The first version of the WMO Space Programme Implementation Plan was developed by the fourth session of the Consultative Meetings on High-level Policy on Satellite Matters (CM-4) in January 2004, and endorsed by the fifty-sixth session of the Executive Council (EC LVI).

The present second version incorporates an update on RARS requested by CM-5 and amendments on the IGDDS section proposed by the first session of the Expert Team on Satellite Utilization and Products (ET-SUP 1).

BACKGROUND

1. Cg-XIV agreed that the main thrust of the WMO Space Programme Long-term Strategy should be:

> "To make an increasing contribution to the development of the WWW GOS, as well as to the other WMO-supported Programmes and associated observing systems (such as AREP's GAW, GCOS, WCRP, HWR's WHYCOS and JCOMM's implementation of GOOS) through the provision of continuously improved data, products and services, from both operational and R&D satellites, and to facilitate and promote their wider availability and meaningful utilization around the globe."

PURPOSE AND SCOPE

2. The purpose of this Implementation Plan is to describe the implementation arrangements for the WMO Space Programme (WMOSP) for the 4-year period starting in January 2004.

3. The principal starting points for this implementation plan are:

- the 6th Long-Term Plan (6LTP);
- the WMOSP Long-term Strategy;
- the outcome of CM-5 and ET-SUP 1.

4. To aid traceability, the implementation arrangements are organized according to the eight elements of the WMOSP Long-term Strategy as contained in the 6LTP:

(a) Increased involvement of space agencies contributing, or with the potential to contribute to the space-based component of the GOS;

(b) Promotion of a wider awareness of the availability and utilization of data, products – and their importance at levels 1, 2, 3 or 4 - and services, including those from R & D satellites;

(c) Considerably more attention to be paid to the crucial problems connected with the assimilation of R&D and new operational data streams in nowcasting, numerical weather prediction systems, reanalysis projects,

monitoring climate change, chemical composition of the atmosphere, as well as the dominance of satellite data in some cases;

(d) Closer and more effective cooperation with relevant international bodies;

(e) Additional and continuing emphasis on education and training;

(f) Facilitation of the transition from research to operational systems;

(g) Improved integration of the space component of the various observing systems throughout WMO Programmes and WMO-supported Programmes;

(h) Increased cooperation amongst WMO Members to develop common basic tools for utilization of research, development and operational remote sensing systems.

5. Following a discussion of the implementation arrangements, the proposed WMO Space Programme Office, which could eventually coordinate and manage the implementation of the WMOSP, is described. However, until the necessary human resources have been identified and in place, a description of specific projects that should be implemented in the interim is also described.

6. Finally, based on a comparison between the resources available within the WMOSP budget and the activities proposed in this Implementation Plan, areas where contributions from space agencies would be most beneficial are identified.

IMPLEMENTATION ARRANGEMENTS

"Increased involvement of space agencies contributing, or with the potential to contribute to the space-based component of the GOS"

7. The increased involvement of space agencies will be primarily achieved through:

(a) the progressive enlargement of the space-based component of the GOS to include relevant R&D satellite operators;

(b) structured discussions on the future evolution of the space-based component GOS.

Enlargement of the space-based component of the GOS

8. R&D Space Agencies have been encouraged to participate in the space-based component of the GOS, provided that an R&D Space Agency:

(i) had the potential to contribute to WMO and supported programmes;

(ii) was willing to follow the relevant guidelines *(Guidelines for Requirements for Observational Data from Operational and R&D Satellite Missions)*.

9. Once WMO was satisfied that these two criteria were met, WMO would propose to CGMS that the particular R&D Space Agency be included as a full member of CGMS. The full CGMS membership of any satellite operator contributing to the space-based component of the GOS requires the agreement of all CGMS members.

10. WMO will, through its members, continue to provide CGMS satellite operators with operational and pre-operational evaluations of the benefits and impacts of their satellite systems. WMO would also act as a catalyst to foster direct user interactions with CGMS satellite operators through available means such as conferences, symposia and workshops.

Future Evolution of the Space-based Component of the GOS

11. All satellite operators (both meteorological and R&D), that are part of the space-based component of the GOS, will be expected to play a key role in the discussions on the future evolution of the space-based component of the GOS.

12. In this respect, it is recalled that the WMO/CBS/OPAG IOS Expert Team on Observational Data Requirements and Redesign of the Global Observing System (ET-ODRRGOS) has been tasked with the following activities:

- assessing the capability of present and planned observing systems to meet the observational requirements of all WMO programmes (Rolling Review of Requirements);
- making recommendations to the Commission for Basic Systems (CBS) of WMO on the "re-design" of the Global Observing System (GOS).

13. These activities are expected to have an important impact on the future evolution of the space-based component of the GOS.

14. Additionally, WMO has been involved in several key area themes within the IGOS Partnership. These themes are Atmospheric Chemistry, Global Water Cycle and Global Carbon Cycle. Guidance resulting from the process to develop the Theme Reports will be important to WMO structures, such as the Commission for Basic Systems and Commission for Hydrology. The WMO structures will utilize the guidance produced during the IGOS process. WMO's participation in the IGOS process is relevant to many WMO supported programmes and should be continued as part of the WMO Space Programme for those portions that are relevant.

15. Through the mechanisms of CGMS and the Consultative Meetings, satellite operators will have the opportunity to provide their views on the vision for the future evolution of the space-based component of the GOS. Of particular importance will be their assessment of the likely impact of future technological developments on the evolution of the space-based component of the GOS.

"Promotion of a wider awareness of the availability and utilization of data, products – and their importance at levels 1, 2, 3 or 4 - and services, including those from R & D satellites"

16. WMO will continue to make use of the following means to promote the wider awareness of the availability of data, products and services from satellite operators within space-based component of the GOS:

- user conferences, symposia and workshops;

- training events;
- WMO publications;
- WMO Space Programme web-site (with links, as appropriate, to the web-sites of satellite operators).

17. With the inclusion of R&D satellite operators within the observing system, it is appropriate to revisit the structure of the WMO Space Programme web-site to check that it meets the needs of the enlarged range of users that are expected to make use of the site.

18. As a starting point, the user categories of the web-site will be updated to reflect the enlarged scope of the observing system.

19. For each category of user, it will then be verified that the structure of the website provides an efficient framework for meeting their anticipated information requirements including, where appropriate, training opportunities.

20. Extensive use will continue to be made of links to satellite operator web-sites and it is envisaged that, where such links are utilized, a dialogue will take place with satellite operators to ensure consistency of data content and format.

"Considerably more attention to be paid to the crucial problems connected with the assimilation of R&D and new operational data streams in nowcasting, numerical weather prediction systems, reanalysis projects, monitoring climate change, chemical composition of the atmosphere, as well as the dominance of satellite data in some cases"

21. Currently, there are a number of fora where organizations that assimilate satellite data within environmental models can address data assimilations issues:

- regular bilateral meetings between satellite operators and environmental modelling entities;
- inter-regional fora (e.g., North America/Europe Data Exchange Meetings);
- the CBS Open Programme Area Groups on Information Systems and Services (ISS) and Integrated Observing System (IOS);
- CGMS standing working groups (e.g., International TOVS Working Group, Precipitation Working Group and the Winds Workshop):
  - International TOVS Study Conference (ITSC) - which is co-sponsored by WMO;
  - International Precipitation Working Group (IPWG) – which is co-sponsored by WMO.

22. These discussion frameworks tend to focus on operational satellite data streams and their assimilation within NWP, Nowcasting and Re-analysis models.

23. In order to increase the impact of satellite data, the challenge for the WMOSP in this area is to widen these discussion frameworks to place more emphasis on:

- assimilation issues relating to the use of both R&D and new operational data streams;
- the assimilation of satellite data in support of a broader range of environmental modelling applications (e.g., atmospheric, oceanographic, climatological).

24. In order to achieve this, the WMOSP will:

(a) act as a catalyst to encourage the systematic establishment of bi-lateral relationships between satellite operators and the environmental modelling entities who make use their data, or who have the potential to make use of their data;

(b) encourage environmental modelling entities to participate in the relevant fora with satellite operators;

(c) review the current participation and mandate of the relevant CGMS standing working groups and propose modifications, as appropriate, to ensure that there is a balanced participation from both environmental modelling entities and satellite operators.

25. The underlying objective behind all these activities will be to facilitate a structured dialogue between satellite operators and the environmental modellers who assimilate their data (or who would potentially benefit from assimilating it).

26. It should also be noted that some of the traditional problems associated with the assimilation of R&D data, and new operational data, should be solved/mitigated with the proposed introduction of an Integrated Global Data Dissemination Service (which is described in a subsequent section of this plan).

27. In particular, the introduction of this service is expected to mitigate some of the known problems with data timeliness, data availability and the lack of standardization in the area of data formats.

“Closer and more effective cooperation with relevant international bodies”

28. In order to promote closer and more effective cooperation with international bodies WMO will continue to place particular emphasis on its participation in:

- CGMS;
- Consultative Meetings.

29. These two fora, together with any subsidiary working groups, will play a central role in the coordination and implementation of the WMOSP, and in discussions on the future evolution of the space-based component of the GOS.

30. Concerning the implementation of the WMOSP, these two bodies are expected to play a fundamental role in coordinating and implementing the Integrated Global Data Dissemination Service, which is described in a subsequent section, and is one of the pillars of the WMOSP within the next four years.

31. In order to ensure the maximum degree of international alignment with the objectives of the WMOSP, WMO will continue to place considerable emphasis on its participation in CEOS and IGOS.

32. On a more technical level WMO will continue to participate in the Space Frequency Co-ordination Group (SFCG), International Precipitation Working Group and the International TOVs Working Group (ITWG).

"Additional and continuing emphasis on education and training"

Current Approach

33. The current WMO Strategy for Education and Training in Satellite Matters is firmly based upon the recommendations made in the final report of the WMO EC Panel of Experts on Satellites (March 1993) and endorsed by WMO EC in June 1993. The strategic goal outlined in 1993 was:

> "Systematically to improve the use of Satellite data for meteorological and hydrological applications over the next 10 years in all Member countries, with a focus on meeting the needs of the developing countries"

34. The three strategic objectives considered critical to the success of the strategy were identified as:

(i) To build on the existing infrastructure in a way which ensures that the timescale and manner in which initiatives for improving satellite data utilisation are introduced, are consistent with the capabilities of the users to absorb and sustain them independently in their own operational environment;

(ii) To focus on the developing countries, directing particular attention to systematically improving the level of expertise of instructors at all RMTCs in the utilisation of satellite data;

(iii) To anticipate future trends in satellite data applications and in education and training techniques, so that new developments can flow through to operational users quickly and efficiently.

35. The EC also noted its strong support for "*the proposal that each satellite operator or group of satellite operators participating in the space-based sub-system of the Global Observing System (GOS) cooperate with at least one of the specialized satellite applications training centres.*"

36. In order to meet these strategic directives the CGMS/WMO Virtual Laboratory for Education and Training in Satellite Meteorology (VL) has been developed. The VL, and its associated Focus Group, provides a coordinating mechanism between the training centres ("centres of excellence") and satellite operators and also encourages the sharing of resources between the various parties.

37. The core of the Virtual Laboratory is the Resource Library. Each "centre of excellence" has an internet connection to the Resource Library and thereby has access to a wide range of teaching resources such as: course material; lectures; keynote

presentations; imagery; software; publications, etc. This Resource Library acts as a place where comprehensive descriptions of available material (also known as resource Meta-data) is stored. This Meta-data allows effective cataloguing and searching for material which matches the requirements of students or trainers alike.

38. The eight "centres of excellence" for education and training consist of:

- six WMO Regional Meteorological Training Centres (RMTCs) in: Nanjing in China; Nairobi in Kenya; Niamey in Niger; San Jose in Costa Rica, Bridgetown in Barbados and Buenos-Aires in Argentina;
- the Bureau of Meteorology Training Centre (BMTC) in Melbourne Australia.
- the Sultan Qaboos University Remote Sensing GIS Centre in Muscat, Oman

39. The RMTCs in Nairobi and Niamey are sponsored by EUMETSAT, San Jose, Bridgetown and Buenos-Aires RMTCs by NOAA, Nanjing RMTC by CMA, Muscat by EUMETSAT and IMD, and BMTC Australia by JMA.

40. In addition to regular ongoing courses, each "centre of excellence", in conjunction with either its parent satellite operator, and/or WMO, also runs intensive short courses (approximately two weeks in duration) for staff from neighbouring countries specifically on satellite meteorology.

41. The funding for these courses is usually from either WMO or the satellite operator and the courses are notionally held in each "centre of excellence" every four years. Additionally, WMO is a CEOS Associate and could benefit from activities of the CEOS Working Group on Education, Training and Capacity Building.

42. Participants in WMO-funded training are selected on the basis that they will provide ongoing training within their own organization upon return from the training event (the "train the trainer concept"). Thus, the WMO-funded training events have a critical role in not only providing high quality training and resource material during the actual course, but also linking into ongoing resources such as the Virtual Resource Library (which is a component of the Virtual Laboratory) for the participant trainers to use within their countries on return from the event.

43. The WMO Space Programme Office has funding allocated to allow one training event every year for the next four years. Each training event currently involves about 20 participants from neighbouring countries and requires funding of the order of 80,000 CHF per event. WMO funding currently covers training in Costa Rica, Barbados, Nanjing and BMTC (Australia). EUMETSAT provides funding for the training events in the two African centres of Niamey and Nairobi on a yearly basis.

Limitations of the Current Approach

44. The following limitations have been identified with the current education and training approach:

- currently, no "centre of excellence" has offered any remote learning to neighbouring countries using tools such as VISITView;

- the current six “centres of excellence” cover four of the six official WMO languages (English, French, Spanish and Chinese), but do not cover Arabic or Russian. Geographically, Eastern Europe and the Western Asia section of WMO Region II are not covered by any of the existing “centres of excellence” and many of the NHMSs in these areas do not have the appropriate internal resources to provide their own satellite meteorology education and training programmes;
- there is a lack of any follow-up support and training for course participants (e.g., follow-up tutorials or discussion fora using the Internet and online collaboration using tools such as VISITView);
- some “centres of excellence” have a limited capability to download near real-time data (due to bandwidth limitations) which is necessary for training events, and there is a need to standardize on appropriate data formats and display and manipulation tools;
- the difficulty in locating training material distributed across a number of physical locations.

Future Implementation of the Education and Training Component of the WMOSP

45. The proposed future implementation of the education and training component of the WMOSP builds on the current education and training strategy and is driven by three main considerations:

- the need to address the identified limitations with the current education and training approach;
- the expansion of the space-based component of the GOS to include R&D satellites;
- the need to adapt the education and training approach to meet the changing needs of WMO Members.

46. With these considerations in mind the following specific implementation approach is proposed:

- Maintain the current education and training strategy, in particular the concepts of the satellite operator co-sponsored “centres of excellence”, and, the selection of course participants on the basis that they will acts as trainers within their own NHMS upon completion of the training event;
- Adapt the content of education and training events to reflect:
  - the needs of WMO Members (as expressed through their returns to the Rolling Review of Requirements);
  - the requirements of other WMO programmes for training on the use of satellite data and products;
  - the evolving capabilities of both R&D satellites and operational satellites within the Global Observing System;
  - the increased availability of data resulting from the proposed introduction of an Integrated Global Data Dissemination Service - where possible using the direct reception of this data within training events;

- the application areas relevant to the course participants (i.e., ensure that, in general, course content focuses on the application of satellite data and products to these application areas, including an appropriate mix of remote sensing, image interpretation theory and practice, incorporating the use of near real-time data as a positive reinforcement of how to use satellite data and products in a real time situation)
- feedback from participants on training events.

- Enhance the capabilities of the WMO Virtual Laboratory:
  - invite the R&D space agencies to participate in the WMO Virtual Laboratory Focus Group to create the necessary training material on the use of data from R&D satellites;
  - improve data access and introduce common formats and tools at "centres of excellence" to allow effective sharing of resource material and sessions between "centres of excellence";
  - develop a semi-automated indexing mechanism to enable subject-specific searches over multiple web sites;
  - hold a high-profile training event with the aim of increasing the effectiveness of the Virtual Laboratory.

- Enhance/increase the training opportunities offered by "centres of excellence":
  - Introduce a range of online follow-on/follow-up activities after each course hosted by a "centre of excellence" to allow consolidation and reinforcement of the course training material;
  - offer remote learning capabilities to neighbouring countries.

- Consider expanding the number of "centres of excellence" with the creation of additional centre(s) to cover Eastern Europe and the Western Asia section of Region II;

- Invite funding for additional training events (80,000 CHF/event) or co-sponsorship of additional "centres of excellence".

47. It is proposed that the enhancement of the WMO Virtual Laboratory is implemented as a specific WMOSP project.

"Facilitation of the Transition from Research to Operational Systems"

48. Recently, the spaced-based component of the GOS has evolved rapidly with the inclusion of R&D satellite operators. One of the main challenges arising out of this evolution is the management of the smooth transition between R&D and operational systems.

49. In order to facilitate the transition from research to operational systems, WMO will:

- promote awareness of the availability and potential uses of R&D satellite data and products (through user conferences, symposia, workshops, training events, the WMO Web-site and WMO publications);
- facilitate access to R&D satellite data and products to potential users;
- provide consolidated user feedback on the usefulness of R&D satellite data and products.

50. The inclusion of R&D satellite products and data within the proposed Integrated Global Data Dissemination Service will facilitate access to a large range of potential users. The introduction of this service will also help to remove some of the traditional barriers to the use of this type of data (e.g., timeliness and data format).

51. The provision, by WMO, of consolidated user feedback to R&D operators will take two forms:

- the fifty-fourth session of the WMO Executive Council (EC-LIV) has agreed that the *Report on the Utility of Existing R&D Satellite Data from the Operational User Community* be prepared on a biennial basis;
- two regional workshops will be organised within a four year period to identify those R&D datasets that have had an operational impact and therefore merit an operational status.

52. Any WMO proposals for an R&D system that should be transformed into an operational system will also be discussed within the CGMS, as well as by the Consultative Meetings.

53. The next candidate for transformation to an operational system is likely to be an oceanographic mission, as the agreement to launch JASON-2 will secure the continuation of the valuable altimeter data provided by JASON-1.

"Improved integration of the space component of the various observing systems throughout WMO Programmes and WMO-supported Programmes"

54. Three areas have been identified where improved integration of the space-based component of the GOS would provide considerable benefits:

- Overall design of the space-based component of the GOS;
- Integrated Global Data Dissemination;
- Contingency Planning.

Overall Design of the Space-based Component of the GOS

55. One of the pre-requisites for optimizing the overall design of the space-based component of the GOS is the availability of a consolidated system-wide view of the observational requirements, together with the appropriate traces to the existing/planned observing systems that meet, or will meet, these requirements. From this consolidated viewpoint it is then possible to identify potential areas of duplication, and areas where the observing system needs further strengthening.

56. The WMO/CEOS database is a tool which provides such a view, and emphasis will be placed on maintaining this tool and using it to propose areas where the overall design of the observing system could be further improved or optimised.

57. Currently, three issues have been identified where the design of the space-based component of the Global Observing System could be optimised to better meet WMO observational requirements:

- equator crossing times for polar orbiting satellites;
- positions of geostationary satellites;
- satellite instrumentation.

58. Concerning equator crossing times, the WMO requirement is for four optimally-spaced satellites to provide global coverage. The current plans of satellite operators will result in an uneven distribution of equator crossing times, which in turn means that it will not be possible to achieve global coverage. Therefore, it is proposed that WMO, acting within the framework of the CGMS and the Consultative Meetings, works with satellite operators to adjust their planning so as to meet the WMO requirement of optimal global coverage.

59. Regarding the position of geostationary satellites, the WMO requirement is for the availability of at least 6 satellites, near equally spaced around the equator. Whilst currently not quite equally spaced, the coverage provide by the geostationary satellites is felt to be adequate to meet WMO's observational requirements. WMO, with the help of CGMS, will continue to monitor the situation and make recommendations, as appropriate to further harmonise the coverage around the equator.

60. Although the geostationary coverage is generally satisfactory, the current plans of satellite operators over the Indian Ocean may result in five geostationary satellites being located in this region by 2005 (Meteosat, KALPANA, GOMS N-2, FY-2 and GIFTS). This issue will be addressed within the framework of CGMS with aim of optimizing the coverage in this area and ensuring that no frequency interference problems are likely to arise.

61. A preliminary analysis of the instrument complement of geostationary satellites has identified issues of homogeneity in the performance of these instruments. In order to achieve a more uniform observational capability across the geostationary satellite systems, it is proposed that WMO, through CGMS and the Consultative Meetings, initiate a debate on a suggested baseline complement for instruments, together with their expected performance.

Integrated Global Data Dissemination Service

62. Bearing in mind the requirement for cost-optimized access to meteorological data/products, and the planned increases in associated data volumes, the concept of Advanced Dissemination Methods (ADM) has been developed.

63. With this approach, access to satellite data and products by WMO Members would be through a composite system consisting of both Direct Broadcast (DB) from meteorological satellite systems and ADM. ADM would be the baseline while DB

reception would serve as a limited backup, as well as for those WMO Members unable to take advantage of the ADM service.

64. As the composition of the space-based Global Observing System evolves, the ADM concept will allow for the seamless inclusion of data/product sets from polar and geostationary operational satellites, as well as from relevant R&D environmental satellites. It is expected that the most demanding application utilizing this composite service would be NWP, and that NWP requirements could thus be taken as a benchmark for sizing the data communications infrastructure.

65. The advantages of the ADM approach include:

- Scalability – the communications infrastructure can be progressively upgraded to match the planned increase in data volumes;
- Accessibility – the availability of standard user terminals, which make data access affordable for a larger number of users. This greater accessibility could also alleviate the need for the internal redistribution of very large volumes of data;
- Flexibility – because of the separation of the observing satellite and the dissemination platform the dissemination scheme can be modified/enhanced without impact on the observational satellite. For example, it would allow the seamless addition of data and products from the relevant R&D environmental satellites to complement the existing operational data and products;
- Transition planning – the transition between different generations of observing satellites will be facilitated as the same user terminals could be utilised for both generations;
- Robustness - in the event of contingencies on observing system satellites the ADM component would be unaffected in the event of problems with the DB components of the observing system satellites;
- Extension of observing system satellite lifetimes – in some cases the lifetime of observing system satellites is constrained by inclination limits associated with direct broadcasting. As ADM would be the prime dissemination mechanism, in such cases, the useful lifetime of the observing system satellite could be extended.

66. Several satellite operators have implemented, or have plans to implement ADM. For the time being the most advanced implementation appears to be EUMETCast by EUMETSAT. EUMETCast already disseminates data from polar and geostationary satellites, as well as from other meteorological data sources. By using K_u- and C-band, DVB services provide a dissemination service at very reasonable cost to both EUMETSAT and the users.

67. In order to ensure that these initiatives result in a dissemination system that is optimized with respect to the needs of the global user community, it is appropriate to consider the possible shape of an Integrated Global Data Dissemination Service; which builds upon this ADM concept.

68. Indeed, the creation of an Integrated Global Data Dissemination Service is central to the vision of an integrated space-based component of the GOS, as it will facilitate the access, in a seamless manner, to the complete range of data and products from this component of the GOS.

69. It is envisaged that the Integrated Global Data Dissemination Service would be constructed from dissemination services provided in four discrete dissemination service areas which, taken together, would provide an integrated data dissemination service to all WMO members around the globe.

70. To minimize data exchange and data dissemination volume requirements, it is proposed that each dissemination service area be delineated by a longitude band; with the longitude band centred close to the orbital position of an operational geostationary meteorological spacecraft.

71. A starting point for the configuration of a four dissemination service area system could be:

Dissemination Service Area	**Approximate Centre of Service Area**
Europe, Africa and East Atlantic	0°
Western Atlantic, North-America, South America and Eastern Pacific	90° W
Eastern Asia, Australia and Western Pacific	120° E
Western Asia and Indian Ocean	76° E

72. In order to cope with the future data volume requirements, and the geographical distribution requirements, it is expected that data dissemination service providers would predominantly make use of commercial communications satellites for dissemination, augmented as appropriate by terrestrial means (e.g., the Internet).

73. It is expected that the precise communications architecture used to provide a particular data dissemination service would depend on the availability of the communication services. Based on the current availability of commercial satellite communications services, it is unlikely that the dissemination requirements for a particular dissemination service area could be met by one communications satellite. Instead, in order to meet the coverage requirements, it is expected that the communications architecture would consist of a mosaic of satellite communications services, augmented, as appropriate, by terrestrial means (e.g., the Internet).

74. Because of this dependency on the availability of commercial services it would not be appropriate to be prescriptive concerning the precise longitude domains for each dissemination service area.

75. Instead it is proposed that, based on “expressions of interest from satellite operators” for providing dissemination services for all, or part of, one of the four dissemination service areas, the CGMS would be invited to:

- Identify the precise boundaries of the dissemination areas, considering that:
  - the coverage of each dissemination service should be consistent with the location of the primary user community of the operational geostationary meteorological satellites;
  - every WMO member should be adequately covered by an ADM service;
  - the boundaries of existing dissemination services need to be considered.

- Consolidate the data dissemination requirements in each dissemination service area, taking due account of:
  - the requirements for regional satellite observational data defined by the relevant WMO Regional Associations;
  - any other regional satellite observational data requirements for which a dissemination service is currently provided, or planned to be provided;
  - the WMO requirements for global satellite observational data;
  - any relevant obligations stemming from the WMO Information System (WIS) concept. For example, satellite operators providing a dissemination service may have to fulfil the role of a Data Collection or Product Centre (DCPC). The adoption of this role could have implications in the following areas:
    - catalogue/metadata standards to ensure catalogue interoperability;
    - protocols;
    - the inclusion within the dissemination scheme of regional observation data not derived from satellites (e.g. data currently broadcast via the GTS).

- Identify the Satellite Operator(s) that will provide the dissemination service for each dissemination service area, noting that within one dissemination service area, responsibility for providing the service may be shared between satellite operators or, indeed, one satellite operator may cover more than one service area.

- Based on the identified dissemination service area boundaries, the satellite operators who have opted to provide a dissemination service would then be responsible for:
  - acquiring and disseminating regional data;
  - exchanging global data with other operators of the integrated global data dissemination service.

- Define the global architecture of the four dissemination services that, taken together, constitute the Integrated Global Data Dissemination Service (including a description of the communications means by which each WMO member will receive data from the service).

- When defining the global architecture, it is considered essential that:

- the underlying requirement for standard, affordable user receptions stations is respected;
- a co-ordinated approach is taken to:
  - communication standards;
  - data format standards;
  - encryption mechanisms;
  - user station operating systems.

- Identify actions that will enable global networking so as to ensure the smooth exchange of data and products between dissemination service operators, noting that:
  - the requirements for data exchange are expected to be restricted to satellite data;
  - data ownership and data protection issues may need to be addressed.

- Produce an overall schedule for the introduction of the Integrated Global Data Dissemination Service.

76. Once these detailed implementation arrangements have been established by CGMS, progress towards the full introduction of the service would be monitored within both the CGMS and the Consultative Meetings.

77. It is proposed that the co-ordination of the design and implementation of an Integrated Global Data Dissemination Service is handled as a specific WMOSP project.

The IGDDS project should include the objective of co-ordinating and facilitating the establishment of a global network of Regional ATOVS Re-transmission Systems, with a particular focus on:

- inter-regional data exchange;
- standardisation in the areas of:
  - product processing software usage;
  - product formats;
  - quality-tagging of data;
  - service management.
- ensuring consistency with the IGDDS concept.

This objective will be achieved through the organization of RARS Workshops, together with technical coordination activities, including participation by WMO in the development phases for the various regional implementations in order to ensure consistency and compatibility when establishing inter-regional data exchanges, and coherence with the overall IGDDS.

Contingency Planning

78. Contingency planning is an essential element in the strategy for meeting the reliability and continuity requirements for the space-based component of the GOS at a realistic cost.

79. In order to optimize the use of the observing system resources, contingency planning needs to be carried out at two levels:

- regional contingency planning;
- global contingency planning.

80. Recently, the development of contingency plans has become more complex due to:

- the expansion of the space-based component of the GOS:
  - new WMO requirement for at least 6 GEO satellites;
  - new WMO requirement for at least 4 LEO satellites (2 am, 2 pm);
  - inclusion of R&D satellites which, by themselves require no contingency arrangements, but could form part of a back-up arrangement for an operational satellite;
  - the expectation that Jason-2 Ocean Surface Topography Mission will also become part of the space-based component of the GOS, and hence the Jason series will de facto provide an important oceanographic operational service – and hence contingency planning will need to be considered.

- the proposed introduction of an Integrated Global Data Dissemination Service, and the additional flexibility it introduces for contingency planning.

81. With the above considerations in mind WMO, with the help of CGMS, will co-ordinate this contingency planning effort with the aim of:

- ensuring the existence of appropriate regional contingency plans (preferably in a standardized format);
- creating two overarching global contingency plans:
  - a geostationary global contingency plan which is consistent with the regional geostationary contingency plans and, additionally, addresses possible inter-regional contingency arrangements;
  - a global contingency plan for polar orbiting spacecraft, which would take account of the possible contribution of R&D satellites.

82. It is proposed that the creation of the global contingency plans is implemented as a specific WMOSP project.

"Increased cooperation amongst WMO Members to develop common basic tools for utilization of research, development and operational remote sensing systems"

83. In order to promote the increased cooperation amongst WMO Members in the area of common, basic tools for remote sensing, WMO will:

- discuss with WMO Members their requirements for tools;
- initiate a dialogue with CGMS members to determine what basic tools could be made available to WMO Members and what related training could be provided;
- investigate the possibility of utilizing the Virtual Laboratory for Education and Training in Satellite Matters as a mechanism for making such tools available to WMO Members.

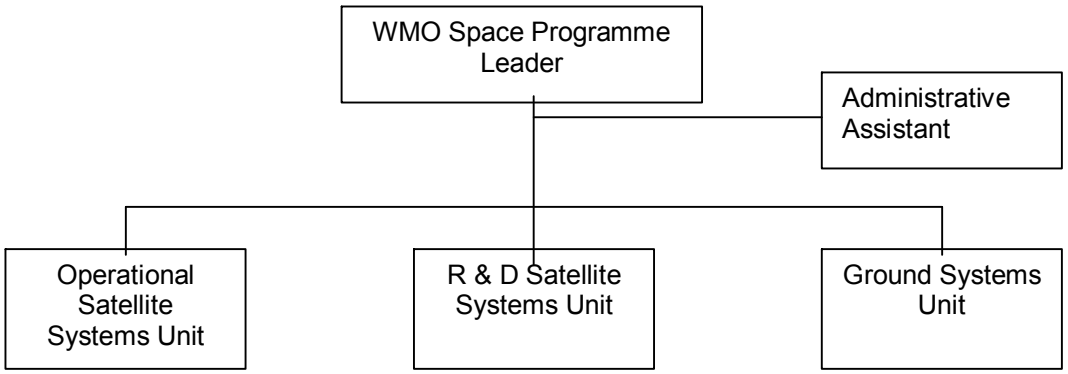
84. The incorporation of a core set of tools within the Virtual Laboratory would help to ensure that training on the use of these tools, where required, could be included within training events.

WMO SPACE PROGRAMME OFFICE

85. In order to ensure the successful implementation of the activities defined within this implementation plan, an appropriately sized and skilled WMO Space Programme Office is required.

86. When considering the appropriate shape and size of the programme office, it is important to recognize that a key component of the duties of this programme office will be internal coordination across WMO and supported programmes. The purpose of this internal coordination activity is to obtain a consolidated WMO position on all issues related to satellites.

87. Based on the activities proposed in this implementation plan, together with the need for internal coordination across WMO and supported programmes, the following structure is envisaged for the WMO Space Programme Office:



88The **WMO Space Programme Leader** will be responsible for:

coordination of the implementation of the WMO Space Programme;
supervision and coordination of all staff in the WMO Space Programme Office;
providing a single focal point, on satellite matters, for all WMO and supported programmes;

interactions with external satellite-related organizations (including CEOS, CGMS, IGOS, SFCG, IPWG, International Winds Workshops, ITWG and the Virtual Laboratory Focus Group);

89. **The Operational Satellite Systems Unit** will be led by a specialist in matters related to operational meteorological satellite systems. This specialist will be responsible for relevant observational data requirements and the satellite systems that meet them. Specific duties will include:

- generation of proposals, as appropriate, to optimise the space-based component of the GOS;
- supporting the maintenance of the CEOS/WMO database;
- coordination of the generation of a global contingency plan for the space-based component of the GOS;
- contributing to a vision of the future evolution of the space-based component of the GOS.

90. **The Research and Development Satellite Systems Unit** will be led by a specialist in research and development environmental satellite systems. This specialist will be responsible for observational data requirements in support of research related WMO programmes. Specific duties will include:

- monitoring of technological developments that could have an impact on space-based observational systems;
- provision of consolidated feedback on the usefulness of R&D satellite data and products;
- fostering dialogue, on the assimilation of data, between R&D agencies and the relevant environmental modelling entities;
- contributing to a vision of the future evolution of the space-based component of the GOS.

91. **The Ground Systems Unit** will be led by specialist in reception, dissemination and production systems required to meet WMO Members' requirements. This specialist will be responsible for all maters related to the ground segment of both the operational and research and development satellite systems. Specific duties will include:

- implementation of the education and training component of the WMOSP, including co-ordination of:
  - the progressive adaptation of the contents of training events;
  - the enhancement of the training opportunities offered by "Centres of Excellence";
  - the further development of the Virtual Laboratory and associated Virtual Resource Library (including the incorporation of basic tools for remote sensing applications);
- coordination and monitoring of the introduction of the proposed Integrated Global Data Dissemination Service;

- reviewing and updating, as necessary, the WMO satellite activities web-pages and maintaining their consistency with the information contained within the VL;
- monitoring of frequency coordination issues.

92. The staff of the programme office will also be augmented by Junior Professional Officers as they become available, and consultants when needed.

WMO RESOURCE IMPLICATIONS

93. The implementation arrangements, proposed in this plan, have resource implications for both space agencies and WMO.

94. The budgetary provisions available for WMO's participation have already been determined, and when the proposals contained within this implementation plan are compared with the available WMO budget, resource shortfalls are evident in two main areas:

- funding of Education and Training activities;
- staffing of the WMO Space Programme Office.

95. In accordance with the discussions at the 3rd Consultative Meeting, space agencies participating in the space-based component of the GOS are invited to make contributions to resolve these resource shortfalls, which are summarised in the following table.

Area	Resource Shortfall	Estimated Cost Implication
WMO Space Programme Office	1 Operational Satellite Systems Specialist	TBD
	1 R&D Satellite Systems Specialist	TBD
	1 Ground Systems Specialist	TBD
	Consultancy Support (2 man-years per year (TBC))	TBD
Education and Training	Creation and co-sponsorship of additional "centres of excellence"	TBD
	Funding of Additional Training Events (including a major VL Training Event)	80,000SF/Event

96. Also, in recognition of the time needed to establish the WMO Space Programme Office, five interim projects have been identified within this plan. Space agencies are invited to second experts to implement these specific projects; pending the full establishment of the WMO Space Programme Office.

97. For each project the corresponding role within the WMO Space Programme Office (that will eventually take over the implementation of the project) is indicated in the following table.

Project	Corresponding Role in the WMO Space Programme Office
1) Enhancement and Evolution of the Capabilities of the WMO Virtual Laboratory	Ground Systems Specialist
2) Co-ordination of the Design and Implementation of an Integrated Global Data Dissemination Service	Ground Systems Specialist
3) Creation of Global Contingency Plans for Geostationary and Polar Orbiting Spacecraft	Operational Satellite Systems Specialist
4) Assimilation of data from present and future R&D environmental satellites	R&D Satellite Systems Specialist
5) Reanalyses related to retrospective satellite data from both operational and R&D environmental satellites	R&D Satellite Systems Specialist and Operational Satellite Systems Specialist