations Programme on Space Applications, has assisted a number of developing countries in capacity-building and in deriving benefits from the application of space technology. The Office for Outer Space Affairs of the United Nations Secretariat, the United Nations Environment Programme (UNEP), the regional commissions of the Economic and Social Council and the specialized agencies of the United Nations, including the Food and Agriculture Organization of the United Nations (FAO), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the International Telecommunication Union and the World Meteorological Organization (WMO), as well as the International Decade for Natural Disaster Reduction, have had considerable involvement. Achieving the ambitious, though necessary, goals outlined earlier will require greater coordination within the United Nations system and a more proactive United Nations role.

46. It is important also to recognize the role, especially the potential role, of the private sector in promoting and accelerating the development and applications of space technology. The private sector will have a major contribution to make in the realization of the goals outlined earlier.

47. 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 major contributor to ensuring the overall health of the planet and the development—even survival—of humanity.

F. Realizing the vision: a plan of action

1. Protecting the environment

(a) Status: environment and Earth sciences

48. 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 often unpredictable ways.

49. 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.

50. 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. A brief subset of successful applications of satellite Earth observation data is listed below:

(a) Climate change research relies on operational and research systems to generate high-quality, consistent, global data sets for use in understanding the global climate system, in detecting potential anthropogenic change, in validating climate models and in predicting the impact of change;

(b) Stratospheric chemistry, particularly related to the ozone hole, benefits from satellite information, which is used to monitor and map ozone concentrations and to assist in understanding the fundamental, underlying processes leading to ozone depletion;

(c) Weather forecasts based on numerical weather prediction utilize, among other things, operational satellite measurements of both surface and upper air winds and atmospheric temperature fields;

(d) Agriculture and forestry services utilize satellite data to provide, *inter alia*, mapping information, crop health statistics, yield harvest predictions and estimated rainfall amount;

(e) Resource mapping utilizing very high-resolution satellite data, when combined with conventional survey techniques, provides not only information needed to locate both renewable and non-renewable resources, such as water sources and mineral deposits, but also a cost-effective means of mapping large, sometimes inaccessible, regions;

(f) Hazard monitoring and disaster assessment schemes are in place which incorporate satellite data to provide wide-area coverage of, *inter alia*, volcano plumes and areas stricken by drought or earthquake;

(g) Ice monitoring with satellite data is provided as an operational service in many parts of the world affected by sea ice and results in improved safety and reduced operating costs through optimum routing for ships through ice fields;

(h) 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. In addition, satellites generally provide much superior sampling compared with conventional surveys;

(i) Oceanographic applications include provision of more 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.

(b) Issues and concerns

51. Since not more than a handful of countries have their own remote sensing satellites, a vast majority of countries can benefit from remote sensing only if they have access to the data on a regular and reliable basis. Sharing of remote sensing data is, therefore, essential, particularly for developing countries. Even for countries with their own remote sensing satellites, getting data from others is necessary, so as to supplement and complement their own data needs. That becomes especially important for applications that require frequent updating, owing to the dynamic nature of the observed phenomena. Thus, access to remote sensing data is a matter of some concern.

52. Another important feature of dynamic phenomena is the vital importance of timely information. Weather-related phenomena involving floods, storm-warnings, crop status and health etc. all require that information be available in a timely manner.

53. An issue of growing concern is the commercialization of remote sensing, including meteorological data. While prices of raw and processed data as well as analysed information continue to decrease, with more commercial entities involved in data distribution, stimulating industrial cost-cutting competition, the cost of acquiring satellite data and analysed information is still too high for some developing countries. In order to allow all the 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. Worries about the misuse of data by vested commercial interests and about prices that put such data out of reach of developing countries should also be addressed.

54. There seems to be a gap between the availability of information on Earth provided by space technology and the implementation of necessary actions to solve environmental problems of regional and global concern. Current space technology and its applications provide essential data on conditions on Earth, allowing experts in the remote sensing field to assess the regional and global environment. While data from Earth observation satellites 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 such disasters. To enhance the quality of life on Earth, satellite data should be fully utilized by policy and decision makers who can turn the available information into specific actions.

55. The data provided by Earth observation satellites should be turned into information that can be easily understood by policy and decision makers. It is also important that policy and decision makers be well aware of the availability and usefulness of such information.

56. The continuity of data is essential to increase the credibility and value of the information provided by satellites. Further efforts should be made to enhance and ensure access, on a continuous basis, to various sources of satellite

data by policy and decision makers concerned with environmental problems to allow them to evaluate corrective actions taken to protect the environment as well as to predict the consequences of the failure to take action.

57. There is also a need to explore ways and means to further coordinate international efforts already made to observe Earth. As discussed below, 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 Earth, 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 different initiatives. To integrate some of the initiatives, it is crucial to ensure the compatibility of the data exchanged.

(c) Specific action programmes and schedule

58. A number of international activities are being carried out to utilize satellite data to assess and monitor conditions on Earth, such as the International Geosphere-Biosphere Programme (IGBP), the Mission to Planet Earth (MTPE) programme 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.

59. The establishment of a global observing strategy should be further pursued and supported. The establishment of a system, which combines current and planned space capabilities with those on the ground, should involve international bodies and national agencies and organizations. As one of the steps towards an integrated global system, an international clearing house should be set up to collate, analyse and disseminate all space-derived data related to the environment. That would include data from passive and active sensors, from different platforms and sources, integrated into a geographic information system format. The possibility of converting the clearing house to a structured international framework for cooperation that combines satellite data with ground-based or other data should be explored.

60. 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.

61. 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.

62. 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.

63. A mechanism should be established to provide expert advice to help define the remote sensing data needs of any country that seeks such assistance, including cooperation in defining and setting up appropriately equipped and staffed centres for analysis and in the use and applications of remote sensing data. In particular, special emphasis needs to be placed on defining sensors, frequency bands and techniques of use to developing countries, in view of their special needs and problems.

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

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

66. 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 UNEP, the Global Environment Facility, FAO, particularly on critical issues such as global warming, climate change and sustainable development.

2. Facilitating and utilizing communications

(a) Status: communications and broadcasting

67. In the last decade, satellite communications and broadcasting have experienced phenomenal growth. New transnational broadcasting services have spurred growth, giving rise to concerns about their cultural impact. Software and technology have both contributed in large measure to the worldwide boom in satellite communications and broadcasting.

68. 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 will continue to drive the development and restructuring of the industry.

69. The information industry has traditionally been defined in terms of the “form” of information and the underlying technologies for handling each type of information, including images, text, voice, data and audio and video material. The primary engine of convergence of the different forms of information is clearly technological change, where the key change has been the rapid evolution of digital technology. Beyond digitization, dramatic changes in the computing and telecommunications industries are also driving the process of convergence.

70. Satellite communications systems reduce the need for terrestrial infrastructure and shorten the time required to establish basic and advanced communications in rural areas. 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).

71. 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.

72. While most developing countries do not constitute a viable market for many of the large-scale satellite communications projects, they can benefit from the impact of economically lucrative markets in developed countries that motivate the commercial international systems. Once global communications systems are in place, developing countries may utilize the excess capacity in the systems to meet their own communications needs.

73. 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.

74. A market research study estimates future spending on geostationary orbit (GSO) satellites at $23 billion to $29 billion for the period 1996-2006. Another market analysis predicts that 273 commercial satellites will be launched between 1997 and 2006 with a value of $37.8 billion. That represents a 27 per cent increase over the forecast done one year earlier, with the additional satellites resulting from the newly proposed Ka-band, broadband and multimedia satellites.

75. The world market for satellite communications is distributed between a space segment (satellites, launchers, insurance, control stations), 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 market for the coming 10-year period can be estimated at $60 billion to $80 billion for the space segment, at $120 billion to $150 billion for the ground segment and at over $400 billion for services. That, in total, will amount to a global market for satellite communications of over $600 billion. It is expected that the World Trade Organization agreement on access to markets negotiated in early 1997 will increase international telephony traffic by 80 per cent.

76. New proposed services via satellite include voice, data, video, imaging, video tele-conferencing, interactive video, television broadcasts, multimedia, global Internet, messaging and trunking. A wide range of applications are planned through those services, including distance learning, corporate training, collaborative workgroups, telecommuting, telemedicine, wireless backbone interconnection (that is, wireless local area network—wide area network), video distribution, direct-to-home video and satellite news-gathering, as well as the distribution of software, music, scientific data, and global financial and weather information. Satellite-based systems are also indispensable for emergency communications services.

77. The economic growth rate of the developing regions will be sustained or significantly accelerated by affordable telecommunication services. Broadband satellite services are ideally positioned to allow those regions to leap directly into modern infrastructures.

78. Recent technological developments have enabled the development of a new type of satellite communications system that is 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, making people and businesses reachable by telephone virtually anywhere on the planet.

79. GMPCS represent the new wave of personal telephony, promising global mobile faxing, messaging data and even two-way voice and 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.

(b) Issues and concerns

80. 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 has also given rise to a growing hiatus between the information-rich and the information-poor societies. Given the growing importance of information, the inequity can be potentially as explosive as large income disparities. 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.

81. One vital necessity, in order to reduce the information gap, is universal access to communications and information. 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.

82. As access increases and technology makes it easier, cheaper and simpler to communicate, the State is steadily losing control over information flows. The ability of the State to exercise any sort of control has effectively been bypassed by advancing technology. Thus, data of all types, radio and television programme delivery via satellite and voice and audio communication, are all available directly and do not need the permission or even the cooperation of national Governments. That is especially—and most visibly—so, in the case of transnational satellite broadcasting. A major point of concern, especially (but not only) for developing countries, is the cultural effect of such transnational broadcasts.

83. Another area of concern is the trans-border data flow via satellite. Information pertaining to financial transactions, whereby vast amounts of money are electronically moved from one country to another is an issue of global concern, in particular to developing countries, since their economies are more susceptible to any large or sudden transfers of funds.

84. 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.

85. 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 insufficient radio-frequency spectrum has become a pressing issue.

86. 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. Over the last 40 years, less than 2 per cent of the World Bank's lending has been for

telecommunications. The World Bank itself estimates that by the year 2000 the developing world will need at least $30 billion annually to satisfy demand.

87. 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. While in a macroeconomic sense, the cost of informatics is declining, other factors, such as the cost of a computer system or modem, the lack of electricity, physical disability, illiteracy, social inequities or simply lack of interest need to be carefully considered.

88. The establishment of priorities is an issue to be considered in investing in information communication technologies, including satellite technologies. While the immediate returns on investment in information and communication 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 communication technologies for certain sectors of society, particularly to benefit illiterate and rural populations, is a particularly important but costly challenge.

89. 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.

90. As a result of deregulation and privatization of telecommunications, most of the major international news agencies now transmit their services by satellite, which makes it necessary for their clients to acquire earth stations. The international agencies provide the stations and encode the information, giving them total control of the information transfer process. Technically, those transmissions are more reliable and efficient than the traditional radio transmission method, but many small agencies in developing countries find the new technology constraining and exorbitantly expensive, which represents a threat to free access to information.

91. Global political acceptability is an important factor having an impact on new satellite services. Developing countries insist that their sovereignty be respected and that they be treated as equals by developed countries that propose to offer global services.

(c) Specific action programmes

92. 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. In developing countries, for example, on average there is one radio station for every 2 million people; in developing countries, the ratio is one station for every 30,000 people.

93. 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. The new global 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. People in those areas will be able to receive digital sound broadcasting of unprecedented quality and diversity on a new type of radio needed to receive programmes from satellites.

94. According to the World Bank, the annual investment necessary for the growth of telecommunications in developing countries over the next five years would amount to $60 billion. The funding provided by international public aid would not exceed $2.3 billion, and most developing countries could not make up the difference. The necessary investment should come from the private sector.

95. However, to 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.

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

97. 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) An expert study should be carried out on the cultural impact of transnational satellite television broadcasts on viewers, especially on young people;

(c) A study should be conducted on the benefits of, and possible problems caused by, transnational data flows via satellite;

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

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

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

(g) 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.

3. Improving and using position/location capabilities

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

98. Global positioning systems (GPS) 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, NAVSTAR (United States of America) and GLONASS (Russian Federation), both consisting of 24 active satellites and both operated by the military. GPS uses satellites as reference points to calculate positions accurate to within metres or, with advanced techniques, to within a centimetre.

99. 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 GPS is to a large extent unlimited, as new applications will continue to be created as a result of technological evolution.

100. 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. GPS will soon become almost as basic as the telephone.

101. The International Search and Rescue Satellite System (COSPAS-SARSAT) consists of a constellation of satellites in polar orbit and a network of ground-receiving stations that provide distress alert and location information to appropriate rescue authorities for maritime, aviation and land users in distress. Since 1982, the system has been used for hundreds of search and rescue operations and has been responsible for the saving of several thousand lives worldwide.

(b) Issues and concerns

102. The performance of NAVSTAR and GLONASS does not meet the requirements of all user categories, in particular civil aviation, and needs to be enhanced through the implementation of system overlay or system augmentation. Since their inception, the use of those two existing military satellite navigation systems has been offered free of charge to civilian users.

103. With a view to developing its use, Europe has decided to implement the 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 free 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.

104. A number of political and economic problems also need to be resolved before any new type of the 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

105. A large degree of regional and global cooperation is essential to achieve a seamless multi-modal satellite-based radio navigation and positioning system throughout the world. In that context, a coordination process among countries and organizations is in progress with the following two objectives: first, to examine the possible extension of GPS coverage to all countries or, alternatively, to assure its compatibility with other regional augmentation systems; and secondly, to study forms of cooperation in the implementation of the future GPS systems.

106. Further international coordination and consultation is necessary to ensure compatibility between existing and planned navigation and positioning systems while maintaining cost-free access to the satellite signals.

4. Furthering knowledge

(a) Status: space science and space exploration

107. 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.

108. In the 40 years of the space age, scores of new worlds in outer space have been transformed from barely discernible points of light to sources of wonder and new discoveries. There have recently been strong indications of past life on Mars, from indirect evidence showing it to have been warmer and wetter and possibly even from direct evidence in meteorites that were catapulted off the planet and that landed here on Earth, millennia later. The moons of Jupiter are far more dynamic than previously thought. Europa probably has an ocean of liquid water continually being heated by tidal forces; Ganymede has a magnetosphere; Io is characterized by continuous volcanic activity. Venus has a surface hot enough to melt lead while sulphuric acid and aerosols make its atmosphere equally hellish to imagine. Comets and asteroids bombard the planets and the collisions have not only been observed first hand (impact of Shoemaker-Levy 9 with Jupiter), but the celestial bodies have been observed close up to see their composition and bizarre topography. It is now known that 65 million years ago the evolution of life on Earth suffered

a catastrophic change resulting from the impact of an asteroid or comet. Earth and all life on it are part of the solar system environment.

109. In addition, people on Earth have made stunning observations of galaxies colliding and being born at the edge of the universe and discovered evidence of black holes and planets orbiting other stars. The broad interest in recent discoveries should not be surprising. The nature of life in the universe intrigues everyone in all countries, rich and poor, as well as developed and developing. Throughout human history, in all human cultures, people have wondered about their place in the cosmos, the nature of planets and stars and their relation to Earth, whether they are alone and the evolution of the universe, galaxies, stars, planets and themselves, as reflected in their folklore, mythology, religion and culture. Now humans can do it through science.

110. The above-mentioned discoveries, and many others, have given birth to new understanding in many sciences, including physics, astronomy, geology, biology, ecology, engineering and computer sciences. However, in addition to the intellectual benefits of new knowledge, the list of significant mundane and practical benefits of space science have long-term positive effects on, and have broadly touched, the life of humanity.

111. 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. Such impacts are now believed to have wiped out species in the past and could do so again in the future. All of those discoveries have important global significance for Earth.

112. 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 will be made available to all people, catalysing learning activities.

113. The benefits derived from the study of space science and planetary exploration are critical to the future well-being of humanity, for the following reasons:

(a) It is a basic element of education;

(b) It facilitates international cooperation;

(c) It leads to technological development;

(d) It offers training for young scientists and engineers;

(e) It enhances understanding of the past and develops a vision for the future.

114. Understanding the orbital debris environment (including the size range of debris, its composition and its distribution by orbital altitude) is necessary to assess the debris hazard to spacecraft in various orbits and to enable decisions to be made on methods to reduce future hazards.

115. Near Earth Objects are responsible for the cratering of the Earth-Moon system. Depending on the size of the impacting body, the effects of those events on the terrestrial environment range from nothing at all to catastrophes

that may pose a very serious threat to life on Earth. It is estimated that near to Earth there may be about 1,700 objects larger than 1 kilometre in diameter that could cause such damage.

(b) Issues and concerns

116. Scientific illiteracy is one of the world's great problems and an increasingly divisive factor between haves and have-nots. Much of the quality of living 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. While learning about the atmosphere of Jupiter does not necessarily contribute to income generation or solve economic problems, learning about the exploration of Jupiter pulls a whole educational experience along with it, motivating students and teachers to achieve in the modern world.

117. Dealing with a waste or loss of talent (brain drain) is a major challenge in many countries, as young people turn away from creative enterprises of high achievement because of the lack of opportunity. Some bright young people interested in science and technology go to developed countries to seek career opportunities, but some others lose interest because of the lack of opportunity and follow less creative paths simply in order to make quick money.

118. The technology of exploration is crucial in this context. Communications, remote sensing, miniaturization, propulsion, electronics, information-processing and navigation are developments needed in all countries. If modern science and technology is not introduced into developing countries, continued poverty and economic depression are guaranteed. Admittedly, such technologies and engineering skills will be developed in far more widespread applications than space science, but the power of space science in the educational system to motivate their learning and inclusion cannot be overestimated. The distinguishing feature of space science is the means by which it advances exploration, which captures the public interest and provides a vision virtually unique in modern science and technology.

119. The United Nations, particularly through its Committee on the Peaceful Uses of Outer Space, is the only forum in which representatives of spacefaring and non-spacefaring countries meet on a regular basis. The Committee has a natural role in the efforts undertaken, as it already has a mandate to ensure that the tangible benefits of space capabilities are made available to developing countries. Extending that mandate, as proposed in section (c) below, is wholly consistent with such an endeavour.

120. 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. They can help bring together the powerful body of materials produced by the European Space Agency, the Centre National d'Études Spatiales (CNES) (French National Centre for Space Studies), the German Aerospace Research Establishment, the National Aeronautics and Space Administration (United States), the National Space Development Agency (Japan), the Russian Space Agency and many other space agencies, the educational resources of international organizations such as the Committee on Space Research, the Council of Scientific Unions, the International Astronautical Federation, the International Astronomical Union, The Planetary Society and international organizations in the United Nations system, as well as other professional scientific organizations throughout the world that want to participate in promoting the benefits of space science and exploration.

(c) Specific action programmes

121. 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 those in developing countries who wish to increase their scientific literacy. 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 United Nations auspices. In addition, the United Nations could create a clearing house for both print and electronic information at various technical levels using contributed funds to translate such material into various languages and constructing a World Wide Web site for information dissemination. Within the Office for Outer Space Affairs, one staff member could be assigned the space science and exploration portfolio and serve as an advocate for a continuing United Nations role in that arena.

122. Space agencies and aerospace educational organizations are increasingly turning to the Internet, and particularly the World Wide Web, for their outreach, as they are forced to reduce personnel, material, printing, and mailing costs in their programmes. But the Web is not really worldwide, and Internet access is extremely limited in developing countries. Supplementary programmes are needed.

123. The United Nations has been effective in distributing information and enhancing communications for scientists and educators in developing countries. It could lead initiatives to develop educational material capturing the latest information and results from space exploration. Such material should present a global outlook and be designed to make the recipients a part of 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. Possible activities that could be undertaken by non-governmental organizations in partnership with space agencies and the United Nations are described in the section below.

124. Printed materials are the main requirement because most of the world lacks ready access to electronic publications, but specific programmes should aim at enlarging electronic access for developing countries.

125. A spin-off of the programmes would be the enhancement of general public education, which would benefit both space science communities and the general public by making space science exploration programmes more relevant to the general interests of the population.

126. 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 that purpose, the major space agencies could initiate an "announcement of opportunity" programme to inform those included in a worldwide distribution list, to be possibly developed by the United Nations and other international space organizations, of missions and technical programmes for which proposals could be received.

127. 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.

128. The ongoing work by the Scientific and Technical Subcommittee through its multi-year plan to study the nature of space debris, to model the debris environment and to consider possible mitigation measures with regard to cost-efficiency, provides a good basis for defining internationally acceptable methods of controlling space debris in order to preserve useful altitudes for functioning spacecraft.

129. Regarding the potential threat posed by Near Earth Objects, an international programme under United Nations auspices could integrate a network of existing telescopes that would have as a goal the location of the estimated 1,700 objects that could cause catastrophic damage to life on Earth.

5. Information needs and the global approach

(a) Status: information systems for research and applications

130. Information systems are fundamental tools for ingesting Earth observation data and other inputs, handling and integrating them through appropriate algorithms, and generating output in the form that is most suited to the intended user group. Dedicated numerical models and Geographic Information Systems (GIS) are the most common types of system, the former largely used for analysis and prediction of weather, climate and ocean currents, the latter being important for land mapping, cadastral applications or disaster monitoring, particularly at local and regional levels.

131. An important asset of the systems is their data handling capacity. First, they allow the ingestion 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 ingesting new data. Earth observation from space provides a coherent, objective and regular source of input data for information systems.

132. 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.

133. 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.

134. 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. The European Communities have adopted a directive on databases that has greatly increased the protection of intellectual property rights of database creators and vendors in both the private and the public sectors. Similar legislative initiatives were introduced in both the United States Congress and the World Intellectual Property Organization (WIPO). Although neither of the proposals was adopted, the legal changes that have been enacted in Europe and that are still being vigorously promoted in the United States and elsewhere have a number of attributes that could severely restrict data exchange, access and use by researchers, educators and other public interest users.

(b) Issues and concerns

135. 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. A common issue for all those problems is the need to have a coordinated means to acquire data in a timely manner for monitoring, analysing and modelling the environment of Earth.

136. For most of the research and 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.

137. 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.

138. 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.

139. 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

140. 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.

141. 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 done through CEOS, with active assistance from the Office of Outer Space Affairs.

142. Efforts should be made to create awareness among managers and decision makers of the cost-effectiveness of using satellite data as a tool for planning and management of environmental and development programmes. A means of achieving that objective could take the form of a programme that facilitates access to satellite data, equipment and software, as well as providing the training necessary for their use.

6. Promoting technology development and transfer

(a) Status: space technology

143. 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 need 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 application areas for developing countries are the provision of health and education services.

144. Another area of greatest need is the development of small satellite technology, which has strong potential for offering a larger number of countries affordable access to space through the rapid development of fully integrated national space programmes. Apart from the direct benefits to be derived from specific space-technology applications that can be tailored to meet local needs, the existence of national space programmes can lead to the development of new local spin-off industries and actually improve opportunities for technology transfer both locally and internationally.

145. There is also a great need for use and development of Earth observation technologies and the analysis techniques required for understanding and subsequently addressing global environmental concerns, such as global warming, ozone depletion, loss of biodiversity, deforestation and desertification.

(b) Issues and concerns

146. The effectiveness of current mechanisms should be enhanced to allow collaborative work between countries on global environmental problems. A major concern is inadequate access to data and information that 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.

147. A favourable environment, that is, trained human resources in sufficient numbers, appropriate infra-structure and institutional arrangements, a suitable policy framework, long-term financial support and opportunities for the involvement of the private sector, should also be created to allow the transfer of technologies to become permanent in the recipient countries. That would enable space technology applications in developing countries to become truly operational and fully integrated into development activities, as opposed to remaining, for the most part, intermittent demonstration studies involving technology transfer.

148. The technology to be transferred should be appropriate and should be transferred on fair terms. 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.

149. The transfer of technologies that have immediate commercial value would be controversial. Technology transfer has often been considered, particularly by law makers, as an action that could give an industrial advantage to the recipient countries, enabling them to catch up with the donor countries in less time and at less cost. Spacefaring countries, however, would not risk losing their industrial competitiveness in the space industry, which, in many of those countries, is far from being a fully-fledged industry.

150. In matters related to promoting technology development and transfer, current mechanisms for cooperation among developing countries are inadequate. The mechanisms for donor organizations to finance technology-transfer projects at the regional level, such as regional information networks, are not sufficient, because of policy constraints that heavily favour bilateral agreements.

(c) Specific action programmes

151. Several cooperative, mainly bilateral, programmes exist between States for the development of small satellites. A few developing countries have also made agreements with commercial entities for the transfer of small satellite technology.

152. In global environmental matters, the major initiatives include the International Geosphere-Biosphere Programme (IGBP), the World Climate Research Programme (WCRP), the Mission to Planet Earth (MTPE), DIVERSITAS and the International Human Dimensions Programme on Global Environmental Change. Three global observations systems, comprising both ground-based and remote measurements, have also been set up: the Global Climate Observing System (GCOS), initiated by UNEP, the Intergovernmental Oceanographic Commission (IOC)/UNESCO, WMO and the International Council of Scientific Unions (ICSU); the Global Ocean Observing System (GOOS), being developed by UNEP, IOC/UNESCO, WMO and ICSU; and the Global Terrestrial Observing System (GTOS), developed by UNEP, FAO, UNESCO, WMO and ICSU.

153. A number of regional centres for space science and technology education are being established throughout the developing world with the assistance of the Office for Outer Space Affairs. Apart from fostering South-South cooperation, the centres contribute to the building of local expertise and ultimately to the success of technology-transfer programmes.

154. In order for technology transfer in the area of space technology and its applications to be successful, there should be more emphasis on the transfer of knowledge by training human resources at the basic level of science and technology, rather than transferring hardware and software or operational and applicational technologies that may have immediate commercial value. In order for a country to be able to fully utilize the transferred technology in the form of hardware or software, it must have adequate infrastructure and trained human resources to receive and further develop the technology to meet its unique national development needs.

155. Technology transfer from spacefaring countries to developing countries could also 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. Providing such opportunities to developing countries may also expand market opportunities for the space-related industry of spacefaring countries.

156. An international mechanism needs to be evolved which, while limiting the transfer of certain technologies for military purposes, does not unduly constrain technology transfer for legitimate civilian benefit.

7. Capacity-building

(a) Status: education, training and development

157. The ability to develop or even use space technology depends critically on the availability of human resources with appropriate knowledge and skills. Conceptualizing, designing and putting together systems for the application of space technology require an even greater level of human capability. Education, training and development of human resources are, therefore, of critical importance. These are part of overall capacity-building, which is the only way of empowering poorer or less developed societies.

158. 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 and by workshops. Thus, a strong and well-developed conventional system of education can provide a good foundation for introducing or carrying forward work related to space science and technology.

159. Specific training courses, however, are required to develop capabilities beyond the general foundation. The first step is to identify the training needs; international help in such a needs assessment would be invaluable, and the United Nations could attempt to coordinate and give impetus to the provision of such assistance.

160. A major prerequisite for successful space science and technology applications in developing countries is the development of various essential indigenous capacities, particularly human resources, within each region. In recognition of such a prerequisite, 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, in developing countries. The centres are based on the fundamental notion that it is vital for developing countries to have indigenous personnel trained in the use of space science and technology, particularly those applications relevant to their national development programmes such as remote sensing, satellite meteorology and the use of geographic information systems, space communications and basic space science. Only then would the developing countries be able to contribute effectively to the solution of global, regional and national environmental and resource management problems.

161. The inauguration of the Centre for Space Science and Technology Education in Asia and the Pacific, affiliated to the United Nations, took place in 1995. The Centre currently has its campus at the Indian Institute of Remote Sensing (IIRS) at Dehra Dun, India. The Centre utilizes the infrastructure available at the Institute for conducting remote sensing and GIS courses and, at Ahmadabad, the Space Applications Centre for courses on satellite communications and satellite meteorology and the Physical Research Laboratory for space science.

162. Brazil and Mexico were selected as the 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 was signed by Brazil and Mexico in March 1997 and is currently being circulated to all countries of Latin America and the Caribbean for their concurrence. Plans for the establishment of such a centre in western Asia and of one each in the French-speaking and English-speaking regions of Africa, in Morocco and Nigeria, respectively, are nearing completion.

163. In the case of central, eastern and south-eastern Europe, discussions between Bulgaria, Greece, Poland, Romania, Slovakia and Turkey are in progress on 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.

(b) Issues and concerns: developing the physical infrastructure

164. 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 in meeting those needs.

165. 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 remote 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.

166. Financing of physical infrastructure is an area where international assistance may be needed, since such infrastructure is often capital-intensive. Multilateral agencies can play a major role in providing such financing, and also in ensuring the inclusion of such infrastructure in non-space-related projects, for example, by including a satellite broadcasting component in an education project. The Committee on the Peaceful Uses of Outer Space and

the Office for Outer Space Affairs need to undertake efforts at creating awareness about the need to integrate such infrastructure facilities into other larger projects in the development field.

(c) Specific action programmes

167. In terms of education and training, the space sector will always need young graduates from all levels of university education in a wide range of disciplines: science, management, law, engineering, economics, architecture, communication, medicine, finance etc. Space agencies, firms, large and small, and international organizations involved in space emphasize that many young specialists should complete their training by acquiring the tools that will enable them to increase their efficiency in an interdisciplinary, international and, consequently, intercultural environment characterized by the following conditions:

(a) The education, in space-related fields, of professionals of all disciplines (education and training);

(b) The creation and expansion of knowledge (research and advanced studies and the training of researchers);

(c) The exchange and dissemination of knowledge and ideas to serve the world community through the development of space-related activities for peaceful purposes, the improvement of life on Earth and the expansion of human activities into space.

168. Identifying suitable training institutions (within a country or region) is another task in which international assistance has an important role to play. In some cases requiring the establishment or expansion of such institutions, faculty development would be essential and international assistance—through financial cooperation in providing, for example, fellowships and faculty training—desirable.

8. Spin-offs and commercial benefits from space activities

(a) Economic and societal benefits

169. 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.

170. With an estimated $77 billion in revenues and more than 800,000 people employed worldwide in 1996, the global space industry is one of the important economic engines of the world. A brief overview of the commercial status of and trends in some of the market segments is given below.

171. 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 communications satellites. For instance, satellite systems enable low-cost and reliable access to telephony, high-speed data transfer, access to the Internet, distribution of video signals for cable and television programmes and other multimedia services even from the most remote areas of the world. The global benefits for society consist essentially in the remote access provided to a large variety of services in such fields as telemedicine, tele-education, telebanking and emergency communications.

172. Thousands of spin-off products 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.

(b) Status of commercial and spin-off activities

173. 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.

174. 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.

175. Next to telecommunications, remote sensing and geographic information systems may be 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.

176. 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.

177. 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. 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.

178. 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.

179. 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.

180. 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.

181. 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.

182. 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. It is estimated that approximately 250 million people worldwide could be targeted as a potential market for space tourism. If the costs of the space infrastructure are drastically reduced and the safety levels increased, tourism in space could be a lucrative market for industry.

183. Another potentially profitable space activity could be the disposal of nuclear waste and other hazardous materials. The disposal of hazardous waste material has long been a problem for Governments and industries. With the development of new technology and reduced costs, the potential to transport hazardous materials far away into space could become a realistic and desirable option. 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.

184. 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.

185. 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.

(c) Issues and concerns

186. 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 aspect 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 of 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.

187. Although activities such as space advertising and space burial services may become commercially attractive, there are scientific and safety-related issues, for instance, the impact of such activities on astronomical observations, that need to be discussed at an international level. Scientific research would also be necessary to determine the effects that transmitting large densities of microwave energy from space to Earth would have on the atmosphere.

188. Technology transfer and spin-off products and processes collectively make an enormous contribution to national economies, new job creation and industrial productivity. They also represent a substantial dividend on national investments in aerospace research. Thus, the circumstances under which such a process could take place at the international level (that is, the identification of the technologies and their intended applications) require detailed consideration leading to well-defined government and industrial policies.

189. Problems experienced by developing countries in the area of space technology transfer 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;

(f) Need to redesign off-the-shelf technologies available in developed countries to meet the specific needs of developing countries.

(d) Specific action programmes

190. 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 they could favour relatively more the less advanced countries and regions and, thereby, have a relatively higher impact on social, economic and human development of such countries and regions.

191. 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 appropriate international legal framework, covering such issues as intellectual property rights, trade marks, copyright, foreign licensing and export control regulations, is essential to foster international cooperation in the area of space technology and spin-offs. The United Nations should take the initiative to create such a framework.

192. 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.

9. Promotion of international cooperation

(a) Status of international cooperation

193. 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.

194. 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.

195. Preserving 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.

196. 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. Moreover, international cooperation can enhance transparency in space activities and further the establishment of new institutions and confidence-building measures to deal with a growing number and complex web of regional crises.

197. 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 of 13 December 1996, entitled “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”. Clearly, the role of international space law in promoting international cooperation in space activities is extremely important.

198. 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

199. 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.

200. 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.

201. 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.

202. 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 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.

203. In terms of project costs, especially for large, unmanned space exploration missions, no longer can a single country pay such a huge bill. The international space station provides an example of 18 States pooling resources to share the technological and financial burdens of a project that will have wide-ranging benefits for all humanity.

204. 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.

205. 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.

(c) Specific action programmes

206. 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.

207. 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.

208. 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.

209. 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. 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.

210. 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.

211. No mechanism currently exists for defining and coordinating the needs of the user community in Earth environmental monitoring activities. An independent body or mechanism that could facilitate the coordination of needs in that field between satellite operators and users would be more effective and could provide a unified set of data requirements to help in designing and operating future Earth observation systems.

212. 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 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.

Notes

[1]See *Official Records of the General Assembly, Fifty-second Session, Supplement No. 20* (A/52/20), sect. II.E.