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REPORT ON THE UNITED NATIONS/EUROPEAN SPACE AGENCY SYMPOSIUM ON SPACE INDUSTRY COOPERATION WITH THE DEVELOPING WORLD, CO-SPONSORED BY THE EUROPEAN SPACE AGENCY AND THE GOVERNMENT OF AUSTRIA

(Graz, Austria, 8-11 September 1997)

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INTRODUCTION

A. Background and objectives

1. The General Assembly, in its resolution 37/90 of 10 December 1982, decided that in accordance with the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82),[1] the United Nations Programme on Space Applications should, *inter alia*, promote greater cooperation in space science and technology between developed and developing countries, as well as between developing countries.

2. The Committee on the Peaceful Uses of Outer Space at its thirty-ninth session, held in June 1996, endorsed the programme of workshops, training courses and seminars proposed for 1997 by the Expert on Space Applications.[2] Subsequently, the General Assembly, in resolution 51/123 of 13 December 1996, endorsed the United Nations Programme on Space Applications for 1997.

3. In response to General Assembly resolution 51/123 and in accordance with the UNISPACE 82 recommendations, the Symposium on Space Industry Cooperation with the Developing World was jointly organized by the United Nations and the Government of Austria at Graz, Austria, from 8 to 11 September 1997. The Symposium was co-sponsored by the Federal Ministry for Foreign Affairs of Austria, the province of Styria, the city of Graz and the European Space Agency (ESA). The Federal Ministry also acted as host of the Symposium, which served as follow-up to the United Nations/European Space Agency/European Commission Symposium on Space Technology Applications for the Benefit of Developing Countries, held at Graz from 9 to 12 September 1996.

4. The main objective of the Symposium was to provide an opportunity for representatives of space industry and the private sector to interact with international space scientists, space technology experts and policy makers from developing and developed countries and to explore possibilities for increased scientific and technical cooperation. Industry and private ventures had become important players in the space applications sector, and by demonstrating to participants the capabilities offered by space technology, as well as the problems usually encountered in developing and using space applications, they might have a greater understanding of the type of requirements that had to be met for a successful commercial venture.

5. Such information could help to convince policy makers and other decision makers in developing countries of the value of allocating resources to implement such applications in support of national and regional development.

6. The present report was prepared for the forty-first session of the Committee on the Peaceful Uses of Outer Space and the thirty-fifth session of its Scientific and Technical Subcommittee. The detailed proceedings of the Symposium, including a list of addresses of all the participants, will be made available in due time.

B. Programme

7. At the opening of the Symposium welcoming statements were made by representatives from the United Nations, ESA and the host country. The programme of the Symposium was divided into a series of sessions, each addressing a specific issue. The invited presentations were followed by panel discussions and brief presentations by participants from developing countries on the theme of the Symposium, describing the status of space technology applications in their respective countries.

8. The different sessions focused on opportunities for and problems of technology exchange in space applications, with special consideration for small satellite platforms, the use of satellite telecommunications for regions with underserved telecommunications infrastructures, the role of space systems for tele-education and telehealth applications, the distribution of data acquired by remote sensing satellites to the end-user, the potential of space technology for agricultural monitoring and precision agriculture, as well as navigation and localization systems and

services. All these applications had the potential to contribute to an improvement in living conditions, particularly in developing countries.

C. Participants

9. Developing countries were invited to nominate candidates to participate in the Symposium. Participants from those countries held positions in institutions or private industry dealing with resource management, protection of the environment, communications, remote sensing systems, industrial and technological development and other fields related to the themes of the Symposium. The participants were also selected on the basis of their work experience with programmes, projects and enterprises in which space technology was already used or was intended to be used.

10. Policy makers and others at decision-making levels from national and international entities were also invited. They were asked to highlight in their presentations the key issues related to placing a higher priority on the operational implementation of space applications.

11. Funds allocated by the Government of Austria and ESA were used to cover the travel and daily expenses of participants from developing countries.

12. The following Member States were represented at the Symposium: Azerbaijan, Bangladesh, Brazil, Cameroon, Costa Rica, Bolivia, China, Egypt, Ethiopia, India, Indonesia, Iran (Islamic Republic of), Kenya, Malaysia, Mongolia, Nigeria, Pakistan, Romania, Sri Lanka, Syrian Arab Republic, Thailand, United Republic of Tanzania, Uruguay, Uzbekistan, Viet Nam and Zambia. The following international organizations and national entities were represented: Office for Outer Space Affairs of the Secretariat, European Commission, ESA, International Space University (ISU); Austrian Space Agency (ASA), Brazilian Space Agency (AEB), Indian Space Research Organization (ISRO), Instituto Nacional de Técnica Aeroespacial of Spain, National Remote Sensing Centre of China and PT. Telekomunikasi Indonesia. The space industry was represented by participants from Aerospatiale (France), Daimler-Benz Aerospace (DASA) (Germany), Gesellschaft für angewandte Fernerkundung (Germany), GISAT (Czech Republic), Resource 21 (United States of America), Satellite pour l'observation de la terre (SPOT) Image (France), Surrey Satellite Technology Ltd. (United Kingdom of Great Britain and Northern Ireland), United States Global Positioning System Industry Council and the World Space Foundation (United States).

I. PRESENTATIONS AND DISCUSSIONS DURING THE SYMPOSIUM

13. While there had been a slight decline of expenditures in many government civil space programmes, there was a clear trend towards an increasing growth in civilian space expenditures from commercial firms and from smaller countries.[3] The year 1996 was the first to record commercial revenues that surpassed government expenditures. According to a recent study, worldwide space industry revenues in 1996 approached 77 billion United States dollars ($) and employment was greater than 800,000.

14. Space industry encompassed a broad range of activities that could be roughly divided into four sectors: infrastructure, telecommunications, emerging applications and support services. Because of its scope and size, telecommunications was considered a separate sector, while other applications such as remote sensing and navigation services, from a commercial point of view, were still being treated as emerging applications.

15. In this emerging market place, developing countries had become significant purchasers of space-related products and services and represented an important customer base for the space industry. It was essential, however, that developing countries increased their indigenous capabilities to participate in this market not only as customers, but also as potential sellers of space technology and service providers.

16. Only a few developing countries had the resources to engage in full-fledged space programmes. Space technology had the potential to offer benefits suiting many specific needs, and seeking mutually beneficial forms of cooperation with industry was one way to address those needs.

17. The keynote address of the Symposium provided some valuable insights into the Indian experience, which was based on the vision that the effective use of technological advances was indispensable if the challenges and demands of an exponentially growing population were to be met. Such a vision made it imperative for India to adopt an application-driven space programme.

18. In the early 1970s, the situation of India was typical of that of any developing country. There was a lack of adequate industry infrastructure and capacity to satisfy the quality demands of a space programme. Thus, from the beginning, priority was given to promoting a close relationship with the industry to develop the required capabilities.

19. Initial space activities were carried out solely by the Government. Subsequent phases involved technology transfer from the space agency to industry, with buy-back guarantees for the products. Once industry had matured to a certain degree, development was carried out by industry with partial research and development (R & D) support from the Government. Several academic institutions were also involved in the research activities. Currently, about 45 per cent of the budget of the Indian Space Department flowed to the Indian industrial sector.

20. Most industries had benefited from this association by improving their own quality standards. The companies were generally among the first to obtain ISO 9000 certification of the International Organization for Standardization (ISO). Cooperation also resulted in the training and education of highly qualified employees.

21. Following the successful launches of remote sensing and communications satellites, ISRO entered the operational phase in providing space-based services for a variety of applications. A commercial venture called ANTRIX Corporation Limited was established and was making significant inroads on the international scene through the forging of global partnerships.

22. The Indian space centres were providing scientists and engineers from other developing countries with training under the sharing of experience in the space fellowship programme (SHARES). This was seen as a contribution towards future partnerships as the Indian experience taught that collaboration between developing and developed countries could lead to synergy, thus benefiting all partners.

23. A representative of Aerospatiale outlined opportunities for cooperation, noting that for the space industry, a key issue was cooperation with developing countries. However, the space industry had little influence in defining an independent policy towards developing countries; its business strategy must be within the framework of a national space policy generally defined by its national space agency. As space was still seen as a high-technology venture, cooperation policies had to be approved by Governments. In addition to the national space agencies, international organizations and national ministries of cooperation might provide financial aid. Cooperation might be direct or through indirect relations promoted by international organizations such as the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), the European Telecommunications Satellite Organization (EUTELSAT), the International Mobile Satellite Organization (Inmarsat) and the International Telecommunications Satellite Organization (INTELSAT).

24. From a space industry point of view, developing countries also needed to be classified with respect to their position in the space arena. In this context, it was often more appropriate to use the concept of purchasing power capacity (PPC) instead of the gross national product (GNP). Emerging space countries like Brazil, China and India, with a high PPC, already had developed strong ties with space industries in other countries. The industry should therefore concentrate on those countries that had not yet begun to use space technology applications.

25. There were two primary axes for industrial cooperation: the building of space industry through technology transfer, with the creation of a technical capability in the country, or the creation of national capabilities in application niches with the aim of becoming a specialized service provider to space industry.

26. The first axis covered mainly the satellite and launcher business and could be conducted following a phased approach. A country could start with sounding balloons, which could provide a payload technology capacity as well as knowledge of meteorology and upper-atmosphere science at a cost of approximately $1 million and taking three to five years to completion. The next step would include the development of microsatellites (weighing less than 100 kilograms) to create a local education base. The cost for such an endeavour was about $10 million and the typical project duration was two to five years. For industries that already had gained some experience in satellite development, there was the possibility of licensing whole multimission platforms and acting as a provider of complete systems. Other possibilities included the development of ground facilities for satellite testing or control and satellite payload development for scientific or application-oriented satellites, both of which could lead to viable commercial perspectives.

27. Cooperation in the launcher business was more difficult to establish. Not only was a considerable amount of investment required, but a country might also have to face restrictions in acquiring certain technologies. The favourable geographical location of many countries would provide excellent conditions for establishing a launch infrastructure. However, it had to be considered that the development of sounding rockets or small launchers with solid propulsion would cost at least $150 million to $200 million, with a minimum development time of 5 to 10 years.

28. Those countries that did not intend or cannot afford to engage in full-scale development of a satellite or launcher could enter via the space service segment, which could be described as the link between the space object and the users. Space services encompassed a multibillion dollar market with a projected growth rate by a factor of three over the next eight years. The relatively low entrance fee and the payback that could be expected for the national economy made the space service business highly relevant for developing space countries. Business opportunities could be found in offering services for data access for multinational projects, transponder leasing, ground stations, participation in regional satellite systems and through the development of skills in specific application niches. Without doubt the biggest problem was in sustaining the political and industrial willingness with a sufficient level of investment over many years to ensure the successful outcome of the project.

29. ESA has over 20 years of experience in cooperation with developing countries in basic sciences, telecommunications and Earth observation. The most effective areas of cooperation were education, technical assistance, the provision of hardware and software tools, the provision of data, meetings and the distribution of information.

30. From a space agency point of view, several issues needed to be considered when engaging in cooperation, including budget adequacy, institutional support and the availability of skilled people and proper infrastructure. Above all, rentability and continuity were the two key factors.

31. Cooperation within an international framework could help begin an activity or obtain better internal support, which could unblock a difficult internal situation and complement technical and material resources. For example, space agencies in cooperation with industry could help demonstrate to decision makers the cost effectiveness of using remote sensing data so that its use as a planning and management tool would be included in future budgets. Industry in the form of value added companies (VAC) acted as an intermediary between the raw data products delivered by space agencies and the information required by the users. As a result of those activities, the number and skill of VACs was growing in Asia and also recently in Latin America.

32. There were evident advantages in cooperation on the technical side, through the higher skill acquired by the personnel involved, on the financial side, through the long-term savings made throughout all phases of a given project, and on the managerial side, through the education of decision makers and project managers.

33. ESA itself was initiating occasions for cooperative ventures between companies of developing and developed countries, stimulating business opportunities and provoking and facilitating the transfer of know-how. A major area of cooperation was projects related to disaster monitoring and mitigation where both telecommunications and remote sensing from space could provide essential and cheap tools.

34. There was still a large gap between the potential and the actual use of space technology. ESA recommended implementing a realistic strategy for cooperation between developed countries, space agencies and companies from developing countries, possibly within the framework of programmes of international organizations. Such a strategy would contribute to reducing the gap between developing countries and the industrialized world, and space agencies, international organizations and more developed countries would see their efforts put to better use in a much larger part of the world.

A. Space industry cooperation and technology exchange

35. The presentations were focused on the issues of technology exchange and, specifically, the microsatellites industry which currently offered realistic prospects for developing countries to gain hands-on experience with space technology.

36. DASA presented its experiences of cooperation with Argentina, China, India and Israel, which involved full technology transfers. The experience of DASA had been that emerging space countries focused on telecommunications, Earth observation and launcher development, which provided a basis for autonomy in space exploitation. All those applications had operational as well as commercial potential.

37. The cooperation between the Chinese Aerospace Corporation and DASA resulted in the creation, in 1994, of a joint-venture company named EurasSpace. Its goal was to jointly develop and market satellites for communications and Earth observation applications for the Chinese and other markets. Another successful example was the cooperation with ANTRIX, the commercial arm of ISRO. In the early stages of cooperation, DASA was providing hardware; it had now begun to procure equipment and satellite components from India. DASA was also involved in the development of the AMOS satellite with Israel and the Nahuel satellite with Argentina. All those ventures had been based on the principle of “Today’s partners are tomorrow’s partners”. Even though emerging space countries had limited resources, together they represented a large market and a driving force for space exploitation.

38. Spain recently launched its Minisat 01 satellite, a low-Earth-Orbit (LEO) spacecraft in the 200-kilogram class, with a scientific mission. The successful operation of the satellite opened opportunities for future application missions. Even for a country like Spain, such an endeavour would not have been possible a few years ago. But with technology facilitating the construction of small satellites, access to space had now become a reality for small- and medium-sized countries. Cooperation with ESA and other international programmes had provided the know-how, methods, procedures and industrial background required for the development of Minisat 01.

39. Small satellites (at a price of $16 million to $19 million) were less costly, decreased the probability of cost overruns, shortened time scales for development and were ideal candidates for the development of domestic capacities and international cooperation. The Government of Spain had expressed interest in cooperating with other countries for the development of future missions.

40. As one of the prime developers of microsatellite technology, Surrey Satellite Technology Ltd. and the Centre for Satellite Engineering Research at the University of Surrey had developed a satellite technology transfer and training programme which involved the design, building and operation of complete satellites. Technology transfer

had already taken place between Surrey, Chile, Malaysia, Portugal, Republic of Korea, Singapore, South Africa and Thailand. About 70 engineers had been trained as part of the technology transfer training programme.

41. Advances in microelectronics had made small-scale space missions very affordable. This development enabled any country, or even universities, to build, launch and operate its own satellite. Although microsatellites were physically small, they were still complex and had all the characteristics and complexities of a large satellite. Low-cost, rapid timescales and manageable proportions made this very attractive for emerging space countries that wished to establish their national expertise by taking a low-cost and minimum-risk approach, which could lead to a space programme evolving over a time period of 5 to 10 years from the development of a 50-kilogram microsatellite to a 400-kilogram-class minisatellite to a fully sized 1,000-kilogram satellite.

42. AEB cooperation with private industry was outlined as an example of a national space policy including interaction with private ventures. As part of its industrial policy, AEB gave incentives to companies investing in research and development of technology relevant to the space programme of the country. AEB experience in cooperation with other countries and industries had been helped by a defined national space policy that also addressed the financial aspects.

43. Starting with its initial stages, the planning for cooperation should consider issues of self-sustenance, the intention to market the final product of the cooperative venture to a third party, the support that big industries or companies can provide to smaller companies and any issues related to technology transfer. In developing countries, the Government might need to be initially proactive and to facilitate industry cooperation and partnerships with developing countries.

B. Satellite systems for domestic communications

44. While the majority of countries were now linked to the global telecommunications infrastructure, a considerable number of regions in the developing world were still without basic domestic communications infrastructures. The advantages and disadvantages of using satellite-based communications systems to alleviate this problem were discussed.

45. The diversity in the telecommunications infrastructure available to countries in the Asia and Pacific region represented one stumbling block for harmonious economic growth in the region. With that background in mind, the preliminary conceptual design of a wideband satellite network—ASIA Sky-Link—was presented. ASIA Sky-Link would deliver wideband access and gigabit digital pipes operating in the Ka-band for the Asia and Pacific region. The system was developed specifically to take into account the urgent needs of developing countries for wideband access, a need that could not be fulfilled by terrestrial systems alone. Although initially only regional in scope, the system could be extended to other regions through the use of inter-satellite links.

46. The cooperative information network linking scientists, educators, professionals and decision makers in Africa (COPINE) was a project aimed at responding to the immediate needs of African countries for information exchange. Initially, it would link urban and rural centres of 12 African countries and selected hospitals, universities and institutions located in Europe and elsewhere. Although the possibilities for data exchange would be superior to those currently available via the Internet, COPINE could also serve to complement already available Internet services.

47. The COPINE project also envisaged the involvement of the private sector. At least one international telecommunications company had expressed interest in shared investment. To ensure longer-term sustainability, the involvement of local telecommunications companies was seen as important and beneficial. The meeting of the COPINE Provisional Governing Board in December 1997 was to agree on the tasks to be performed and the resources to be made available for the completion of the COPINE preparatory activities.

C. Space systems for tele-education and telehealth applications

48. WorldSpace Inc., a private company, would soon launch its first satellite, which was part of a planned constellation of three satellites providing digital audio broadcasting (DAB) to a worldwide audience of 4.6 billion people living in 130 developing countries.

49. The project was based on the assumption that in rural areas with underdeveloped telecommunications infrastructures, radio was the preferred and most accessible means of distributing and receiving information. The end-user equipment would be solar-powered, addressing the problem that three fourths of the African population was still without a reliable source of electricity, which made it unlikely that the Internet would be available to the general public in a short time. The addition of a small liquid-crystal-display-screen providing visual information would support the distribution of educational programmes.

50. Distance learning was certainly not equivalent to a teacher-led interactive learning dialogue, but it was clearly an improvement on a situation where at least 50 per cent of African children were not in classrooms. The World Space Foundation was seeking to establish contact with educational organizations and national governments that fully understood the cultural milieu in which they worked, in order to develop and deliver programmes addressing critical issues relating to basic education, health, literacy, disaster relief, women and family development, the environment, cultural heritage and vocational training. A conference on distance education was held at Accra in April 1997 and was attended by 14 African Ministers of Education and some 180 education specialists, donors and media representatives. The consensus was that distance education was a credible option for education, an option that needed to be adopted.

51. Though India had one of the largest education infrastructures in the world, the education and training needs of the country were still not met. The large number of illiterates and three million teachers who were often inadequately trained remained a serious problem. Traditional education systems could not keep pace with education requirements. Distance learning was one answer to the problem. Satellites had been used since the 1970s for tele-education purposes. The Indian National Satellite (INSAT) series of satellites provided two-way audio and one-way video capabilities which allowed the students to directly interact with the teachers.

52. The use of satellite links for telehealth applications was demonstrated with the Satellite Health Access for Remote Environment Demonstrator (SHARED) project. SHARED was a pilot platform to support a remote health-care structure and was originally proposed and coordinated by the San Raffaele International Biomedical Science Park in Italy in cooperation with ESA, the Italian Army, Marconi-Alenia and Joanneum Research of Austria. The system was based on the multipoint videoconferences system of the Direct Inter-Establishment Communications Experiment (DICE) which was the primary communications medium for the EUROMIR missions and other human space missions, including the Austrian AUSTROMIR, the German MIR-92 and the French CASSIOPEE missions. The system was used to test new approaches and innovative models allowing access to health care and biomedical services in remote and underdeveloped regions.

53. While satellite-based systems for tele-education and telemedicine applications might initially appear to be rather expensive, a large number of people could be reached quickly and efficiently. The cost of hardware would continue to decrease, the ground systems would become more compact and less cumbersome to use, and more people would benefit from those applications. Given the large number of people that needed to be serviced, they also opened up tremendous opportunities for industry and for partnerships between developed and developing countries.

D. Remote sensing applications: the role of distributors and users

54. SPOT Image was one of the major companies acting as a distributor of remote sensing data and information. The use of remote sensing data was steadily increasing with applications in environmental control, urban planning, agriculture and forestry, geology, public services, mapping and geographic information systems (GIS). Data vendors like SPOT Image had recently experienced a strong growth in revenues.

55. SPOT was trying to enhance the development of integrated solution packages through a number of projects aimed at proving the capability of SPOT satellites and their applicability to specific problems, as well as to expand the application market and to increase SPOT data sales. The projects were carried out in partnership with service providers and VACs. For example, the parties involved in the projects conducted geological studies and a national inventory of natural resources in Madagascar, established a forest inventory in Tunisia, created an agricultural land information system in Egypt and an action plan for flood control in Bangladesh, controlled resettlement of refugees in Cambodia, and prepared a demographic census in Nigeria, a dam site impact study in Cameroon, erosion studies in Chile and a cartographic survey of mine dumps in South Africa. A large number of donors contributed to the success of the projects.

56. New operational satellite data products such as digital elevated maps would be made available to users. VACs were to be promoted and encouraged for catering to user needs more effectively. Clearly, where appropriate, the relationship between donors and developing countries should be closer to ensure that the needs and concerns of all parties involved were better understood. Finally, the market for remote sensing data offered great opportunities for specialists in developing countries to serve certain niche markets and to act as a commercial distributor of value-added remote sensing data.

57. The importance of information derived from remote sensing data was illustrated with applications in disaster monitoring and assessment. In China alone, there was an annual loss of approximately $20 billion because of floods. Remote sensing data integrated into a GIS could be used to help monitor droughts and forest fires and to assess the probability of and possibly predict earthquakes. These applications constituted the basis for a large future commercial market.

58. The European Commission was funding several Earth observation projects in cooperation with developing countries. The projects included the Tropical Ecosystem Environment Observations by Satellite programme, the Fire in Global Resource and Environmental Monitoring programme, the Satellite Assessment of Rice in Indonesia programme, the South East Asia Rice Radar Investigation of the Joint Research Centre of the Commission, as well as several others.

59. The European Commission was also financing the transfer of equipment, technology and know-how (training). Cooperation with developing countries was based on three priorities: the improvement of public health, the improvement of agricultural and agro-industrial production and the sustainable management of renewable natural resources (forests, oceans, water and energy). One reason for its involvement in such projects was certainly also to develop the commercial market for remote sensing applications.

E. Remote sensing applications and value-added services for agricultural monitoring

60. “Precision agriculture” or “precision farming” described a method of agricultural monitoring which included the use of frequently updated information gathered by remote sensing satellites. The aim of the technology was to help maximize agricultural yields in a sustainable manner.

61. Two often expressed concerns of would-be operational users of remotely sensed data would be resolved in the near future. Those concerns related to the frequency of coverage and the dependability of the source. Approximately 31 land observation satellites were planned to be launched by the year 2000. The frequency of coverage would increase to several times per week, increasing the range of applications that might benefit from the use of remote sensing data. With regard to dependability, it was very likely that individual needs would soon be met by more than one supplier, thus providing the redundancy for supply continuity.

62. Resource 21, a business partnership involving agricultural and aerospace companies, intended to launch a constellation of four satellites. Their main application would be to provide timely data on crop yield modelling, but they would also serve to monitor natural resources, the environment and national security, and would be used for

scientific applications. The gathered information would then be integrated into a GIS environment, for example, a scenario for nitrogen fertilizer management based on sensing and detection of symptoms, diagnosis and remedy.

63. Representatives from GAF/EUROMAP and GISAT presented examples of the use of remote sensing data for agricultural applications in Europe. In that context, the European Commission acted as the largest buyer of remote sensing data in Europe which is used for the control of area-based subsidies.

64. The application demand was an important driving force for the development of space industry and space technology. The demand for more accurate weather predictions resulted in the development of meteorological satellite systems. Similarly, the demand for more accurate data enabling sustainable planning would drive the development of Earth resource and environmental satellites. The development of space industry and space technology in general was accelerating the operationalization of remote sensing applications. Compared to meteorological applications, the monitoring of natural disasters, crop growth conditions, predicted yield and environmental processes such as desertification and urbanization was currently in what could best be described as a pre-operational stage, with mapping applications close to being operational.

65. Operational and commercial aspects, however, did not necessarily go hand in hand and should be considered separate entities. Nevertheless, the benefit derived from remote sensing applications was mostly a social benefit. To become commercial, the economic benefit had to be increased. That was also reflected in the fact that the majority of users of remote sensing data were governmental agencies, while the broad market still required some time to develop.

F. Positioning and localization systems and services

66. Applications based on the Global Positioning System (GPS) increasingly penetrated many facets of everyday life. The GPS market had shown an exponential growth rate from $40 million in 1989 to $460 million in 1993, and was expected to grow to $5 billion to $6 billion by the year 2000. In the meantime, the average cost of hand-held GPS receivers had fallen from $500 to $300, and recently to as low as $150. There was a huge potential market for space-based navigation and localization systems, and new applications were being developed continuously.

67. The United States Global Positioning System Industry Council was an alliance of companies including the original technology innovators, accounting for 60-75 per cent of total United States production. The aim of the council was to act as an information source for the Government and to promote sound policies for the development of commercial markets and civilian applications, while preserving the military advantages of GPS.

68. The most promising markets included vehicle navigation, the recreation market, agricultural applications such as precision farming and the military market. However, the existing regulatory framework and standards might be inadequate to accommodate such a broad range of GPS applications. New policy perspectives coordinating the commercial, consumer and strategic requirements on a national and international level needed to be established, and the dialogue between military, industry and civilian users needed to be extended. Those coordination activities were essential to maintain open markets and to ensure the global acceptance of GPS. Similar organization in Europe and in other countries on a national and regional basis also needed to be established.

69. One major application of GPS was the integration of GPS data into a GIS to provide information for land, sea and air navigation, cadastral surveying, geodetic network densification, high-precision aircraft positioning, photogrammetry without ground control, monitoring deformation and hydrographic surveys. Other applications involved urban planning, environmental analysis, transportation, watersheds, soils and agriculture, demographics, wildlife and endangered species, public health and emergency management. The development of new GPS applications usually took place in universities, which also provided training. The private sector, however, was responsible for ensuring that GPS applications became a practical and commercial reality.

70. The European Satellite Navigation Programme (ESPN) was being defined in cooperation with industry by the European Commission, ESA and Eurocontrol. A first step in the programme was the development of the European geostationary navigation overlay service, a European regional augmentation to GPS and the Global Orbiting Navigation Satellite System (GLONASS) of the Russian Federation. It would greatly improve the integrity and accuracy of the navigational signal, primarily driven by aeronautical requirements. Currently neither GPS nor GLONASS met civil navigation requirements, and suffered from a lack of civilian control.

G. Wrap-up session

71. The final presentation of the Symposium tried to provide answers to the question, “How can space activities be brought into the economic mainstream?”, which had been posed to participants in the Second Annual International Symposium of the International Space University (ISU), focusing on the theme “New space markets”, held at Strasbourg, France, in May 1997.

72. Most participants expressed the opinion that the space community needed to build bridges between the technical and the commercial world. While private ventures would increasingly displace Governments from the telecommunications, Earth observation and launch service markets, it was agreed that Governments should continue to pursue “bold, difficult and audacious” programmes. To ensure that market forces satisfied national needs, especially those of developing countries, concerted efforts at all levels, sustained over a long period of time, were necessary, as the Indian example showed. The benefits of space technology applications must be brought into the political and bureaucratic mainstream and into the everyday consciousness of the ultimate end-users. That was the ultimate challenge for the space community.

II. OBSERVATIONS AND CONCLUSIONS

73. The involvement of industry in space activities addressed all space sectors: the space segment (such as satellites, launchers and space balloons), the ground segment (such as facilities, infrastructure and networks), data distribution and applications. It encompassed the lifetime of every project, starting with the feasibility study and including the preliminary and detailed design, development, implementation, integration, testing, operations, maintenance and upgrading.

74. In the context of the Symposium, most participants were interested in discussing application projects, namely for telecommunications and remote sensing.

75. For any new partnership, two categories of opportunity existed: joining an ongoing project or creating a new one. The value of an application project for possible investment by industry and the development of a market was mostly related to the credibility of the project in leading eventually to the delivery to the final user of an operational system for routine activity.

76. The most productive way to achieve successful involvement of companies from developing countries was to seek joint ventures with industry from more advanced countries, whereby the cooperation would allow the exchange and transfer of know-how through technical application projects.

77. However, many difficulties and sensitive issues had been identified, arising mostly from the wide range and variability of conditions around the world, involving such matters as costs and local laws and regulations (relating to labour, trade and funding), standards, patent rights and intellectual property, local environmental conditions, sociocultural aspects and transient political situations.

78. In the above-mentioned context, international organizations could and should play an important role, by providing both a higher-level institutional framework to cooperative projects and the necessary starting conditions, which often included a limited amount of start-up funding.

79. Numerous comments and remarks were made with respect to the various aspects of possible cooperation initiatives between the three major parties, namely international bodies (such as agencies and banks), industry and national entities.

80. In setting up a project, cooperation must be recognized as a two-way process and needed to be based on an equal and fairly balanced partnership. It required mutual knowledge and respect; frequently, companies from developing countries were forced to act only as agents of firms from industrialized countries, not as parties in a genuine partnership. Technology transfer must enable the receiving country to progress on its own, not to depend on the supplier forever.

81. A strategic vision had to be shared among partners, in order to remove barriers and to make risks affordable just by sharing them. Programmes that grew together and shared risks and rewards were the most productive.

82. Grand projects should be avoided and experience should be sought in small and affordable endeavours. Once selected, they should be carried out without major discussions. Such an approach required imaginative leadership and foresight.

83. Developing countries should start their own national programmes. That was the only way to trigger the market and create conditions for growth and market development, although the timing of investment could be typically compared to the problem of deciding which came first, the chicken or the egg. However, the two components (the chicken and the egg) should be developed together in order to grow together.

84. National programmes should seek to create a market where one did not exist, and industry from developed countries should be prepared to pre-invest in project studies in developing countries in order to bypass the chicken and egg problem. However, in this case also, the prerequisite was a fair partnership between firms from developed countries and those from developing countries.

85. For the implementation of projects beyond the study phase, the participants noted that a combination of the following considerations should be addressed:

(a) To gain a foothold, industry in developing countries should concentrate on specific industries and develop niche markets, in order to acquire, as far as possible, specialized skills without dispersing resources;

(b) Industry should be encouraged to advise on how to proceed, since industry would not participate in something that did not hold out the prospect of financial benefit;

(c) The involvement of major industries would often mean opening possibilities for numerous small companies working downstream and acting as parts or service suppliers;

(d) Regional or global projects, such as regional thematic initiatives, generally had good prospects of being funded by Governments and international bodies, thus presenting opportunities for local industry to perform a part of the task on a commercial basis;

(e) Companies and agencies in developing and developed countries should actively seek opportunities to meet and open the way for cooperative ventures;

(f) Technology transfer meant increasing the knowledge of people, and hence training and hands-on activities;

(g) Creating a market meant educating the users, which could in turn lead to very interesting opportunities.

86. Issues specifically relating to the responsibilities and roles of senior management in institutions and policy makers in Governments were as follows:

(a) Ensuring that long-term commitments would be honoured;

(b) The limitation and alleviation of regulations concerning technology transfer;

(c) The possibility of promoting exports, based on some initial elements of technology, and starting local production with national funding;

(d) The use of fair pricing policies.

87. The actual strengths of the developing countries should be fairly recognized as appropriate, and criteria for partnership selection should be technical and financial only.

88. Because of the commercial trend in the development of the telecommunications market and, at the same time, the need for continuing investment in scientific programmes endorsed by the Government, a national space plan should aim at developing scientific applications and at deregulating the telecommunications market as a commercial activity. In both areas, commitments with other countries were required to make the system work.

89. International organizations might provide very important support, not only in financial terms, but also in arranging opportunities to meet and advise on building cooperative endeavours.

90. Managers and policy makers in developing countries often proposed measures to be taken nationally, but national priorities in most cases did not allow funds to be made available. International agencies could help by providing a small part of the funds (for example, 2 per cent) required to encourage national investment and allow progress to be made.

91. A proposal had been made for the creation of a specific international body that would screen, develop and provide some sort of technical and political support to space projects, by fostering cooperation among the three main actors: international entities, industry and national authorities.

92. Similarly, international bodies had been urged to encourage cooperation with regional space organizations, in particular those serving African and Arab countries, with the aim of providing international support to foster regional cooperation and stimulate efficiency and effectiveness.

93. When referring to developing countries in the context of space technology applications, a distinction should be made between emerging space countries and countries that had not yet started or were not yet involved in any space programmes, but wished to do so. Since the level of development varied enormously from one developing country to another, cooperation with developing countries should also be varied to meet their specific needs.

94. Governments that became aware of the benefits to be derived from space technology applications were more likely to find ways to remove bureaucratic bottlenecks that impeded international cooperation and commercial ventures. Some participants in decision-making positions noted that it would be useful to make available a document outlining the advantages of, and the necessary working procedures for, the utilization of space technology applications tailored to the needs of developing countries at various levels of development.

Notes

[1]See *Report of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 9-21 August 1982* (A/CONF.101/10 and Corr.1 and 2), para. 430.

[2]*Official Records of the General Assembly, Fifty-first Session, Supplement No. 20* (A/51/20), para. 37.

[3]George Ojalehto and Henry Hertzfeld, “Space spending balance shifts in 1996”, *Aerospace America*, July 1997.