UNITED
NATIONS

A

General Assembly

Distr.
GENERAL

A/AC.105/611
2 November 1995

ORIGINAL: ENGLISH

COMMITTEE ON THE PEACEFUL
USES OF OUTER SPACE

MICROSATELLITES AND SMALL SATELLITES: CURRENT PROJECTS AND FUTURE PERSPECTIVES FOR INTERNATIONAL COOPERATION

Note by the Secretariat

1. The Working Group of the Whole to Evaluate the Implementation of the Recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82), at its eighth session (A/AC.105/571, annex II, para. 17), proposed that several studies on space applications should be undertaken by the Office for Outer Space Affairs in view of the recommendations adopted at the workshops, seminars, symposia and conferences organized by the United Nations Programme on Space Applications. The Working Group of the Whole identified a number of possible subjects for such studies, including microsatellites and small satellites, current projects and future perspectives for international cooperation.

2. The report of the Working Group of the Whole was adopted by the Scientific and Technical Subcommittee at its thirty-first session (A/AC.105/571, para. 22), and the recommendations contained therein were endorsed by the Committee on the Peaceful Uses of Outer Space in its report on the work of its thirty-seventh session [1] and by the General Assembly in its resolution 49/34 of 9 December 1994.

3. The present study has been prepared by the Secretariat in response to the request of the Working Group of the Whole. The study, which is available in English only, is presented in the annex to the present note. The purpose of the study was to give an overview of the rapidly evolving field of small satellites, which should be easily accessible even to countries with limited or newly conceived space programmes. The study was prepared using a variety of national and international sources that are listed in the selected bibliography at the end of the study. It was also sent in draft form to external experts for comments. A summary of the study is provided below.

V.95-58817T

SUMMARY OF THE STUDY

4. Small satellites have already been used with considerable success by many organizations. Their attraction lies in the promise of low-cost and short development time, which is made possible by the use of proven standard equipment and techniques, together with a realistic expectation of performance. The space age began with the launching of small scientific satellites in 1958, the International Geophysical Year. Those satellites were small because of the limited capacity of the first space launchers. After a modest beginning with small, simple and lightweight satellites, space systems evolved into large, complex and expensive space platforms for scientific research and other applications that often require many years of development prior to launch.

5. While such large platforms exist and will continue to exist, there has recently been a growing interest in returning to the use of small satellites, which can be launched within a few years after programme initiation. As a consequence of the evolution of space-related technologies, this class of spacecraft can make significant space capabilities accessible to a wide number of users, ranging from students in secondary schools and universities to engineers and scientists in every country in the world. In many ways, projects involving small satellites are ideal for extensive international cooperation.

6. The development of small satellites will not replace that of large satellites, as the goals and issues involved are often different. Missions involving small satellites can, however, be a complement to large satellite missions. By exploring new methods and techniques, small satellites can be a tool for pioneering experiments and technologies for future missions involving larger satellites.

7. Small satellites have several advantages over large satellites and these hold true no matter who the users are: more frequent, and a larger variety of, mission opportunities; more rapid expansion of the technical knowledge base; greater involvement of local industry; and greater diversification of potential users. Moreover, even a country with a modest research budget and little or no experience with space technology can afford to participate in missions involving small satellites. Small satellites also offer excellent opportunities for training students, engineers and scientists in different disciplines, including engineering, software development for computers on board and on the ground and management of sophisticated technical programmes.

8. Recent technological progress in many areas means that small satellites can offer services previously only available from much larger satellites. Fairly sophisticated scientific and technological experiments, as well as application missions, can be flown in space at modest costs. The areas of application include: space physics, astronomy, astrophysics, technology demonstrations, communications experiments and acquisition of Earth resource data, including disaster information.

9. The definition of a small satellite varies, but an upper limit of about 400 kg (in exceptional cases 500 kg) is usually adopted, within which there are two main categories: small satellites (or minisatellites), which weigh about 100-400 kg; and microsatellites, which weigh less than 100 kg. A typical "small satellite mission", including launch, generally costs less than US$ 20 million and most microsatellite projects cost approximately US$ 3 million.

10. A central issue in any small satellite mission is the optimum balance between programme complexity and risk. Small satellites are likely to offer new opportunities for procurement methods. The selected model philosophies are important in terms of both risk and cost and, as a maximum, a protoflight approach is acceptable for such programmes. The advantages of small satellites are as follows:

(a) Orbital parameters optimized to individual instrument requirements;

(b) Augmentation of conventional satellite programmes, such as additional capability, redundancy for critical missions, or replacement of a failed instrument;

(c) Missions with limited lifetime and/or coverage requirements;

(d) Improved responsiveness to the end-user (more frequent launch opportunities and increased mission flexibility for individual instruments, plus schedule independence);

(e) Quick-reaction, launch-on-demand launches using low-cost dedicated vehicles (e.g. crisis monitoring, replacement after an in-orbit failure, or monitoring of unexpected environmental conditions);

(f) Relaxed reliability owing to the shorter lifetime or agreed, lower levels of product assurance or lower-quality parts as appropriate to lower development costs;

(g) Reduced satellite design complexity (e.g. simplified interfaces, optimized for instrument requirements), shorter development schedule and suitable test-bed for proving technique and/or technology.

11. There are three general classes of orbit that may be suitable for small satellites: the geostationary orbit (GSO), the highly elliptical orbit (HEO) and the low Earth orbit (LEO).

12. GSO is where the satellite appears fixed relative to the ground, thus allowing continuous visibility and simplifying the ground segment and operational requirements. Because of the large space-to-ground distance involved, however, the data rates are small, or larger ground antennas and higher electrical power on board the spacecraft are required. This orbit is usually reached from a standard geostationary transfer orbit (GTO) provided by a large launch vehicle.

13. The use of GTO is interesting as it could benefit from frequent piggyback launch opportunities while avoiding the complexity and extra costs associated with an apogee propulsion system.

14. LEO is generally preferred for small satellite missions. Small launch vehicles may be used, offering flexibility in the selection of the orbit parameters; piggyback launches may also be used. A low-energy transmitter on board is sufficient because of the short distance from the ground, but infrequent and short visibility periods are a drawback, leading to some ground-segment and operational complexity. A distinction should be made between the near equatorial or low inclination orbits, for which the visibility zone will be limited to the topical zone, and the polar and quasi-polar (Sun-synchronous) orbits that allow accessibility to any point on Earth, either for communication (e.g. store and forward) or for remote sensing of Earth.

15. The current and future development of small satellites is closely linked to the appearance of new, low-cost launchers (Pegasus, Taurus etc.) and lower-cost launch opportunities on existing vehicles (for example, Ariane-4 or small canisters on the Space Shuttle). The potential availability of cheap launchers has spurred much of the recent surge of interest in small satellites, which was initially driven largely by defence and global civil communication programmes of the United States of America. Of the major low-cost launchers of European countries and the United States, only Pegasus and Taurus are flight-proven. Conestoga is planned for flight in the near future, development of the Italian San Marco Scout has not yet started (although its forerunner, the United States Scout, has been operated for many years) and the Ariane-5 derivative programme should be completed in 1999.

16. In order to maximize their potential, small launcher developers must apply the same innovative, low-cost design approach used on small satellites. Launch costs represent a large portion of total programme costs (generally over 25 per cent) and satellite mass and size must therefore be constrained to take full advantage of low-cost launch opportunities. Options include:

(a) Small dedicated launchers;

(b) Multiple launch of several small satellites, nominally on Ariane-4 or Ariane-5 for European missions (e.g. Cluster scientific satellites of the European Space Agency (ESA));

(c) Flight opportunities on larger launchers (Arianespace has strongly promoted its vehicles for this purpose, with Ariane-4 offering: Ariane Structure for Auxiliary Payloads (ASAP) for piggyback microsatellites (up to six 50 kg satellites (300 kg total)); Ariane Radioamateur Satellite Enseignement Espace (ARSENE)-type configuration for satellites of up to 200 kg; and SPELDA Dedicated Satellite (SDS) for satellites in the range of 400-800 kg within the short Ariane Dual Launch External Bearing Structure (SPELDA) adapter.

17. Similar options are provided by other medium-sized or large launchers, for example, the United States Atlas Centaur and the Delta-2.

18. Requirements for the ground segment of a small satellite system vary enormously depending on the application area. At one extreme, low data rate sensors with only local or regional coverage on missions with low tracking and command requirements impose relatively low demands on the ground segment, possibly comprising only 10 per cent or less of total programme costs. More complex data retrieval and processing requirements could result in ground segment costs of up to 50 per cent of total programme costs. Assuming that ground segment costs tend to average 25 per cent of total programme costs, it is clearly important to identify potential savings in the ground segment in concert with those of the space segment.

19. In attempting to reduce the ground segment costs, there are limits on simplification because it is still necessary to ensure the achievement of capabilities such as reliable operation, rapid response to critical commands and regular form of data on time and with low loss. The ground segment model, which forms the basis of any technical and cost assessments, must include not just the provision of the ground stations, but also ground communications infrastructure, mission control etc. Very small, in some cases transportable, stations have been made commercially available by several suppliers in European countries and in the United States. Commercial providers of remote sensing data are likely to press for the adoption of such approaches in attempts to reduce the cost of distributing and processing the data.

20. Space science activities are obviously valuable, and most space-faring nations have begun their involvement in this field with small scientific satellites. A university environment is often an ideal environment for the development of space activities and, because such projects often require the creation of new laboratories, these facilities are a lasting, beneficial by-product of such projects. Thus the usual spin-offs of a space programme, the acquisition of technology and the development of industrial organization and management methods, will begin to accumulate at the national level as students leave the university and enter local industry.

21. The first small scientific satellite of Argentina will be the Scientific Applications Satellite (SAC-B), which is being developed jointly by its national space agency, the National Commission for Space Activities (CONAE), and the National Aeronautics and Space Administration (NASA) of the United States. The 190 kg satellite is to be launched in 1996 by a Pegasus rocket into a circular orbit of 550 km with an inclination of 37 degrees. SAC-B will be inertially stabilized and permanently oriented to the Sun. It will monitor energetic X-rays from solar flares and survey the sky with X-ray charge-coupled device (CCD) sensors along an axis perpendicular to the Sun line.

22. Between 1978 and 1991, scientific microsatellites weighing 15-50 kg were developed for the Magnetosphere-Ionosphere (MAGION) research programme in the former Czechoslovakia. MAGION-1 was launched on 24 October 1978 as a subsatellite of the INTERCOSMOS-18 geophysical satellite. Although it was designed for an operational lifetime of three weeks, MAGION-1 remained operational for three years. MAGION-2 and MAGION-3 were launched into high-inclination low-eccentricity orbits (with an altitude of 500-3,200 km) as part of the ACTIVE and Ariane Passengers Experiment (APEX) mother-daughter active space missions launched on 28 September 1989 and on 18 December 1991, respectively. The MAGION-4 subsatellite was successfully launched by a Molniya launcher from the cosmodrome at Plesetsk, Russian Federation, on 3 August 1995, as part of the INTERBALL-tail mission. MAGION-5 is currently scheduled for a 1996 launch.

23. The Central European Satellite for Advanced Research (CESAR) is a spacecraft of about 300 kg that will fly in an orbit with a perigee of 400 km, an apogee of 1,000 km and an inclination of 70 degrees. The scientific mission

is related to the study of the magnetosphere, ionosphere and thermosphere of Earth. Ten different experiments, provided by scientists from Austria, Czech Republic, Hungary, Poland and Slovakia, will be accommodated on the spacecraft, which is being funded by the Italian Space Agency (ASI) and designed by Alenia Spazio. This mission is one of the objectives of the cooperation among the countries of the Central European Initiative.

24. Space industry and research institutions in Finland have acquired experience in satellite payloads and instrumentation through their associate membership in ESA and have long been active in remote sensing and other space-related disciplines. To initiate a study of a Finnish small satellite (FS-1), Finnish institutes defined their interests by contacting selected institutes with an unofficial announcement of opportunity and by asking for proposals. After the proposal phase, system design was performed for two alternatives: a scientific satellite and an Earth observation satellite. Each satellite would contain a technology demonstration package in which new electronic components would be tested in the space environment.

25. The French National Centre for Space Studies (CNES) is currently considering the following small scientific satellites:

(a) Mission SAMBA: registration of the local fluctuations of 3 kelvin radiation from the big bang (similar to the Cosmic Background Explorer (COBE) satellite of the United States) and detailed measurement of possible anisotropies;

(b) Mission COROT: astroseismology, new data on the convection and internal rotation of stars by long-term measurement of stellar oscillations;

(c) Mission IBIZA: registration of the plasma accelerated in the geomagnetic auroral regions, interaction of ionized particles with the ionosphere and magnetosphere of Earth, creation of electromagnetic disturbances;

(d) QUICK-STEP: verification of the equivalence of the inertial and gravitational mass (theory of relativity) with a relative precision of 10^{-17}.

26. On 3 February 1994, the small satellite of the University of Bremen, BREMSAT, was carried into orbit by the United States Space Shuttle Discovery. The spacecraft, which weighed 63 kg, waited six days in its Get Away Special (GAS) container before it was deployed into its initial circular orbit of 350 km. The satellite carried six experiments with different scientific objectives, including heat conductivity under microgravity, micrometeorite and dust particle distribution, atmospheric atomic oxygen mapping and re-entry pressures and temperatures. The satellite functioned until its in-orbit decay on 12 February 1995.

27. In developing its indigenous launching capacity, India prepared a series of small technology development and scientific satellites called Rohini and the Stretched Rohini Scientific Satellite (SROSS) series. The Rohini satellites were launched between 1980 and 1983 and carried a landmark sensor payload including a solid state camera. More than 2,500 frames in both visible and infrared bands for identification of landmarks and altitude and orbit refinement were obtained. The orbital mass of the Rohini satellites was about 42 kg.

28. SROSS-C and SROSS-C2 were launched on 20 May 1992 and 4 May 1994, respectively. They each carry two scientific payloads. The first is the retarding potential analyser, consisting of two planar detectors to measure plasma parameters and to investigate the energetic structure of the equatorial ionosphere. The second is the gamma-ray burst experiment, consisting of two scintillation detectors to study celestial gamma-ray bursts in the energy range of 20-3,000 kilo-electronvolts.

29. The Instituto Nacional de Tecnica Aeroespacial (INTA) of Spain, situated at Torrejón de Ardoz, has been entrusted by the Government with the direction of a research project for the development of a Spanish space system, called MINISAT. The system will consist of a multi-purpose platform (service module), payload module and an associated ground segment. Both the platform and the subsystems comprising it are modular in character. The

platform will be capable of receiving, integrating, operating and carrying on board a payload module by means of standard interfaces. This will permit all the required adaptations for a particular mission to be easily conducted. The platform will be able to carry payloads with masses that vary between 80 and 500 kg. The first of these satellites will be a MINISAT mission carrying a payload module (PLM-1).

30. The first Swedish-built satellite was the 283 kg Viking, which was launched into low polar orbit in 1986 in a piggyback configuration with the French remote sensing satellite, satellite pour l'observation de la Terre (SPOT). The scientific objective of the Viking satellite was to study ionospheric and magnetospheric phenomena at high geomagnetic latitudes in the altitude region of up to about two Earth radii. Simultaneous measurements were made of electric and magnetic fields, particle distributions, plasma composition and waves, as well as imaging in the ultraviolet of the aurora variations.

31. A more advanced small scientific satellite, called Freja, was launched on 6 October 1992 by a Chinese launcher. This satellite of 214 kg is designed for auroral research and other related magnetospheric phenomena.

32. Because Swedish magnetospheric scientists are very interested in the possibilities of small satellites, a compact satellite platform has been developed that is 10 per cent of the mass of the Freja. This new microsatellite, called Astrid, is shaped like a box with sides measuring approximately 50 x 50 cm and has a mass of 25 kg in its stowed configuration. It is spin-stabilized with a Sun-pointing capability and deployable solar panels. The first Astrid was launched on 24 January 1995 from the cosmodrome at Plesetsk on a Cosmos launcher.

33. The best example of the small satellite programmes in the United States is the NASA Small Explorer (SMEX) programme, which provides for frequent flight opportunities for highly focused and relatively inexpensive science missions. Each SMEX spacecraft weighs approximately 250 kg and each mission is expected to cost approximately US$ 50 million for design, development and 30 days of in-orbit operations. The first satellite of this series, the Solar, Anomalous and Magnetospheric Particle Explorer (SAMPEX), was launched on 3 July 1992. It has been successfully investigating the composition of local interstellar matter and solar material and the transport of magnetospheric charged particles into the atmosphere of Earth. The Submillimeter-Wave Astronomy Satellite (SWAS) is to be launched on a Pegasus rocket in 1995 or 1996.

34. Probably the most experienced research unit in the field of microsatellites is the Spacecraft Engineering Research Unit at the University of Surrey in the United Kingdom of Great Britain and Northern Ireland. Since 1981, UOSAT and, more recently, the Surrey Satellite Technology Limited (SSTL) team have logged over 25 orbit-years of microsatellite operations. A total of 10 University of Surrey Satellite Project (UOSAT) satellites were launched between 1981 and 1993. The operational microsatellite S-80/T, which is based upon the UOSAT platform, was launched in August 1992 with a mission objective to explore communication possibilities of the very high frequency World Administrative Radio Conference (WARC-92) bands allocated to non-geostationary satellite systems. The initial mission objective has been successfully achieved. S-80/T completed its first operational year in October 1993 while continuing its flawless functioning. Amateur satellites of the UOSAT series are capable of transmitting images of the surface of Earth, as well as meteorological data.

35. The latest additions to the UOSAT family are a Portuguese satellite (POSAT-1), HEALTHSAT-2 and KITSAT-2, which were launched together in September 1993 aboard Ariane V-59, together with the SPOT-3 commercial remote sensing satellite. POSAT is the result of close cooperation between SSTL Satellite and a Portuguese industrial consortium. KITSAT-2 was built in the Republic of Korea by engineers trained by SSTL. Its platform retains many similarities with S-80/T and KITSAT-1 (launched in August 1992), while some payloads have been developed by engineers of the Republic of Korea.

36. On 9 February 1993, a Pegasus launcher launched the first Brazilian data collection satellite (SCD-1) with an inclination of 25 degrees and an altitude of 750 km. SCD-1, designed and built by the Brazilian National Institute for Space Research (INPE) is a small spin-stabilized satellite dedicated to the collection and distribution of environmental data acquired and emitted by data-collecting platforms over Brazilian territory. Since its launching,

SCD-1 has been performing excellently. SCD-2, which is very similar to SCD-1, is now in the final integration stage; it is to be launched early in 1996.

37. The first satellite of an Italian data collection satellite series called the Telespazio Micro Satellite (TEMISAT) was launched by a Russian Tsiklon launcher from the cosmodrome at Plesetsk on 31 August 1993, together with a Meteor-2 satellite. The satellite is orbiting the Earth at an altitude of 950 km and with an inclination of 82.5 degrees and an orbital eccentricity of less than 0.0001. A second unit (TEMI SAT-2) was manufactured together with the first one; it is stored on the ground and could be launched to increase the in-orbit service capacity.

38. Applied to Earth observation missions, small satellites can be utilized independently to fulfil the function of specific payload instruments. Several can be flown in a constellation to replace or augment the functions of a larger multi-instrumented satellite. Small satellites will not entirely replace such large platforms, which offer both financial and scientific benefits, such as economies of scale and synergy of measurements. In addition, large satellites are essential where specific instruments must be large enough to achieve their mission objectives with high power and very high data rates (e.g. depending on the size of radar antenna or optical performance on aperture and focal length).

39. Potentially suitable Earth observation missions for small satellites include: global ocean sampling (by a constellation of satellites); geophysical sampling (by a single satellite in polar orbit); ocean and coastal zone colour monitoring; single instrument payload in support of larger missions, commercial mapping and land surveys; crisis and/or disaster monitoring (e.g. floods, forest fires, oil spills), launched on demand or into a constellation; and vegetation monitoring for agriculture and forestry.

40. The recurrent orbit Earth observation satellite project of Japan provides an example of a small satellite that is being used for remote sensing purposes. By using a recurrent orbit (with a repeating ground track every fifteenth revolution), the observation frequency of the area is greatly improved. This is the origin of the Domestic Urban Area Observation Satellite (DUOS) concept.

41. The DUOS system is based on the Optical Intersatellite Communications Engineering Test Satellite, which is currently scheduled to be launched by the J-1 in 1998. It will have a three-axis stabilized bus with two panels of solar arrays and batteries. Within the given mass limit, the satellite could carry the Visible and Near Infrared Radiometer and a thermal infrared radiometer.

42. The long-term goal of the Technical University of Berlin Satellite (TUBSAT) programme is the development of a three-axis stabilized observation platform that can be autonomously oriented to any desired direction with arc minute accuracy. Of primary interest is the remote sensing of Earth, so that precise stabilization is required both for observation and for a high data transmission rate to permit real-time or almost real-time reception of the pictures. These goals are being approached in several steps.

43. Based on the orbital experience of TUBSAT-A and TUBSAT-B, launched in 1991 and 1994, respectively, instrumentation of the third spacecraft will also include three fibre optic laser gyroscopes. A preliminary structure of TUBSAT-C has already been manufactured and is being used for three-axis air bearing experiments.

44. The pre-operational Fire Reconnaissance System (FIRES), recently studied in Germany, will demonstrate the feasibility and usefulness of a future operational small satellite system for fire reconnaissance. It is anticipated to be of use not only for pure detection of a fire event in large areas, but also for its ability to locate the fire, assess the extent (in space and time) and type of the fire and provide this information to local authorities in a timely manner. In addition to this primary task, the system should be able to solve secondary problems such as assessment of vegetation damage, assessment of atmospheric pollution and evaluation of the revitalization of burned areas. Furthermore, when the satellite is not over vegetated areas, its sensor system can contribute to other remote sensing tasks related to high temperature detection.

45. A satellite health network has been proposed for western Africa by a non-profit agency in the United States, Volunteers in Technology Assistance, using a constellation of small LEO communication satellites to link regional medical centres with village clinics and mobile health teams. Where it would be more economical to do so, two-way radio-telephones would be used to link villages or mobile units to local clinics, which in turn would be linked to a regional centre via satellite. It has been estimated that 10 microsatellites could be built and launched for about US$ 21 million, while about US$ 30 million would be required for the medical facilities and the Earth station network. Such a system could dramatically improve the access of rural people to good medical care. If successful, the experiment would serve as a model for other remote regions.

46. The recent availability of relatively low-cost launch opportunities has made it conceivable for educational institutions to develop, manufacture, test and operate a small satellite. There is always an emphasis on the active participation of members of the university community (professors, students, postgraduates), which gives them invaluable practical experience with space technology and scientific research.

47. For example, the first Spanish microsatellite, UPM/SAT 1, with a mass of 47 kg, has been designed and manufactured by the Universidad Politécnica de Madrid. It is a low-cost platform with a moderately long operational life capable of future evolution. It was launched on 7 July 1995 as an auxiliary payload of the Ariane-40 rocket carrying the French Helios-1A satellite. The main experiment on the satellite comprises monitoring of the behaviour of a fluid configuration called liquid bridge in microgravity conditions. Developing a moderately complex design in a university environment should allow professors and students to get the experience necessary for more complex projects.

48. The Sunset satellite being developed by graduate students in electronic engineering at Stellenbosch University in South Africa is planned for launch early in 1996. It is a microsatellite weighing 50 kg that is compatible with an Ariane launcher and is capable of three-colour stereo imaging of Earth. Pictures can be transmitted in real time or stored on the satellite. The attitude of the satellite can be controlled within 1 milliradian. The communications package includes an S-band downlink and amateur radio store and forward communications with an audio repeater to stimulate radio interest among schoolchildren.

49. The opportunities for small and medium-sized countries to enter into space activities at a relevant level have, in the past, been limited. In the past decade, however, technological advances in materials and microelectronics, together with the experience gained, have allowed many significant space missions to be performed with small satellites. In recognition of the importance of this trend for international cooperation in outer space, the International Academy of Astronautics, at its meeting in August 1992, elevated the status of its subcommittee on small satellite programmes to the status of a full committee. At the same time, a new subcommittee on small satellites for developing nations was created under the auspices of the committee. It will act as a liaison with the Committee on the Peaceful Uses of Outer Space, the International Space University and the International Astronautical Federation, particularly with its Committee for Liaison with International Organizations and Developing Nations.

50. The long-term goals of the new subcommittee are to promote the use of small satellites for the benefit of developing countries. An assessment of these benefits is made on a regional basis, starting with the situation in Latin America. Each assessment is to be prepared during a workshop organized by the subcommittee with representatives of interested countries. The resulting reports will be published and will serve as a basis for further action. The first regional workshop was held at São José dos Campos, Brazil, on 20 to 23 June 1994 at the invitation of INPE.

51. The eventual success of small satellites and microsatellites is not considered to be in doubt; however, before the full potential of these emerging technologies can be realized, it will be necessary to radically rethink the way missions are specified, realized, funded and operated. The changing role of international cooperation to this effect should be further explored. Because of the diverse nature of both applications and instruments, their needs are unlikely to be met with a common small satellite bus design, but more intensive exchange of experience with different designs could eventually lead to some kind of standardization. The ability to adapt existing hardware readily and cheaply will also be a valuable economic asset for both manufacturer and user.

52. Among the main difficulties in promoting the use of small satellite technology for developing countries is the fact that the countries with established space programmes frequ ently do not understand the scope of problems within developing countries and that there is a lack of adequately trained local personnel. In this context, it would b e extremely valuable if the Committee on the Peaceful Uses of Outer Space would pay more attention to this issue. It is therefore pertinent that the theme fixed for special attention by the Scientific and Technical Subcommittee at its thirty-third session is "Utilization of microsatellites and small satellites for the expansion of low-cost activities, taking into account the special needs of developing countries".

53. Based on the results of its delibe rations on this special theme, as well as on recommendations contained in the present report, the Committee might propose some wa ys and means of ensuring substantial progress in international cooperation in this rapidly developing field. For example, it might recommend that one or more of the educational activities of the United Nations Programme on Space Applications should be devoted to the theme of microsatellites and small satellites.

Notes

[1]*Official Records of the General Assembly, Forty-ninth Session, Supplement No. 20* (A/49/20), para. 29.