Windhoek
17–24 November
2010

Commission for Basic Systems

Extraordinary session

World Meteorological Organization

WMO-No. 1070

Weather • Climate • Water

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Abridged final report with resolutions and recommendations

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World Meteorological Organization
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This report contains the text as adopted by Plenary and has been issued without formal editing.

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GENERAL SUMMARY OF THE WORK OF THE SESSION

1. OPENING OF THE SESSION *(agenda item 1)*

1.1 At the kind invitation of the Government of the Republic of Namibia, the Extraordinary Session of the Commission for Basic Systems was held in Windhoek, Namibia from 17 to 24 November 2010. The opening ceremony took place at 10 a.m. on Wednesday, 17 November 2010 at the Windhoek Country Club Resort.

1.2 The opening ceremony was chaired by Mr George Simataa, Permanent Secretary of the Ministry of Works and Transport, Namibia. Mr Simataa welcomed all to Namibia. He noted that the World Meteorological Organization's Commission for Basic Systems, in consultation with other WMO technical commissions takes a leading role in defining and coordinating basic operational meteorological systems and infrastructure. He recalled that the Namibia National Meteorological Service, which falls under the Ministry of Works and Transports, cooperates with WMO to ensure delivery of the crucial weather and climate predictions necessary for the safety and wellbeing of Namibian citizens. He highlighted that weather and climate information are critical to many decision-making processes, particularly in socio-economic sectors such as transport in all its modes (air, sea and land), agriculture, environment, water resources and many others. Mr Simataa highlighted that Namibia, with its relatively young meteorological service, looked forward to working closely with CBS and other constituent bodies of WMO to ensure acquisition of capacity in all areas of meteorology and operational hydrology.

1.3 Mr Fred Branski, president of the Commission, welcomed all to the meeting. He expressed his appreciation to the President of the Republic of Namibia and its Government for hosting this meeting in their beautiful country. Noting that CBS-XI, 1996 was held in Cairo, Egypt, he expressed his delight at holding this CBS session in Region I. He further highlighted that such a location as Namibia, as the first country in the world to incorporate protection of the environment into its constitution, is an ideal country to reflect on how CBS can improve services, take the decisions that will make CBS a better Commission, and to plan how CBS could help all Members improve their National Meteorological and Hydrological Services (NMHS). Mr Branski noted that this session of CBS was well placed in the run up to the Sixteenth WMO Congress in May 2011 to reflect and build on the outcome and recommendations of all the other technical commissions and regional associations that have already met.

1.4 The president of CBS mentioned that there were several challenges to be discussed at the session. These included the further implementation of the WMO Information System (WIS) including the recommendation for designation of the first WIS centres by Congress, the review of the WMO Integrated Global Observing System (WIGOS) including the recommendation to Congress to Implement WIGOS. He noted that WMO observing systems and information systems were the foundational blocks on which WMO was built. Other challenges included the continuing evolution of the Global Data Processing and Forecasting System including the Severe Weather Forecast Demonstration Projects, the further strengthening of the Public Weather Services Programme, which is where WMO Members deliver the services to their governments, the public, commercial sectors and all the rest of the users of Members' services.

1.5 Mr Branski expanded on the meaning of services in WMO, highlighting that data and products were, after all, intended to help a user make a decision. Whether that decision was what to wear, when to plant seed or what precautions a city must take because of an approaching storm. Providing information is a service. Helping someone make a decision is a service. Contributing to the saving of lives, property or resources is a service. The understanding of what services users need or want and what is required to deliver those services should be the driver for CBS activities. Observations are taken, information is shared and processed so services can be delivered. NMHS's are the vehicles through which those services are delivered. He further noted that the session would consider what the Global Framework for Climate Services (GFCS) may mean for CBS. WMO needs to deliver WIS to support the GFCS. It needs to implement WIGOS to support the GFCS. Data processing and forecasting systems must address GFCS needs and

public weather services must understand and deliver on the service needs that arise from the GFCS. Mr Branski further reiterated that although the GFCS was still being developed and it was necessary to await the decisions of Congress, it was not too early for CBS to prepare as it would not meet again as a full Commission until 2012.

1.6 Mr Branski highlighted that the Technical Conference to be held during the Session was on "End-to-End Service Delivery: From Observations to Services, the Way Users Need Them". That would give the Commission a chance to examine how the work of the Commission could be improved. The president concluded by reiterating his appreciation to the host, noting that with such wonderful facilities and support, and such an inspiring location, the Extraordinary Session of CBS would be an exceptional one.

1.7 Mr Michel Jarraud, Secretary-General WMO, welcomed all to this Extraordinary Session of CBS. On behalf of WMO, he thanked the Government of the Republic of Namibia through the Deputy Prime Minister, the Honourable Marco Hausiku, for hosting this session and the WMO Technical Conference on "Demonstration of End-to-End Services" in Windhoek. He also thanked Mr Franz Uirab, Chief of Meteorological Services and Permanent Representative of Namibia with WMO, as well as his staff, for their warm hospitality and the excellent arrangements made to ensure the success of the session. He further thanked Mr Franz Uirab for Namibia's active support to WMO Programmes and activities since Namibia joined the Organization on 6 February 1991.

1.8 The Secretary-General thanked the president of CBS, Mr Fred Branski, for his leadership of the Commission and for the work accomplished during the intersessional period since the fourteenth session of CBS held in Dubrovnik (Croatia) in March and April 2009. He also thanked the vice-president of CBS Ms Susan Barrell, as well as the chairs and members of the open programme area groups, the experts and coordination teams and the rapporteurs.

1.9 Noting WMO celebrated its sixtieth anniversary on 23 March 2010, Mr Jarraud briefed the Session on the history of CBS and its origin from the International Meteorological Organization (IMO), whose responsibilities WMO took over in 1951. Originally known in IMO as the Commission for Synoptic Information, it became the Commission for Synoptic Meteorology in WMO, but became CBS in 1971. The Commission took the initiative in expanding observations and telecommunications in its early days of WMO that coincided with a surge in telecommunication and computing power as well as the coming of the space age. The World Weather Watch (WWW) vision evolved in this environment and was approved conceptually by Congress in 1963, adopted as a programme by Congress 1967 and officially launched on 1 January 1968. The Commission successfully guided the development of the WWW as a coordinated and integrated system, based on facilities operated by WMO Members and on the recognition that all parts of the weather system are interactive and that no single country can be self sufficient. Supported by WMO and its partners' research activities which bridged the way from science to applications, including the Global Atmospheric Research Programme (GARP) and its subsequent globally coordinated experiments, the WWW became the cornerstone of WMO's global framework for weather services.

1.10 The Secretary-General highlighted that CBS faces new challenges and would have to meet unprecedented requirements of other WMO Programmes and WMO partners. This included new initiatives such as the GFCS, the development of which would depend on WIGOS and WIS. He encouraged the Commission to further support WIGOS development and implementation by considering, in particular: Guidance on the development of a space-based architecture for climate monitoring; A Strategy for the evolution and future hosting of the WMO database of observational user requirement and observing system capabilities; and further guidance on the roles and responsibilities of CBS in WIGOS implementation. He further noted the significant advances achieved during the Congress intersessional period in WIS regulatory material and the analysis of WIS centres. He suggested the Commission could recommend a first set of such centres to Congress, following the approval of which the WIS would be entering into its operational phase. Accordingly, it was expected that WIS priorities would be shifting from development to capacity-building. However, he noted that complete WIS implementation by all Members could take some

time and he encouraged the Commission to provide further guidance in the following areas, among others: Continued GTS improvement to ensure that as many Members as possible were connected; Development and promotion of regional pilot projects to facilitate Members' efforts in implementing WIS capabilities; and promotion of WIS applications to address other WMO programme's requirements.

1.11 Mr Jarraud highlighted that the growth in information communication technologies (ICTs) was also increasing the need for vigilant protection of radio frequencies for meteorological activities. He noted that despite consolidated radio frequency allocations by the World Radio communication Conference 2003 (WRC-03), scarcely regulated expansion of these activities in some regions continued to pose significant threats, for which the next WRC in 2012 would also be critical.

1.12 In concluding Mr Jarraud noted that WMO stood at a crossroad, perhaps as important to its future as was once WWW development, since GFCS would provide benefits to all climate-sensitive activities. He emphasised that the challenge for CBS would be to continue to guarantee the basic systems infrastructure in support of all WMO Programmes, so that WMO could carry on contributing to meet the needs of national sustainable development as well as objectives of global strategies. At the same time, he stressed the need for closer collaboration with other technical commissions and with regional associations, and to further encourage the active participation of experts from developing countries in the work of CBS. He reiterated WMO's gratitude to the Republic of Namibia for hosting this extraordinary session of CBS and wished all the delegates an enjoyable stay in Windhoek and a most successful and productive meeting.

1.13 The Minister for Information and Communication Technology, Hon. Joel Kaapanda welcomed delegates to Namibia on behalf of Hon. Erkki Nghimtina, Minister for Works and Transport. He wished all an enjoyable time in Namibia and hoped that most would have the opportunity to visit other parts of the country as well as Windhoek before returning to their respective countries. He spoke of the impacts of global warming as seen through floods, droughts and large-scale population displacements associated with hazardous weather phenomena such as heat waves, cyclones, tropical storms, hurricanes and even tsunamis. He noted that doing nothing about these events could have far reaching effects, so it was essential to define the challenges facing meteorology and related sciences. He highlighted that the transport sector, including land, sea and air were major users of the meteorological and related services at all levels of their activities from planning to operations.

1.14 The Deputy Prime Minister for the Republic of Namibia, Hon. Marco Hausiku, presented the keynote address on behalf of His Excellency, Hifikepunye Pohamba, President of the Republic of Namibia. He stated it was an honour for Namibia to host this important meeting of the WMO CBS Extraordinary Session. Noting that weather and climate systems were dynamic in nature and did not recognize national boundaries, he highlighted that it was important that all countries cooperate to ensure meteorological service organizations were properly capacitated and equipped to accurately report weather matters. He noted that the activities of CBS related to the development, implementation and operation of integrated systems for weather observations, data processing, data communication and data management, and the provision of public weather services. He noted that this could be done more effectively by harnessing the emerging scientific knowledge and technological developments and that the challenge facing CBS was to guarantee the development of the basic systems infrastructure in support of all WMO programmes. He hoped that during its deliberations, the session of the Commission would address these challenges in order to find appropriate solutions.

1.15 Hon. Hausiku reported that the Namibian Government had put plans in place to strengthen meteorological services in its country as a part of their national development plan. This was done in recognition of the need for meteorological information that supports the activities of many socio-economic sectors, operations which are sensitive to weather climate and water. He noted Namibia's long-term development strategy, Vision 2030, recognized the importance of climate in its development agenda. As Namibia's climate varies from semi-arid to arid, it was very

to droughts and floods. He highlighted that incidences of these have been noticeably more frequent in recent years and called for mitigating actions and design of effective coping mechanisms. He hoped this Commission would facilitate the development of meteorological infrastructure and systems to improve the accuracy of systematic observations and weather predictions.

1.16 Recognizing the importance of NMHS cooperating with each other within a region and further afield to ensure better services and efficiency, the Heads of State and Government of SADC Member States recently endorsed the establishment of the Meteorological Association for Southern Africa (MASA). It is the President of Namibia's hope that the efforts of MASA will feed productively into the work of CBS and other constituent bodies of WMO. Hon. Hausiku further reported that as a Member of WMO, Namibia would continue to participate in the activities of WMO's constituent bodies, including the Executive Council and its working groups. He further noted that the President was proud that Namibia had joined hands with other nations to address issues related to weather. The ongoing challenges of global warning require joint action from the international community in order to find lasting solutions. The President had no doubt that WMO, with its wealth of expertise and knowledge would make many positive contributions to these efforts.

1.17 Hon. Hausiku, on behalf of the President of the Republic of Namibia, commended all those involved in organizing and facilitating the Session to ensure that it achieves its objectives. He wished all very fruitful deliberations and a resourceful stay in Windhoek.

1.18 Ms Balbina Pienaar, Deputy Permanent Secretary, Ministry of Works and Transport, thanked the Hon. Hausiku, for finding the time to be at the opening ceremony of this historic conference and to officially open it. She noted that this reflected Namibia's seriousness with regard to weather and climate matters. Noting that this conference was sponsored jointly by WMO and the Namibian Government, she acknowledged the assistance given by many organizations here in Namibia, including the time and effort put in by the Local Organizing Committee.

1.19 A complete list of participants is given in the appendix to the present report.

2. ORGANIZATION OF THE SESSION *(agenda item 2)*

2.1 CONSIDERATION OF THE REPORT ON CREDENTIALS *(agenda item 2.1)*

In accordance with General Regulations 20 to 23, the Commission noted and approved the report of the representative of the Secretary-General as the first report on credentials.

2.2 ADOPTION OF THE AGENDA *(agenda item 2.2)*

The agenda for the session was unanimously adopted, as contained in CBS-Ext.(10)/PINK 2.

2.3 ESTABLISHMENT OF COMMITTEES *(agenda item 2.3)*

In accordance with WMO General Regulations 24 and 28, the Commission agreed to establish:

(a) A Coordination Committee, comprising the president of the Commission, the vice-president of the Commission, other members of the CBS Management Group, the representative of the Secretary-General and a representative of the host country.

(b) An ad-hoc WIS Committee tasked to review the recommendations of the Expert Team on GISC and DCPC Demonstration Processes (ET-GDDP) and to review those centres wishing to demonstrate their WIS capability for endorsement during the session. The ad-hoc WIS Committee comprised Zhao Licheng (China), M. Dell'Acqua (France) (co-chair), H. Ichijo (Japan), J. Kongoti (Kenya), L. Bezrouk (Russian

Federation), C. Hegemann (United States of America) and S. Foreman (co-chair) in his capacity as chair of the OPAG-ISS.

The Commission agreed that the work of the session be carried out in plenary, and that General Plenary be chaired by the president of the Commission and consider agenda items 1, 2, 3, 5, 6, 7, 8, 9 and 10, while Plenary A be chaired by the vice-president and consider agenda item 4 (except for agenda items 4.4 and 4.5), and Plenary B be chaired by Mr F. Uirab (Namibia) and consider agenda items 4.4 and 4.5.

2.4 OTHER ORGANIZATIONAL QUESTIONS *(agenda item 2.4)*

The session agreed on the working hours of the session. It was agreed that minutes of plenary meetings were not required in view of the technical nature of discussions. In accordance with Regulation 3, the Commission agreed to suspend for the duration of the whole session Regulation 109.

3. REPORT BY THE PRESIDENT OF THE COMMISSION *(agenda item 3)*

3.1 The Commission noted with appreciation the report by Mr F. Branski, president of the Commission for Basic Systems (CBS). Noting the significance of CBS activities for all WMO Programmes, including the leading role for many activities, the Commission recognized the substantial work carried out since the fourteenth session of CBS (2009), and in particular:

(a) CBS significantly contributed to further testing and developing of the WIGOS concept including the successful completion of the tasks specified in WDIP; it worked with CIMO, other Commissions, regional associations and the EC Working Group on WIGOS/WIS to update the WIGOS Concept of Operations (CONOPS) to better cover operational aspects of WIGOS implementation and therefore, more fully meets user expectations; it contributed to the WIGOS Development and Implementation Strategy (WDIS) submitted to EC-LXII for consideration and endorsement and is contributing to the Skeletal WIGOS Implementation PLAN (WIP) (http://www.wmo.int/pages/prog/www/wigos/principal_documents.html);

(b) The Statements of Guidance (SoGs; http://www.wmo.int/pages/prog/sat/RRR-and-SOG.html) for 11 observation application areas were reviewed;

(c) The Implementation Plan for Evolution of the GOS (EGOS-IP; http://www.wmo.int/pages/prog/www/OSY/Reports/ET-EGOS-5-Final-Report.doc) has been reviewed; steps have been taken to develop a new Implementation Plan for Evolution of the global observing systems in response to the new Vision for the GOS in 2025 and WIGOS requirements;

(d) Results of impact studies conducted by major NWP centres and by participants in THORPEX have been kept under review and results will be presented to the Fifth Workshop on the Impact of Various Observing Systems on NWP in 2012 (http://www.wmo.int/pages/prog/www/OSY/Reports/ICT-IOS6-Geneva2010.doc);

(e) Progress has been made on the development of a suitable aircraft based water vapour sensor and efforts continue to further promote the inclusion of a suitable humidity sensor with a generic software and hardware solution for all major aircraft types and models (http://www.wmo.int/amdar/documents/AMDARPanel_13andET-AIR_2FinalReport.doc);

(f) CBS, together with CIMO, developed a guidance statement on weather radar/wind turbine siting (http://www.wmo.int/pages/prog/www/IMOP/reports/2009/Final%20Report%20ET-SBRSO%20and%20ET-RSUTT.pdf), Guidelines for the Transition from Manual to Automatic Observing Stations (http://www.wmo.int/pages/prog/www/OSY/Reports/ET-AWS-6_Geneva_2010_REV.doc) and the Siting Classification for Surface Observing Stations on Land;

(g) A WMO Guidance Statement on Weather Radar/Radio Frequency Shared Spectrum Use was developed which through coordination with the Steering Group on Radio Frequency will be made available for consideration (http://www.wmo.int/pages/prog/www/IMOP/reports/2009/Final%20Report%20ET-SBRSO%20and%20ET-RSUTT.pdf);

(h) The inventory and assessment of space-based observation capabilities were developed and the WMO Technical Document No. 1513 – the Space-based Global Observing System in 2010 (GOS-2010) – was printed and distributed;

(i) The concept of an architecture for climate monitoring from space has been outlined;

(j) The biennial survey on availability and use of satellite data and products by WMO Members for 2008–2009 was completed and analysed;

(k) Regional expert groups have been set up in RA I, RA III and RA IV to review satellite data access requirements;

(l) Satellite sounding data from 74 per cent of the globe have been standardized and made available for near-real time retransmission over the GTS;

(m) Infrared imagery data from geostationary and polar-orbiting satellites have started to be been routinely inter-calibrated;

(n) Space Weather activities were initiated through the Inter-Programme Coordination Team on Space Weather in collaboration with the International Space Environment Service (ISES);

(o) Strong progress was made with WIS and the procedures for designation of WIS centres were sufficiently mature to be endorsed by EC and will be submitted to Congress;

(p) Initial WIS Centre designation evaluations have been performed; these and further and recommendations, if any, will be submitted to Congress;

(q) Updates to WMO *Technical Regulations* (WMO-No. 49) including a draft Manual on the WIS and Guide to the WIS have been prepared for consideration of recommendation for approval by Congress;

(r) Achievements have continued in the Severe Weather Forecasting Demonstration Projects (SWFDP) in Southern Africa and South Pacific Islands, along with new developments in Southeast Asia and East Africa;

(s) SWFDP, through multi-programme collaboration addressing regional needs in building multi-hazard early warning systems, is benefiting many developing countries by improving forecasting and warning services;

(t) SWFDP has been an important delivery vehicle for EPS-based products for probabilistic forecasting by NMHSs of developing countries to extend the lead-time of alerting to severe weather and for estimating forecast uncertainty;

(u) A comprehensive revision of the Manual on the GDPFS has been undertaken, and a draft outline for a new Manual has been developed;

(v) The guidelines related to Public Weather Services (http://www.wmo.int/pages/prog/amp/pwsp/publicationsguidelines_en.htm) were updated and enhanced, the World Weather Information Services (WWIS) Website (http://worldweather.wmo.int/) was revamped and an online Register of WMO Members Alerting Authorities (http://www-db.wmo.int/alerting/edit.asp) was developed;

(w) Preparation of some short 'How-To Guides' (1–2 pages; http://www.wmo.int/pages/prog/amp/pwsp/publicationsguidelines_en.htm) that summarize and readily communicate the key principles and information contained in the various Guidelines and Reports that ET/COPE has published over the years;

(x) Activities in support of World Expo Nowcasting Services (WENS) Demonstration Project in preparation of the WMO/China Meteorological Administration (CMA) Pavilion;

(y) Updating and enhancing some existing Guidelines that ET/DPM had produced;

(z) The Intercommission Task Team on Meteorological Support to Humanitarian Agencies was established and had its first meeting attended by 29 experts from international and United Nations agencies involved in coordination of humanitarian contingency planning and response, including IFRC, UNICEF, UNITAR, WFP, WHO, experts in operational meteorology, hydrology and climate forecasting from the NMHSs, specialized and international centres and staff from the WMO Secretariat.

3.2 The Commission noted the priorities for the work of the CBS until the next session of CBS as follows:

(a) Development of the new Implementation Plan for the global observing systems based on the new Vision for the GOS in 2025 and WIGOS requirements, continuity of the Rolling Review of Requirements (RRR) process and further development/update of relevant regulatory material in support of WIGOS;

(b) Preparation for and initiation of the WIGOS Implementation Phase;

(c) Implementation of the first WIS centres, and support to the NMHSs, including training activities, needed for the production of metadata;

(d) Migration from Traditional Alphanumerical Codes to Table Driven Code Forms for the presentation of WMO data and products, including support to NMHSs;

(e) Development of the Severe Weather Forecasting Demonstration Project (SWFDP) in Southeast Asia, Eastern Africa, and possibly in other regions; transfer of well established projects to the responsibility of regional associations;

(f) Review and updating of the Manual on the GDPFS;

(g) Further development of the system of Global Products Centres for Long-Range Forecasts, collaborating with CCl to support delivery of services by RCCs and national centres for seasonal and longer-time frame predictions in support of the development of the Global Framework for Climate Services;

(h) Development of designation criteria for Regional Centres of the Sand and Dust Storm Warning Assessment and Advisory System, jointly with CAS, with two anticipated requests for designation;

(i) Support to capacity-building for the implementation of the WWW systems and the Public Weather Services;

(j) Participation in communication, outreach and publication aspects of PWS in support of major WMO activities;

(k) Capacity-building and training to meet the needs of developing countries;

(l) Assisting NMHSs to develop positive partnerships with the media;

(m) Application of emerging new technologies for communicating services;

(n) Promoting awareness of the impact of high quality, well-communicated and well delivered PWS on the image and visibility of NMHSs;

(o) Continuing to provide guidelines on the development of the WWIS and the Severe Weather Information Centre (SWIC);

(p) Providing guidance on the role of PWS in the development of cross-border exchange of warnings;

(q) Identifying and providing recommendations on emerging needs for new and improved products and services with emphasis on key PWS user groups;

(r) Assisting NMHSs in the development of quality management procedures and practices, in particular through training activities for aeronautical meteorology;

(s) Assisting NMHSs in the development of the evaluation and demonstration of economic development of weather, climate and water services;

(t) In addition to the contributions of the Space Programme to WIGOS, further development of SCOPE-CM – Sustained Co-Ordinated Processing of Environmental satellite data for Climate Monitoring -- as a key component of GFCS;

(u) Support the Global Framework for Climate Services;

(v) Support the Disaster Risk Reduction Programme;

(w) Support development of the Quality Management Framework.

4. DECISIONS RELATED TO THE COMMISSION FOR BASIC SYSTEMS WORK PROGRAMME *(agenda item 4)*

4.1 REVIEW OF DECISIONS OF THE EXECUTIVE COUNCIL RELATED TO THE COMMISSION AND THE REQUIREMENTS OF THE REGIONAL ASSOCIATIONS, INCLUDING THOSE RELATED TO THE WMO STRATEGIC PLAN AND WMO OPERATING PLAN AND THE GLOBAL FRAMEWORK FOR CLIMATE SERVICES *(agenda item 4.1)*

Review of decisions of the Executive Council related to the Commission

4.1.1 The decisions taken by the sixty-first and sixty-second sessions of the Executive Council that are relevant to its work were presented to the Commission. The Commission discussed the relevant impact on the future work programme of the Commission and included its conclusions in the general summary under their respective agenda items.

4.1.2 The Commission recalled that WMO has adopted the Results-based Management (RBM) approach and that Strategic Planning, the WMO Operating Plan as well as Monitoring and Evaluation are an integral part thereof. The Commission noted the progress in the development of the WMO Strategic Plan and Operating Plan, and the involvement of the regional associations and technical commissions in the process. The sixty-second session of the Executive Council requested that the draft WMO Operating Plan 2012–2015 be further refined with inputs from technical commissions. The Commission invited its Management Group to continue to work with the Secretariat to contribute to all aspects of the RBM process, including the refinement of the draft WMO Operating Plan 2012–2015.

Coordination between regional associations and the Commission

4.1.3 The Commission noted that the sixty-second session of the Executive Council (EC-LXII) (Geneva, June 2010):

(a) Stressed the need to further improve the coordination between regional associations (RAs), the technical commissions (TCs), and the relevant Secretariat Departments, in particular through the definition of regional requirements and implementation priorities by regional associations, through the identification of joint activity areas by TCs and RAs, and through the identification of appropriate regional programmatic focal points within each regional management structure;

(b) Noted that, when reviewing the working arrangements and roles and responsibilities of technical commissions and regional associations, the Executive Council Working Group on WMO Strategic and Operational Planning proposed that each technical commission designates, based on regional associations' recommendation, an active rapporteur for each regional association.

4.1.4 The Commission requested the president to coordinate action with the presidents of regional associations, with the support of the Management Group, with a view to establishing a two-way communication mechanism for improving the strategic level coordination and feedback between CBS and the regional associations.

Global Framework for Climate Services

4.1.5 The Commission was pleased to note the progress of the High-Level Taskforce on the Global Framework for Climate Services and in particular the draft report's availability for review by governments and experts.

4.1.6 The Commission wished to stress that present capabilities to provide climate services did not exploit all that we know about climate, falling far short of meeting present and future needs, and delivering their full and potential benefits, particularly in developing countries. The widespread, global use of strengthened climate services would lead to improved decisions that would in turn contribute to social and economic development and reduce disaster risks and losses. The Commission also noted that climate services are also fundamental in adapting to climate change.

4.1.7 The Commission was pleased to see that the Taskforce had, in essence, adopted the formulation of the key components for a Global Framework for Climate Services as outlined by the WCC-3; the User Interface Platform, the Climate Services Information System, the Observations and Monitoring Component and the Research, Modelling and Prediction Component along with the important addition of the Capacity Development Component.

4.1.8 The Commission noted that the Global Framework for Climate Services, if broadly endorsed by Congress in May 2011, would provide NMHSs with a range of opportunities and urged that a focus of the implementation strategy for the Framework be the strengthening of the capacity of NMHSs to issue climate services in support of GFCS. In this regard the Commission noted that NMHSs are uniquely placed to provide the seamless weather and climate services many users are seeking.

4.1.9 The Commission noted that the Taskforce's draft report has set an indicative target of US$ 50M per year of capacity development projects over the WMO's next financial period (2012–2015) and urged that this development funding be directed towards upgrading the operational capacities of NMHSs. It further recognized that endorsement of this target by the WMO and its achievement would only occur with strong support from developing countries and encouraged this support.

4.1.10 The Commission noted that it is possible that, through initiatives to assist countries in their adaptation to climate change, resources may become available for supporting components of the Global Framework for Climate Services. The Commission, therefore, recommended that resources may be invested to strengthen NMHSs to undertake research, monitoring, service provision and capacity-building to contribute to GFCS and also to better support climate change adaptation decisions.

4.1.11 The Commission noted that the Global Framework for Climate Services is likely to call upon an increased degree of regional or subregional cooperation and information and data exchange and encouraged Members to strengthen their regional networking in climate-related areas and to look for opportunities to exchange data and information that would underpin improved national climate services. Strengthening the RCOFs process, and consolidating effective Regional Climate Centres where possible, would greatly assist this process. Further, Members should look for opportunities, directly and through national coordination mechanisms, to work with communities across other affected areas, such as agriculture, health and disaster risk reduction, to ensure synergies and shared benefits are delivered.

4.1.12 The Commission affirms its intention to reflect the implementation plans and methods of work of the GFCS, as they develop further, in the development of its own work programmes and especially in the implementation of WIGOS and WIS and for the Disaster Risk Reduction Program. It notes, in particular, the need to ensure that the Rolling Review of Requirements process adequately supports the changes in understanding of the needs for observations, in collaboration with GCOS, to support GFCS, that the implementation of WIS reflects the data access and exchange requirements, both within and external to the WMO and NMHS communities, and that the delivery of services benefits from alignment and optimization across all service delivery programmes of WMO in the context of multi-hazard, multi-scale early warning systems.

4.1.13 The Commission agreed to assist EC-PORS in the development of the Implementation Strategy for the Global Cryosphere Watch and invited the Secretary-General to open dialogue with IOC and ICSU to explore whether a partnership structure might be appropriate. The Commission further agreed to assist EC-PORS in defining the scope of Arctic and Antarctic Regional Climate Centres noting their contribution toward increasing the number, and improving the quality, of climate products and services.

4.1.14 The Commission requested its Management Group to pay close attention to the opportunities to contribute effectively to GFCS in the development of its work programmes for the coming period.

Education and training requirements and competencies

4.1.15 The Commission noted the decision of EC-LXII to replace WMO Publication No. 258 "Guidelines for the Education and Training of Personnel in Meteorology and Operational Hydrology. Volume I: Meteorology" with a series of new publications. Two of these in the new series: (1) education and training required to be qualified as a WMO Meteorologist or as a WMO Meteorological Technician; and (2) competencies and education and training requirements for trainers, would be overseen by the EC Panel of Experts on Education and Training (EC Panel). The remaining volumes in the series would be overseen by the relevant technical commissions as they developed competencies and education and training requirements for personnel undertaking tasks in their respective areas of interest.

4.1.16 The Commission noted the distinction made between the use of qualifications for determining personnel classification, and specific competencies needed in relation to tasks a person undertook. Noting the importance of subject matter experts for defining the competencies, and education and training material for weather forecasting tasks related to public weather forecast and warning services, the Commission agreed to take the lead in determining these competencies and their associated education and training requirements. The Commission stressed that these competencies should be kept at an appropriately useful and useable level, and not be too detailed or prescriptive. Similarly, the Commission agreed on the need to have a separate group examine the issues of competencies and the associated education and training requirements for the service delivery tasks in PWS. The Commission requested that these competencies are developed by the OPAG-DPFS and OPAG-PWS in close liaison with the EC Panel of Experts in Education and Training to ensure close linkage to the underlying WMO Meteorologist and WMO Meteorological Technician education and training qualifications. Such a coordinated organization-wide approach

should lead to consistency in competency descriptions. The Commission noted that the EC Panel will ensure that there is a consistency of approach by the commissions to the definition of competences and will work with the commissions to resolve overlap issues.

Follow-up of the recommendations of the Task Group on the WMO Reform

4.1.17 The Commission recalled the decision of EC-LXII to continue to investigate the recommendations of the Task Group on WMO Reform established by the EC Working Group on Strategic and Operational Planning (WG/SOP). The Commission further recalled that their president had offered to trial some of the recommendations of the WG/SOP Task Group on WMO Reform during CBS-Ext.(10) and report back to Members through the WG/SOP. The Commission, as a result, proposed the establishment of a two-way communication mechanism between the regional associations and CBS and trialled a shortened session with documents focused on decisions.

4.1.18 Regarding the move to more decision-focused documentation, the Commission agreed that there was good progress, making it faster to finalize documents. However, it felt that there is still more that can be done to reduce the non-decision related text in the general summary, and requested the Secretariat and the Management Group to consider further improvements to the documents that would enable even greater focus on the decisions required.

4.1.19 The Commission expressed the view that the embedding of the TECO-E2E within the bounds of the session was very successful. The combination of having interpretation available and having so many delegates already in attendance resulted in a highly attentive and interactive conference.

4.1.20 The Commission noted that sessions of CBS have been held every two years with similar agendas, except for the agenda item related to the election of officers which was only included in the agenda of ordinary sessions every four years. That is, it has in effect been conducting ordinary sessions every two years. As regards the periodicity of CBS sessions, the Commission was strongly of the view that CBS needs to meet every two years because of the rapid evolution of basic system technologies and user requirements, and asked its Management Group to advise on how best to structure the intermediary sessions with a view to the time spent intergovernmentally. Subject to the outcomes of Sixteenth Congress, the Commission requested the president to meet with the president of CIMO, and in close consultation with the Management Group, discuss options for conjoint meetings of management groups and commissions.

4.1.21 The Commission requested the president to provide a report of CBS's experiences to the WG/SOP for further consideration by Cg-XVI.

4.2 DECISIONS FOR THE OPEN PROGRAMME AREA GROUP ON INTEGRATED OBSERVING SYSTEMS, INCLUDING THE WMO INTEGRATED GLOBAL OBSERVING SYSTEM AND THE WMO SPACE PROGRAMME, CAPACITY-BUILDING AND THE QUALITY MANAGEMENT FRAMEWORK *(agenda item 4.2)*

Decisions for the Open Programme Area Group on Integrated Observing Systems (OPAG-IOS)

4.2.1 The Commission expressed its appreciation to the Chair of the OPAG-IOS, Dr Lars Peter Riishojgaard and his Co-Chair Dr Jochen Dibbern, for their comprehensive report on the performance and further development of the surface-based and space-based subsystem of the GOS. It noted that the GOS, through coordinated efforts of Members, continued to provide sustainable observational data and information on the state of the Earth and its atmosphere to meet evolving requirements of various users. It underlined that along with the broadening satellite data and services, especially through R&D satellites, further improvements were achieved in the availability of data produced by other components of the GOS, notably marine and AMDAR data.

4.2.2 Based on the activities and results achieved under various areas under the OPAG-IOS responsibilities, the Commission decided on the below guidance relevant to OPAG-IOS.

4.2.3 The Commission endorsed a Strategy for the evolution and future hosting of the WMO database of observational user requirements and observing system capacities (Rolling Review of Requirements [RRR] database), described in Annex I to the present report, and requested OPAG-IOS to invite potential candidates willing to host the RRR database and to evaluate candidates according to a process to be defined by ICT-IOS. The Commission also requested the OPAG-IOS to ensure that any particular requirements of Polar Meteorology are captured through the ongoing RRR process.

4.2.4 The Commission noted that the implementation of stations and the availability of reports from RA I Regional Basic Synoptic and Climatological Networks (RBSN/RBCN) remain very low, and agreed that a concentrated effort on the part of the international community is needed to assist RA I Members in implementation and operation of RBSN/RBCN stations. The Commission further noted that the reduced availability of, especially, upper-air data over Region I has a negative impact on the quality of medium-range forecast products over all Regions, not just over Region I itself.

4.2.5 The Commission agreed that participation of Regional Representatives in the work of OPAG-IOS is essential for better understanding the regional aspects of the observing systems, and expressed its appreciation to the Secretariat (Development and Regional Activities Department, DRA) for coordinated nominations of Regional Representatives to OPAG-IOS with the respective presidents of the regional associations. The Commission proposed the Terms of Reference of these Representatives, as presented in Annex II to the present report, which should be submitted to the regional associations' session for consideration. It was agreed that Regional Representatives to ICT-IOS should have appropriate linkage to the regional working structures.

4.2.6 The Commission noted that the requirements of NWP and Climate monitoring for global exchange of precipitation data are not currently being fully met and urged Members to exchange the appropriate data.

4.2.7 The Commission noted that some Members have changed observing practices for upper-air sounding from two ascents per day to only one at some of their observing sites. The Commission encouraged Members to retain two soundings per day in those regions where no other upper-air observing system, such as AMDAR, is available.

4.2.8 The Commission agreed on a mechanism for the development of observing practices for the GCOS Upper-Air Reference Network (GRUAN) stations. For GRUAN to become fully operational, its operational practices will have to be accommodated in the WMO Regulatory Material, in particular in the Manual and Guide on the GOS. The Commission agreed that an expert meeting should be organized to finalize these practices with a view of submitting them to CBS-XV for consideration. It requested the chairs of the Expert Team on Evolution of the Global Observing System (ET-EGOS), the Expert Team on Surface-based Remotely-Sensed Observations (ET-SBRSO) and the Expert Team on Satellite Systems (ET-SAT) to nominate members participating in this effort together with the OPAG-IOS Rapporteur on Regulatory Material. It was agreed that the GCOS Secretariat will be in charge of coordinating these activities.

4.2.9 The Commission agreed that the AMDAR Programme has the potential to expand in most Regions, and that steps should be taken by the RA presidents to encourage greater participation in the AMDAR Programme. In this regard, the Commission requested its OPAG-IOS, through the Expert Team on Aircraft-based Observations (ET-AIR), to provide guidance on steps that would help strengthen the AMDAR Programme in the Regions.

4.2.10 The Commission requested the OPAG-IOS to facilitate collaboration of ET-EGOS with the EC Panel of Experts on Polar Observations, Research and Services (EC-PORS) on issues of mutual interest, including IPY Legacy observing initiatives, increasing the number of observations from Polar Regions (including buoy programmes), and actions for acquiring real-time data from Polar Regions. The Commission requested the Secretariat to inform the co-chairs of EC-PORS accordingly. In addition, the Commission agreed that the new version of the Evolution of Global Observing System must address Polar Regions.

4.2.11 The Commission requested its president to identify the appropriate CBS points of contact for activities related to observations, research and services in Polar Regions and inform EC-PORS co-chairs accordingly.

4.2.12 The Commission requested interested Members to conduct impact studies as specified in the Annex to paragraph 6.1.32 of the general summary of the Abridged Final Report with Resolutions and Recommendations of CBS-XIV (2009; conclusions and recommendations from the Fourth workshop on impact of various observing systems on NWP) and, in addition, experiments to address the following issues:

(a) In the presence of dense satellite observations of ocean surface wind, what is the requirement for the density of in situ surface pressure observations?

(b) Guidance is needed on desirable coverage of Automated Ship-borne Aerological Programme (ASAP) soundings over oceans;

(c) In support of high-resolution NWP, what observations are needed for the planetary boundary layer – which variables, and what space/time resolution?

(d) Studies are needed to address identification of critical locations for surface-based stations.

4.2.13 The Commission noted that preparations for the Fifth Workshop on the Impact of Various Observing Systems on NWP had started, and that the organizing committees have been established. The Commission requested the OPAG-IOS to develop the scope of the workshop as soon as possible, including exact dates for holding the Workshop in 2012. It welcomed the proposal from the United States representative to host this workshop.

4.2.14 The Commission noted the guidance by ICT-IOS on the "Role of the WMO Secretariat in coordination and support of AMDAR Programme activities" and requested that the WMO Secretariat continues to coordinate AMDAR Programme activities and that the respective staff be funded preferably from the WMO Regular Budget In the context of assisting RAs and Members to expand their AMDAR programmes, the Commission noted the value of continuing an identified AMDAR Technical Coordinator role and appreciated that under recent WMO Secretariat and AMDAR Panel arrangements, a new position "Scientific Officer – Aircraft and Remote Sensing Observations" will be opened and funded equally from the AMDAR Trust Fund and the WMO Regular Budget. The Commission also noted that the AMDAR Panel, in collaboration with ET-AIR, is updating the brochure "The International AMDAR Programme" describing, among other things, the benefits of AMDAR to WMO Members and is developing a new publication on benefits to airline companies.

4.2.15 The Commission requested its OPAG-IOS to arrange, as soon as possible, for the publication of the *Guidelines and Procedures for the Automation of Observing Stations,* as a joint CBS and CIMO technical report, to assist Members undertaking implementation of automated observing systems.

4.2.16 The Commission noted the recommendation from the ICT-IOS-6 to work towards establishing an international forum of users of satellite data telecommunication systems covering a wide user base (ocean observing stations, AWS and other automatic environment observing stations in remote areas), and build on the existing WMO-IOC Argos Joint Tariff Agreement (JTA) while addressing all relevant satellite data telecommunications systems. The Commission recognized that it would be beneficial having a strong user base covering multiple applications to address system deficiencies, negotiate tariff and potential improvements of the rendered services with all relevant operators of satellite data telecommunication systems, and requested the Secretariat to approach partner organizations such as IOC and FAO, and coordinate with the JTA with the view to establish such a forum to address remote data communication requirements –

including tariff negotiations as needed – for automatic environment observing systems coordinated through WMO and those partner organization. The Commission emphasised that such a forum should not only consider tariff negotiations but should take a very broad view of available technologies, options and prices as well as cooperative data collection platform mechanisms.

4.2.17 The Commission recommends that the *Siting Classification for Surface Observing Stations on Land*, adopted by CIMO-XV, be promoted as a common WMO and ISO standard. The Commission also recommends that the guidelines for the implementation of the Classification be developed by ET-AWS and used in training courses in the Regions.

4.2.18 The Commission agreed to rename the “Implementation Plan for the Evolution of the Global Observing System” to the “Implementation Plan for the Evolution of global observing systems” to respond to the WMO Integrated Global Observing System strategy for implementation. "The Commission also agreed to rename "the Expert Team on the Evolution of the GOS" to "the Expert Team on the Evolution of global observing systems".

4.2.19 The Commission noted the development of the new Implementation Plan for the Evolution of the global observing systems (EGOS-IP) that is responding to the Vision for the GOS in 2025 and WIGOS requirements. The Commission requested the OPAG-IOS to ensure that the development of the Implementation Plan progress smoothly and that the final version be ready for CBS-XV in 2012 for consideration.

4.2.20 The Commission recognized that transmitting high resolution upper-air data in BUFR format involved upgrading upper-air sounding systems at a cost. Nevertheless, considering the impact of such data, the Commission encouraged Members to make appropriate arrangements for the provision of high resolution upper-air data using appropriate BUFR template.

4.2.21 The Commission noted that satellite observations are recognized as an integral part of the implementation of the IGACO strategy within the GAW programme. At the same time there is considerable activity in the satellite community including by operational satellite operators, in support of atmospheric composition observation and monitoring. These activities will result in a substantial contribution to meeting the objectives of the WIGOS/GAW programme. Taking into account the cross-cutting nature of satellite programmes and missions and the need to coordinate data requirements for satellite observations for atmospheric composition monitoring, the Commission recommended that an ad hoc team of experts be established between CBS and CAS to address this issue. It requested its president to coordinate this with the president of CAS.

4.2.22 Noting the request from EC-LXII to develop an architecture for sustained, space-based climate monitoring, the Commission agreed that defining and implementing such an architecture should take into account the different roles and responsibilities of the respective entities (including R&D and operational space agencies, and their coordination bodies) while responding to the essential need for continuous and sustained operation. In this respect, the Commission supported the initiative to prepare a workshop focussing on the specific requirement for continuity of climate observations, and on architectural implications of these special requirements; this workshop would respond to the request from the Coordination Group for Meteorological Satellites (CGMS) to convene a “contingency planning workshop” for the climate observations reflected in the Vision for the GOS in 2025.

4.2.23 The Commission reaffirmed the importance of satellite systems, whether on geostationary, polar or other orbits, as a unique source of observational data. Regarding the geostationary constellation, it was informed on the evolution planned in the 2014–2017 time frame with the coincident implementation of new spacecraft series by China (starting with FY-4 in 2014), Europe (starting with MTG-I1 in 2017), Japan (starting with Himawari-8 in 2014), Republic of Korea (COMS Follow-on, starting in 2017) and the United States (starting with GOES-R in 2015) that will continue and expand the current operational missions in geostationary orbit. The Commission was also informed of the planned launch of Elektro-L1 by the Russian Federation. In order to take advantage of these enhanced capabilities and to avoid any disruption for

operational users, the Commission agreed that these forthcoming changes be brought to the attention of the relevant regional associations ahead of time, and that a strategy should be developed to facilitate user readiness for these new systems in all WMO Regions. It furthermore recommended that Members who are planning to implement new geostationary satellite generations include an appropriate overlap period between current and future satellite generations to allow intercomparison and validation of products, and to facilitate a smooth transition for users.

4.2.24 The Commission noted the plans and related challenges for satellite systems in Low Earth Orbit (LEO) and in Highly Elliptical Orbits (HEO). The Commission recalled that polar-orbiting satellites were operated on morning orbits by China (FY-3A), EUMETSAT (METOP-A), and the Russian Federation (Meteor-M1, in commissioning, with advanced payload as the first of the three polar-orbiting satellites), and on afternoon orbits by China (FY-3B, in commissioning) and the United States (NOAA-18 and -19), with additional satellites in secondary or back-up mode. Since satellite soundings from LEO systems are a crucial input to NWP, the Commission expressed concerns that, according to current plans of satellite operators for the next decade, there was still no path towards implementing a sounding mission on an early morning orbit as required in the Vision of the GOS in 2025. In addition, the Commission highlighted that HEO missions, such as those being currently planned by Canada and the Russian Federation on Molniya orbits, have the potential to extend geostationary imaging and space weather capabilities to provide quasi-permanent observations over the full Arctic Polar Region. The Commission was informed of plans by China to launch a Precipitation Radar Satellite in 2015.

4.2.25 The Commission noted the need for increased attention to satellite data and products delivery, particularly in developing countries, and agreed that, in the context of the Integrated Global Data Dissemination Service (IGDDS) and GEONETCast, the strategy for improving data access should consider among its priorities: (a) to organize the formulation of data requirements and the dialogue between data users and providers; (b) to implement sustainable regional DVB -S dissemination systems offering cost efficient access to satellite data in every region; (c) to integrate all relevant data types in such broadcast services, including inter-regionally exchanged data; and (d) to support harmonization of future Direct Broadcast systems as well as the implementation of complementary data access and distribution services via the Internet, recognizing the different user needs. Considering the positive outcome of the RAs III/IV Satellite Data Requirements workshop, the Commission encouraged a similar approach in other Regions where satellite data access is a limiting factor. The Commission was informed that the first Asia-Oceania Meteorological Satellite Users' Conference had been held in Beijing, China on 1 and 2 November 2010, and welcomed the intention of China, Japan and the Republic of Korea to collaborate on the organization of similar events in the future.

4.2.26 The Commission requested the OPAG-IOS to work closely with other technical commissions, ICAO and other relevant organizations to advise on the design and implementation of a sustainable capability for the observation of volcanic ash. The Commission further joined with the United Kingdom of Great Britain and Northern Ireland on behalf of the London VAAC in expressing sincere thanks to those Members who shared specialised observational data during the eruption of the Eyjafjallajökull volcano. The ICAO representative indicated the willingness of ICAO to contribute to the work of the OPAG-IOS related to volcanic ash, in view of its prime importance and urgency for international aviation.

Capacity-building and technical cooperation

4.2.27 The Commission agreed that more effort is needed to support developing countries, LDCs and SIDS, especially by providing guidelines and organizing training and capacity-building events in the respective Regions.

4.2.28 The Commission agreed on the following guidelines for the allocation of priorities for technical cooperation activities for the integrated observing systems:

(a) Highest priority should be given to the projects aiming at improving and restoring the existing, and building the new upper-air observational capabilities, of the RBSN/RBCN with emphasis to the activation of silent upper-air stations and the improvement of coverage over data-sparse areas (in particular as regards the purchase of equipment and consumables, telecommunications and the training of staff);

(b) Highest priority should be given to extend AMDAR coverage to developing countries, LDCs and SIDS to supplement scarce upper-air observations or to provide a cost-effective alternative to countries that cannot afford costly upper-air sounding systems;

(c) High priority should be given to the projects related to the improvement of data quality, regularity and coverage of surface observations of the RBSN/RBCN with emphasis to the activation of silent stations and the improvement of coverage over data-sparse areas;

(d) High priority should be given to projects related to the introduction and/or use of new observing equipment and systems including, where cost-effective, surface-based AWSs, AMDAR, ASAP and drifting buoys;

(e) Medium priority should be given to the projects related to the improvement/upgrading of stations not included in RBSN/RBCN list of stations.

4.2.29 The Commission agreed with the revised TOR for the ET-SUP as described in Annex III to the present report.

4.2.30 The Commission agreed with the updated workplans of the OPAG-IOS expert teams as described in Annexes IV to IX to the present report.

WMO Integrated Global Observing System (WIGOS)

4.2.31 The Commission considered the status of the WIGOS development and implementation with respect to the CBS current and future mandate.

4.2.32 The Commission noted with appreciation the updated version of the WIGOS Concept of Operations (CONOPS) and the WIGOS Development and Implementation Strategy (WDIS), which was endorsed by EC-LXII, to be presented to Cg-XVI for approval with the understanding that these documents may be further refined in view of the lessons learned from the WIGOS Test of Concept Phase. The WIGOS Implementation Phase (2012–2015) as described in WDIS, builds on lessons learned from the WIGOS Test of Concept Phase (2007–2011) and lays the groundwork for the Operational Phase (from 2016 onward). The WIGOS Implementation Plan (WIP) will be developed in line with WDIS.

4.2.33 In this regard, the Commission stressed the importance of the development of the new version of the Implementation Plan for the evolution of global observing systems (EGOS-IP) responding to the Vision for the Global Observing System in 2025 as an integrated core component of WIGOS, with the overall guidance on how to design, develop and implement integrated national observing systems to provide comprehensive observations in response to the needs of all WMO Members and Programmes for improved data products and services, for weather, water and climate.

4.2.34 The Commission underlined that integration must be pursued to ensure interoperability and facilitate optimization across WIGOS constituent systems and to overcome existing deficiencies and gaps in the constituent observing systems.

4.2.35 The Commission noted a need to develop further details on what specific actions would be required at a national level for implementing WIGOS. These details should draw on the lessons learned from the WIGOS Pilot Projects and WIGOS Demonstration Projects. The Commission

requested OPAG-IOS and the Secretariat to address this, in coordination with CIMO and other technical commissions as necessary.

4.2.36 When considering the status of the WIGOS development and implementation, the Commission agreed with the Executive Council Working Group on WIGOS and WIS (EC-WG/WIGOS-WIS) that the WIGOS implementation would require active coordination and support from the WIGOS Project Office with suitable project management functions. This would also allow for better interactions with the Pilot and Demonstration Project Teams, the future Intercommission Coordination Group on WIGOS (ICG-WIGOS) and the respective technical commission working bodies.

4.2.37 The Commission agreed with EC-LXII that meeting the quality requirements and expectations of users was critical to the success of WIGOS. This would require an in-depth examination of current practices used by WMO observing programmes, specific mission-related requirements that were already in place, and available technological opportunities. The WIGOS Quality Management Framework (QMF) implementation strategy would specify all processes of the Quality Management Systems (QMS) to be implemented for any observing network/system. Attention should also be paid to the guidance on how to manage observing networks and observing sub-systems to fully meet QMF requirements.

4.2.38 In this regard, the Commission agreed that one of the key areas of standardization that CBS, in collaboration with CIMO, should embrace in the WIGOS context is the WMO QMF and the development, use and maintenance of the relevant WMO regulatory material (technical regulations, manuals, guides) to ensure that:

(a) Observations, records and reports on weather, water, climate and other environmental resources, operational forecasts, warnings, related information and services are of identified quality, and in compliance with relevant joint standards agreed upon with other international organizations;

(b) The best possible observational data and products are delivered to end users. This should be based on agreed-upon quality assurance and quality control standards, with the goals of developing and implementing an integrated QMS that delivers reliable and timely observational data and product streams with adequate quality control and relevant metadata.

4.2.39 In this regards, the session took note of the JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia), held in Tokyo, Japan (27–30 July 2010). It welcomed the conclusion of the workshop regarding the importance of a regular review of user requirements as well as collecting feedbacks from users.

4.2.40 The Commission recognized the requirement for the development of standardized quality management procedures for observational data, products and services. It further agreed that implementation of standards would significantly contribute to improvements of the quality of meteorological services provided by NMHSs, as it depends to a large extent on the quality of observations.

4.2.41 The Commission agreed that CBS will provide the technical lead in the WIGOS development and implementation and underscored the need for close collaboration and enhanced coordination among the technical commissions in which CBS should take the leading role.

4.2.42 In this regard, the Commission welcomed the decision of EC-LXII to establish ICG-WIGOS for this purpose immediately after Cg-XVI. In a spirit of its technical lead in the WIGOS integration process, the Commission recommended that the CBS president be, ex-officio, a core member of ICG-WIGOS.

4.2.43 In accordance with WIGOS requirements and the request of EC-LXII, the Commission responded with relevant adjustment of the Terms of Reference (TOR) for its open programme area groups (OPAGs), expert teams (ETs) and rapporteurs to best address WIGOS requirements for integration, interoperability, standardization and quality management. In this regard, the Commission requested its Management Group to coordinate with the chairs of OPAGs, ETs, and relevant rapporteurs the inclusion of relevant tasks and activities in their workplans to contribute to the implementation of WIGOS as a high priority.

4.2.44 Taking into account key tasks specified by WDIS, the Commission agreed on the following priority areas during the next intersessional period:

(a) Development of the EGOS-IP including the updating of the application areas of the RRR process;

(b) Development of WIGOS standards, including QM procedures and metadata standards, in close collaboration with other technical commissions and partner organizations;

(c) Provision of the technical guidance and advice to Members and regional associations on WIGOS;

(d) Review, update and harmonization of WMO regulatory material that must document the structure and requirements of WIGOS operations.

Decisions for the WMO Space Programme

4.2.45 The Commission expressed its appreciation to the Members operating satellite systems for their participation in developing the concept for a space-based architecture for climate monitoring. The Commission noted that an end-to-end system, much like what has been developed for weather monitoring and forecasting over the last fifty years, needs to be developed for climate monitoring.

4.2.46 The Commission endorsed the proposal given in Annex X to the present report for a space-based architecture for climate monitoring based on the requirements established by the Global Climate Observing System (GCOS) and the Essential Climate Variables (ECVs) that can be derived from space-based observations. The proposed architecture will enhance, and is modelled after, the end-to-end system which has been created for weather observations, research, modelling, forecasting, and services; it will be part of the space-based component of the WMO Integrated Global Observing System (WIGOS). Other components of this end-to-end system would include the inter-calibration activities of the Global Space-based Inter-calibration System (GSICS), additional calibration and validation activities to be conducted in coordination with the Commission for Instruments and Methods of Observation (CIMO), the product generation efforts as done within the Sustained Co-Ordinated Processing of Environmental satellite data for Climate Monitoring (SCOPE-CM) and the training and capacity-building activities of the WMO/CGMS (Coordination Group for Meteorological Satellites) Virtual Laboratory (VLab).

4.2.47 Given the magnitude of developing a space-based architecture for climate monitoring and the importance of this effort to the Global Framework for Climate Services (GFCS), the Commission recommended to invite Members to consider options for further support of the WMO Space Programme either through secondments to the Office or voluntary contributions to the Space Programme Trust Fund.

4.2.48 The Commission expressed its support to all the Members who nominated technical experts to serve on the Inter-Programme Coordination Team for Space Weather (ICTSW), and to China and the United States for their willingness to provide co-chairs. The ICTSW was encouraged to pursue its workplan, including a review of Space Weather observing requirements in coordination with ET-EGOS, and data management standardization in coordination with OPAG ISS, as priority issues.

4.2.49 The Commission welcomed the expansion of the Virtual Laboratory for Education and Training in Satellite Meteorology (VLab) through the creation of a Centre of Excellence on remote sensing applications and satellite meteorology training at the National Satellite Meteorology Centre (NSMC) of the Korea Meteorological Administration (KMA) in Jincheon, Republic of Korea. It thanked KMA for its commitment on this training activity. The Commission congratulated the Republic of Korea for the successful launch of COMS in June 2010 and welcomed the announcement that COMS data and products will be made available in support of meteorological activities including typhoon monitoring.

4.3 DECISION FOR THE OPEN PROGRAMME AREA GROUP ON INFORMATION SYSTEMS AND SERVICES, INCLUDING THE WMO INFORMATION SYSTEM, CAPACITY-BUILDING AND THE QUALITY MANAGEMENT FRAMEWORK *(agenda item 4.3)*

4.3.1 The Commission noted the report of the chair of OPAG-ISS, Dr S. Foreman, and expressed its appreciation to the work achieved under a very demanding schedule. It noted the trial, in collaboration with the ICG-WIS, of the use of online tools such as the WIS Wiki (http://www.wmo.int/wiswiki) and a case and project tracking system, and encouraged the OPAG-ISS to continue with the trial.

4.3.2 The Commission was pleased with the progress on the Improved Main Telecommunication Network (IMTN) with the merging of the two IMTN clouds. It noted that as most MTN centres are now on the IMTN cloud and that the others have plans to join the cloud, the IMTN project is now completed. It thanked the ET-CTS and the ECMWF for their contributions to this successful project. It noted the progress in the regional networks and that the migration to IP was almost complete. Furthermore it noted that most X.25 circuits had been replaced and recommended that X.25 technology be considered obsolete and requested the Secretariat to remove references to the X.25 from the GTS Manual and Guidelines.

4.3.3 The Commission noted that the MTN cloud can now include the core network of WIS connecting all GISCs as well as being a major component of AMDCNs. It noted the findings of the expert teams that to ensure the performance requirements of an “All Hazards Network” of 2 minutes end-to-end within WIS, all GISCs must utilize the any-to-any connectivity of the WIS Core Network to send warnings from their AMDCN to all other GISCs. It requested the relevant expert teams to review procedures and guidelines for message switching in the Manual on GTS to align with the performance metrics identified by the ET-CTS for support of a WIS “all Hazards Network”. The Commission also noted the findings of ET-CTS on the linear relationship between network bandwidth required for GISCs and the number of GISCs, which results from the required all-to-all connectivity of GISCs. It recommended that centres considering offering to be a GISC take into account this overhead, and that when considering adding a new GISC to WIS, this linear relationship of overheads to existing GISCs be taken into account relative to the benefits of inclusion of a new GISC to WIS. The Commission noted that this restriction may be eased in the future if multicast technology proves to be effective at reducing bandwidth requirements and encouraged the ET-CTS to test multicast technologies both from network and application view points. The commission recommended that regional associations take note of the potential cost to all GISCs related to the numbers of GISCs and review their regional requirements accordingly.

4.3.4 The commission noted the satellite distribution services are an important component of WIS. Furthermore it noted that some satellite systems also perform a data collection service. It thanked EUMETSAT for implementation of the new HRDCP-system and urged its members to consider taking advantage of this new service in designing their new observing and warning systems.

4.3.5 The Commission noted and strongly echoed the concern of EC-LXII with the need for additional support and funding for the work on radio frequency coordination including the ongoing work and WMO representation in radio frequency management process (ITU/WMO Handbook on

Use of Radio Spectrum for Meteorology: Weather, Water and Climate Monitoring and Prediction; http://www.itu.int/publications/publications.aspx?lang=en&media=electronic&parent=R-HDB-45-2008). It requested Congress to take the necessary steps to safeguard the continuous protection of meteorological frequencies and ask the Secretariat to continue support for radio frequency activities as in the past. It further recommended to secure additional support by establishing a voluntary trust fund. The Commission noted, however, that many Members already make trust fund contributions to radio frequency management efforts of EUMETNET, to the direct benefit of WMO positions, and that such countries might not be in a position to also contribute to a WMO trust fund on the same topic. The Commission advised the Secretariat not place reliance on the trust fund to carry out the required important ongoing work and WMO representation in radio frequency management process, in particular in view of ITU-R WRC-12. It further requested the Secretariat to write to Members requesting contributions to this fund and for Members to support local frequency management process. All CBS members should emphasize the importance of local involvement in frequency management and for the need for experts to participate in awareness raising and capacity-building exercises, working closely with relevant national and regional bodies.

Modification to the *Manual on Codes*

4.3.6 The Commission noted that after CBS-XIV the president of CBS approved amendments to the *Manual on Codes* submitted by the Inter-Programme Expert Team on Data Representation and Codes (IPET-DRC) through the new procedure for adoption of amendments to the *Manual on Codes* between CBS sessions and the fast track procedure.

4.3.7 The Commission noted with satisfaction that the application of the new procedure for adoption of amendments to the *Manual on Codes* between CBS sessions makes it possible to reduce the delays in the adoption of amendments, in some instances from two years to one year. With a view to ensuring that users better benefit from this reduction of delays, the Commission stressed the importance for users to be aware of this new procedure and to submit as soon as available the requirements for amendments to the IPET-DRC, including the requirements for the possible dates of their implementation. EC-LXII invited the CBS to ensure that the amendments implemented under this procedure are limited to those that do not create an additional financial burden on Members nor pose operational problems.

4.3.8 In the light of the experience gained in the use of the new procedure for adoption of amendments between CBS sessions and noting the increasing use of TDCF for the representation of weather, climate and water data, the Commission agreed to review the procedures for adoption of amendments to the *Manual on Codes*, as proposed by the OPAG-ISS. The Commission adopted Recommendation 1 (CBS-Ext.(10)) – Amendments to the *Manual on Codes* (WMO-No. 306), Introduction chapter of Volumes I.1 and I.2.

4.3.9 In response to the requirements submitted by ICAO the Commission endorsed the relevant amendments to the aeronautical codes, METAR (FM 15), SPECI (FM 16) and TAF (FM 51) in the *Manual on Codes* as proposed by the IPET-DRC. The Commission adopted Recommendation 2 (CBS-Ext.(10)) – Amendments to the *Manual on Codes* (WMO-No. 306), Volume I.1.

4.3.10 The Commission noted with satisfaction that the Secretariat makes available the code tables in electronic formats that can be used by the NMHSs when running automated processing systems such as encoders and decoders. The Commission also noted that the electronic format of presentation of the code tables facilitates the management of the changes to the *Manual on Codes*, Volume I.2, and that accordingly the Secretariat was adapting the format of the *Manual on Codes*, including links to the code tables.

Migration to Table Driven Code Forms (TDCF)

4.3.11 Noting the difficulties met by WMO Members in meeting the 2010 deadline to complete the migration of the data category 1 (SYNOP, PILOT, TEMP and CLIMAT), EC-LXII invited CBS to

consider measures with a view to ensuring that all WMO Members continue accessing the observational data available on the GTS in the appropriate format as well as to facilitate and foster the migration from TAC to TDCF.

4.3.12 The Commission noted the significant effort made by many Members to successfully meet the deadline, and the significant support provided by CBS experts. It agreed that after November 2010 the parallel distribution of TAC and TDCF category 1 data may continue and will be discontinued step by step whenever possible with respective advance notification. The Commission agreed on the deadline of November 2014 to stop the parallel distribution of TAC and TDCF data for the category 1 as well as the category 2 (satellite observations) and 4 (marine data). After November 2014, the TAC may be used only for the exchange of data between two NMHS under bilateral agreement. The Commission agreed that although TACs will be phased out, the IPET-DRC will continue to consider proposals for changes to the aeronautical TAC codes (i.e. METAR, SPECI and TAF) which will have to continue to be updated in response to amendments to ICAO Annex 3/WMO Technical Regulations [C.3.1] until the ICAO endorse the migration to TDCF codes. Any other requests for new encoding capabilities should be addressed through TDCF.

4.3.13 Noting the discontinuation of the provision and international exchange of the monthly upper-air CLIMAT TEMP reports, the Commission agreed to include CLIMAT TEMP and CLIMAT TEMP SHIP data into the category 6 (obsolete data).

4.3.14 The meeting agreed to amend the migration matrix as given in Annex XI to the present report.

4.3.15 The Commission restated that:

(a) All Members should develop and implement their national plans, in particular by using available guidance, self-training and encoder-decoder software developed by the CBS expert teams, regional coordinators/rapporteurs and Members;

(b) Members having developed and/or implemented their national migration plan should assist other Members to do so, in particular those operating GTS Regional Telecommunication Hubs (RTH) should assist the Member countries located in the zone of responsibility of their RTH;

(c) Members should stress the importance of providing training on TDCF in the WMO Regional Training Centres;

(d) Members should give priority to the development and implementation of projects under technical cooperation activities required to support the migration.

4.3.16 The Commission invited the WMO Members operating an RTH to consider contributing to facilitate the migration, in particular that their RTH:

(a) Facilitate the step-by-step migration by assisting in the definition of ad hoc arrangements between zones of responsibility of RTHs, and by monitoring the exchange of TDCF bulletins and reports on the GTS;

(b) Convert TAC data into TDCF data when an associated NMC is still not in a position to send TDCF data and the parallel distribution of TAC and TDCF data has ceased;

(c) Convert TDCF data into TAC data if an associated NMC still needs to receive TAC data and the parallel distribution of TAC and TDCF data has ceased.

4.3.17 The Commission endorsed the ET-OI recommendation to provide a formal practice for one NMHS to transform another NMHS's messages and files between TAC and TDCF. The NMHSs should ensure that the bulletin(s), comprising the converted data, are included in

Volume C1 and that the information that the data were converted by the NMHS, is included in the column "remarks" of Volume C1 for each bulletin. Similarly, those converting TAC into TDCF should include relevant metadata required to create the TDCF as approved by the TAC originator, including information on the templates used for conversion. Regarding the distribution of metadata by the monthly newsletter, a standardization of its content is recommended. In this context the Commission pointed out the importance of keeping Volume C updated in particular for the solution provided with WIS. The Commission requested the relevant expert teams to review the GTS guidelines and update accordingly.

4.3.18 The Commission was informed by the United Kingdom of the development of a two way TAC to TDCF converter package that has been running operationally at the Met Office since July 2010. The Commission welcomed the offer from the United Kingdom to distribute this TDCF Converter software package via the CBS Software Registry. The Commission further noted that the United Kingdom encouraged Members to explore collaboration opportunities for the future development of the software.

Operational Information Service related to Information Systems and Services

4.3.19 The Commission noted the proposed migration plan for transition from the catalogue of meteorological bulletins (Volume C1) to WIS DAR metadata catalogue. The transition plan indicates that RTHs will continue to maintain Volume C1 using existing procedures in parallel with providing updates to the WIS DAR metadata catalogue. Volume C1 will be considered the primary source of this information until 2015. As the robustness of WIS DAR metadata catalogue (and associated GISC implementations) improves, RTHs will consider extraction of amendments to Volume C1 from the WIS DAR catalogue via some automated process. The expectation is that the manual collation of amendments for Volume C1 will gradually disappear during the period 2011–2015. The Commission noted the offer from Météo-France to collate amendments to Volume C1 and update the WIS DAR metadata catalogue during the beginning of the WIS pre-operational phase on behalf of Members who are unable to provide their DAR metadata updates via a GISC.

4.3.20 The Commission invited the OPAG-ISS:

(a) To follow-up the implementation of the plan for the transition from Volume C1 to the WIS DAR metadata catalogue;

(b) To develop a mechanism to be implemented by the GISCs to inform the WMO Members of the changes in the catalogue in replacement of the METNO bulletins;

(c) To review the practice used for maintaining the list of "additional" data and products and to make relevant proposals, including the role of the GISCs.

4.3.21 Noting that several MTN centres had not implemented the maintenance of their parts of Volume C1 and/or had not provided updates of their routeing catalogue, the Commission urged these centres to fully implement the standard procedures for the maintenance of Volume C1 and the recommended practices for updating the routeing catalogues.

4.3.22 Noting the deficiencies in the updating and presentation of Volume C2 of WMO-No. 9 – Transmission Programmes, the Commission recommended that WMO Members review the contents of Volume C2 and send amendments to the WMO Secretariat as required.

Procedures for collection, routing and distribution of data and products

4.3.23 The Commission agreed to recommend amending the Attachment II-5 to the Manual on GTS with a view to allocating:

(a) T_1 = X for Common Alert Protocol (CAP) messages in Table A;

(b) $T_1T_2A_1$ = IOZ for data issued from a deep ocean tsunameter in Table C6;

(c) New entries in Tables C6 and C7 for ozone data.

4.3.24 The Commission noted the need to update the Manual on GTS to reflect other changes recommended by OPAG-ISS. These include updates to switching systems practices and modified procedures for the use of e-mail and the web as a path for submitting and receiving information on the GTS.

4.3.25 The Commission adopted Recommendation 3 (CBS-Ext.(10)) – Amendments to the *Manual on the Global Telecommunication System* (WMO-No. 386), Volume I, Part II, including the update of Attachment II-15 on the Recommended Practices and Procedures for the Implementation, Use and Application of TCP/IP on the GTS.

Routing of CLIMAT bulletins on the GTS

4.3.26 The Commission noted that issues on the reception of CLIMAT messages from the GTS were raised by the GCOS/WCRP Atmospheric Observation Panel for Climate. These were both telecommunication and encoding issues. The Commission urged the WMO Members operating an RTH:

(a) To ensure that the designated RTH focal points can contribute to addressing such issues, in particular in cooperation with the CBS Lead Centres for GCOS;

(b) To review the contents of the catalogue of meteorological bulletins (Volume C1 of WMO-No. 9) and the routeing catalogues, and update them as necessary and promptly.

Quantity monitoring of the operation of the WWW

4.3.27 The Commission emphasized that the planning and implementation of the Integrated WWW Monitoring (IWM) was relying on the action taken by RTHs. The Commission noted that ten MTN centres participated in the IWM in 2009/2010, primarily by providing RTH/MTN monitoring reports showing the availability of reports on the MTN. It urged all RTHs:

(a) To coordinate the implementation of the IWM with their associated NMCs;

(b) To provide IWM RTH reports, including the monitoring reports of their associated NMCs;

(c) To examine the analysis of the monitoring exercises as provided and posted by the Secretariat on the WMO server, and to take further action to mitigate the deficiencies observed, in particular within their zone of responsibility.

4.3.28 The Commission was pleased to note that RTHs Beijing, Tokyo, and WMC Melbourne agreed to contribute to the extension of the Special MTN Monitoring (SMM) to the monitoring of BUFR climate and marine data: the three centres agreed to provide the raw data, and WMC Melbourne to provide the relevant pre-analysis files. The Commission further invited the Secretariat to review the procedures of the Annual Global Monitoring (AGM) and the procedures of the IWM with a view to extending the monitoring of observational data to BUFR climate and marine data.

4.3.29 The Commission for Climatology decided to discontinue the provision, dissemination and international exchange of CLIMAT TEMP reports (Resolution 3 (CCl-XV), WMO-No. 1054), with effect from June 2010. The Commission requested the Secretariat to amend the Manual on GTS to reflect the discontinuation of the exchange of CLIMAT TEMP reports, in particular as regards the monitoring procedures.

4.3.30 China Meteorological Administration (CMA) offered to assist the Secretariat in the development of an integrated quantity WWW monitoring application. The application will be instrumental in making more efficient the tasks of the Secretariat for the analysis of the monitoring

exercises coordinated by the Secretariat. The Commission noted that the possibility to use the application by the RTHs and NMCs to carry out their own analysis of the monitoring reports was being considered. The Commission thanked CMA for this important contribution to the quantity monitoring activities.

Metadata development and implementation

4.3.31 The Commission endorsed the editorial corrections proposed by the first meeting of the Inter-Programme Expert Team on Metadata and Data Interoperability (IPET-MDI; http://www.wmo.int/pages/prog/www/WDM/IPET-MDI-I/documents/Doc2-1-1_Core1.1.doc) to the UML representation of the version 1.1 of the WMO core profile of the ISO metadata standard as given in IPET-MDI-I/Doc. 2.1 (1) with a view to aligning it to the Annex A to ISO 19115 Cor 1.

4.3.32 The Commission noted that the IPET-MDI developed a set of 62 recommendations in response to clarifications required for the implementation of the WMO Core Profile by WIS centres or related to the tools required to support the development of WMO Core Profile. The Commission was pleased to see the specification of a "package manifest" that will accompany each release of the WMO Core Profile, noting in particular the inclusion of automated validation tools and guidance materials. Recalling the role given by EC-LVIII to the presidents of the technical commissions as WMO's authority for the management of metadata, the Commission recommended to invite the presidents of technical commissions to endorse, and to request the Secretariat to publish, the packaged metadata release including editorial corrections to version 1.1, code-list extensions and recommendations from the first meeting of IPET-MDI, as WMO Core Profile version 1.2 at http://wis.wmo.int/2010/metadata/version_1-2.

4.3.33 The Commission noted the revision timescales for ISO19115 Geographic Information – Metadata: a Draft International Standard (DIS) is expected in 2011, with final publication of ISO19115:2012 in 2012. The WMO Core Profile v2.0 (the next major release) is expected to incorporate a move to ISO19115:2012 and harmonization with JCOMM/Marine and Hydrology metadata profiles.

4.3.34 The Commission identified the need for interim releases of the WMO Core Metadata Profile in order to respond to the evolving needs from other technical commissions and Cross-Cutting Programmes. The interim releases will be published as version 1.2.1 (second quarter, 2011) and version 1.2.2 (first quarter 2012). The Commission recommended that these interim releases be published under the authority of the presidents of technical commissions, and that backward compatibility with previous versions be maintained.

4.3.35 Noting that some centres were developing experience in the implementation of the WMO Core Profile, the Commission invited IPET-MDI to consider means to share this experience with other centres. The Commission also stressed the need for clear guidance on the transition from current practices.

Development of WMO data models

4.3.36 The CAeM-CBS Expert Team on OPMET Data Representation (ET-ODR) was tasked to specifically address the requirements of aeronautical meteorology, including ICAO, for Data Representation systems. The Commission noted that, within the framework of the development of a pilot project for the presentation of OPMET data in XML, a test of the transmission on the ICAO Aeronautical Fixed Telecommunication Network (AFTN) of a METAR instance of a three-level Modelling of WMO data products based on BUFR/CREX tables presented in XML was carried out in July 2009. The ET-ODR concluded that XML could be accepted for encoding and exchanging OPMET data within the aviation community. With a view to satisfying the requirements of ICAO to use the WXXM model for the representation of OPMET data in XML, the Commission invited the IPET-MDI to further consider the possibility to map a WMO data model for the aviation domain and the WXXM model and to continue working on WMO data models derived from TDCF tables.

4.3.37 The Commission was pleased to note that a Memorandum of Understanding (MoU) between WMO and the Open Geospatial Consortium (OGC) was signed in November 2009. The WMO/OGC MoU is instrumental in providing the mechanism for the coordination between the activities carried out by OGC and WMO with a view to facilitating the use of ISO/OGC standards where applicable, including potentially the development of WMO data models. It also noted the commitment between IPET-MDI/Met-Ocean- and the Hydrology-Domain Working Groups (DWG) to undertake joint interoperability experiments, due to commence in 2011, that aim to cover data management relating to the entire water cycle.

4.3.38 The Commission stressed the importance of the participation of the technical commissions in the definition of the requirements of the WMO Programmes and the development of the WMO data models. It noted that the initial proposal for the WMO Conceptual Data Model is complementary to the work of the OGC Met-Ocean DWG Conceptual Modelling sub-group, as they are based on "ISO/DIS 19156 Geographic Information – Observations and Measurements" (O&M), which is aligned with decisions from FAA/EUROCONTROL and OGC Hydrology DWG to derive WXCM/WXXM2 and WaterML2 respectively from O&M. The Commission noted the IPET-MDI plan to proceed to create a profile of ISO19156 that relates the O&M model to WMO Table-Driven Representations. The Commission requested that this approach must be validated to ensure that the data model is compatible with existing WMO TDCF. It stressed the importance of ensuring a strong linkage between the BUFR tables and the WMO data models so that the main contribution of the IPET-DRC to the governance of the WMO models remained with the maintenance of the BUFR Tables and associated regulations.

GISC and DCPC demonstration process

4.3.39 The Commission noted that the Expert Team on GISC and DCPC Demonstration Processes (ET-GDDP) developed a questionnaire in order to get evidence from the candidate WIS centres on their capabilities to run GISCs and DCPC functions, and drafted a document providing procedure and guidelines for the WIS demonstration process.

4.3.40 The Commission noted the importance of the demonstration test cases for ensuring the compliance of the WIS candidate with the functional and technical specifications of WIS. The Commission stressed the importance for each candidate WIS Centre to set-up an integrated system ready for operation to demonstrate to the ET-GDDP its capabilities, in particular as regards to metadata harvesting, metadata publishing, discovery of data, supporting ad hoc request, user authentication and access authorization.

4.3.41 The Commission noted with satisfaction that for GISC candidates, the assessment process includes a site visit, to enable the ET-GDDP to audit the technical facilities, the operational process and the organization in place, to review the WIS documentation and procedures and to run demonstration test cases. The Commission welcomed the audit process highlighting strengths, weaknesses, opportunities for improvement and potential area of concern.

4.3.42 The Commission noted with satisfaction that 18 members/organizations entered into the first round of the demonstration process for a total of 13 GISCs and 56 DCPCs. The first evidences were analysed by the ET-GDDP and feed-back provided to the candidates. The Commission was pleased to recommend to Congress the GISC candidatures of China, Germany and Japan and their associated DCPCs along with the DCPCs of EUMETSAT, and ECMWF. It noted that some of these recommended centres have been in pre-operational mode since May 2010. It noted that the candidatures of Australia; Brazil; France; India; Islamic Republic of Iran; Republic of Korea, Saudi Arabia; Sweden; Italy; Norway; Morocco; Hong Kong, China; and the United Kingdom were still under review. It further agreed that those centres, if endorsed by ET-GDDP and CBS Management Group before Congress, would also be recommended to Congress. The Commission also decided to request Congress to designate centres under review subject to demonstration of pre-operational compliance to CBS, including those centres who declared their interest in completing the demonstration process, such as those of the Russian

Federation and the United States. The Commission adopted Recommendation 4 (CBS-Ext.(10)) – Designation of centres of the WMO Information System.

4.3.43 Stressing the importance of the demonstration process for starting the pre-operational phase of WIS, the Commission requested the ET-GDDP to set-up and start the second round of the demonstration process. The Commission also noted that further designations will be performed by EC through the review of the Manual on the WIS.

4.3.44 Noting the recommendation of CGMS session (November 2010, New Delhi), the Commission encouraged all relevant meteorological satellite centres to work towards designation as DCPCs for facilitating their services to WMO community.

4.3.45 With a view to ensuring that the DAR metadata catalogues and caches be complete and reliable, and noting that some WIS centres were developing experience in the implementation of synchronization of data and metadata between GISCs, the Commission stressed the need for a global demonstration of WIS, and invited the ET-GDDP to coordinate this.

4.3.46 Noting the responsibility of the GISCs in the coordination of a WIS telecommunication infrastructure that can meet the requirements for information exchange of WIS centres located in their areas of responsibility, the Commission recommended to invite the GISCs to start defining proposals for Area Meteorological Data Communication Networks (AMDCNs) and requested the ET-GDDP to verify that all WIS centres are included in the AMDCNs and that where there is an overlap between the proposals, each GISC must clarify if they are to be a centre's principal GISC or an associated GISC.

Regulatory documentation on the WMO Information System

4.3.47 The Commission recalled that Cg-XV emphasized the need for appropriate regulatory documentation for facilitating the implementation by Member countries at global, regional and national levels. As regards the *Technical Regulations* (WMO-No. 49), it had requested ICG-WIS and CBS, in consultation with regional associations and technical commissions, to prepare amendments to the relevant section for consideration of Cg-XVI. The Commission reviewed and endorsed the draft amendments to the *Technical Regulations*, Volume I – General Meteorological Standards and Recommended Practices, Section A.3, and adopted Recommendation 5 (CBS-Ext.(10)) – Amendments to the *Technical Regulations* (WMO-No. 49), Volume I, Section A.3.

4.3.48 The Commission also recalled that Cg-XV tasked CBS, in collaboration with the ICG-WIS, to develop regulatory documentation, including organization and recommended practices and procedures (e.g. a Manual on WIS), in phases based on the validation of preliminary organizational, functional and operational design. In this regard, EC-LXII emphasized the high priority need for the development of the Manual on WIS, and noted and supported the important building blocks that were developed towards the future "Manual on WIS". Cg-XV emphasized that the WIS implementation should build upon existing WMO information systems, including through the continued consolidation and further improvements of the GTS for time-critical and operation-critical data. In this regard, the Commission agreed that, at this stage, the Manual on WIS complement the Manual on GTS (WMO-No. 386). Eventually, the Manual on WIS should update and integrate the content of the current Manual on GTS. It tasked its OPAG on ISS to further develop the Manual on the WIS in this respect. The Commission reviewed and adopted Recommendation 6 (CBS-Ext.(10)) – The *Manual on the WMO Information System* (WMO-No. 1060), and requested the Secretary-General to make the necessary arrangements for its submission to Cg-XVI.

4.3.49 The Commission noted the progress on the Guide to WIS and requested that this work continue to be developed. It emphasized the need for additional components including a "best practices for metadata management" and appropriate training material. It noted that due to the requirement for all Members to benefit from WIS, the Guide to WIS should also be made available in all official languages.

4.3.50 The Commission noted the success of the WIS Jump Start project for individual centres and training workshops such as those held in Turkey and Japan. It encouraged Members to continue to support the WIS Trust Fund and to maintain in-kind contributions and secondments to support WIS implementation.

Future priorities for WIS implementation, capacity-building

4.3.51 The Commission noted that WIS implementation is now on track for new centres to go operational following Cg-XVI. It emphasized that although the implementation of the new functionality of WIS will then be operational in a few core centres, many Members will still have to begin their implementation. Thus, the full implementation of WIS by all Members will be a longer term endeavour. The Commission noted that the priority of WIS has moved from development to capacity-building, especially those activities aimed at developing and least developed countries. It welcomed the offer from the Republic of Korea to contribute to the capacity-building activities on migration to TDCF and WIS implementation. The Commission encouraged Members that have implemented WIS to assist those who have still to do so. It noted that WIS is a continuously evolving system, improving as new technologies become available. Thus, CBS expert teams should continue to refine WIS components to increase the efficiency and effectiveness of WIS, paying particular attention to address fully any security issues associated with these new technologies. It encouraged Members to interact with the standards bodies to ensure those standards on which WIS interoperability is based, better meet the WMO community's needs.

4.3.52 The Commission highlighted that WIS is an essential component of many WMO high priority initiatives, including Disaster Risk Reduction, WIGOS and GFCS. It encouraged Members to ensure that new projects take advantage of the WIS and its set of interoperability standards with an aim to increasing their ability to respond to user requirements while reducing the costs of developing and implementing new initiatives.

4.4 DECISIONS FOR THE OPEN PROGRAMME AREA GROUP ON DATA PROCESSING AND FORECASTING SYSTEM, INCLUDING CAPACITY-BUILDING AND THE QUALITY MANAGEMENT FRAMEWORK AND EMERGENCY RESPONSE ACTIVITIES (ERA) *(agenda item 4.4)*

4.4.1 The Commission noted the considerable progress made by the OPAG on DPFS chaired by Mr Bernard Strauss (France), and that the OPAG is responsible for the Global Data-processing and Forecasting System (GDPFS) and the ERA programmes. These programmes are core components of the Members' operational infrastructure that support a wide range of forecasting-related and environmental services that WMO Members provide. They contributed directly to WMO Expected Result 1 (production of forecasts and warnings), and to others including climate information and prediction, disaster risk reduction, services and applications, and capacity-building. The DPFS activities addressed several WMO priority areas including the GFCS development, disaster risk reduction, capacity-building, and aviation meteorology, and collaborated with the developments in WIS and WIGOS, and with WWRP in weather and climate predictions.

4.4.2 The Commission reviewed the Manual on GDPFS and adopted Recommendation 7 – Amendments to the *Manual on the Global Data-processing and Forecasting System* (WMO-NO. 485).

Severe Weather Forecasting Demonstration Project (SWFDP)

4.4.3 The Commission noted that the GDPFS, with a focus on disaster risk reduction, continued to address day-to-day forecasting of severe and high-impact weather phenomena, over a wide range of forecast time scales. Many NMHSs of developing countries have been benefiting from their participation in the Severe Weather Forecasting Demonstration Project (SWFDP), especially in the provision of advisories and warnings of severe weather events, with increased lead-times and greater reliability. The SWFDP represented the implementation of a "Cascading Forecasting

Process", an approach that facilitated improved access to, and interpretation and use by forecasters in developing countries of NWP/EPS products made available by advanced GDPFS Centres.

4.4.4 The Commission noted that the SWFDP was currently progressing well in two regions: namely sixteen countries of southern Africa; and up to nine island states of the South Pacific Islands.

4.4.5 The Commission noted that JMA (Japan) has implemented a dedicated Website to support the SWFDP for the South Pacific Islands, as well as providing support to the continuing development of a regional project in Southeast Asia.

4.4.6 The Commission noted with appreciation ECMWF's support to the SWFDP as a global products centre, and the annual training it provided on the Centre's NWP/EPS products for use by WMO Members. While priority has been given to selecting qualified participants from SWFDP participating countries, supported by WMO, it is anticipated that with the growing number of SWFDP regional projects, the increasing demand for this valuable training will not likely be adequately met at the current level of allocated resources.

4.4.7 The Commission encouraged those few participating countries that had been experiencing some difficulties to fully participate in the SWFDP to identify specific training requirements that could address gaps and weaknesses, in order to bring them fully on board.

4.4.8 The Commission recalled its request to its Steering Group on SWFDP (SG-SWFDP) to continue to give guidance and monitor the further development of existing and new projects, and was encouraged to note that plans have been initiated for the development of two new subprojects: targeting four countries in Southeast Asia; and six countries in Eastern Africa including involving countries bordering on Lake Victoria and nearby countries.

4.4.9 The Commission noted that in conjunction with the SWFDP development in Eastern Africa, a workshop was held in Nairobi, Kenya (4–8 October 2010) with participants from six Eastern African countries (Kenya, Uganda, Ethiopia, United Republic of Tanzania, Burundi, and Rwanda). The main objective of the workshop was to commence development of a plan for the implementation of the SWFDP in the Greater Horn of Africa (GHA) focused on improving the ability of NMHSs to forecast severe weather events using available NWP/EPS products, and to deliver warning services, through implementing a cascading forecasting process. The meeting further discussed a strategy for a roll-out of the project in the GHA. As well, the Commission noted that a training workshop was held in Dar es Salaam, United Republic of Tanzania (19–29 October 2010) to enhance capacity-building in the Eastern Africa region in preparation for the SWFDP for this region.

4.4.10 The Commission reconfirmed the importance to move the SWFDP forward with a phased approach, starting with the most feasible elements, taking into account local requirements, and scientific and technical feasibilities towards its successful implementation, and agreed that in the initiation of new regional subprojects, the number of participating countries should be limited ideally to three or four countries, and the focus should be on hazards of strong winds and heavy precipitation, with possible expansion to additional countries and other weather-related hazards in a subsequent phase(s).

4.4.11 The Commission noted that a new subproject is arising in Southeast Asia with participants from four countries (Cambodia, Lao People's Democratic Republic, Thailand and Viet Nam). These countries have suffered from natural disasters even in recent years such as tropical cyclones, heavy rains, which cause large losses in human life and property. The mission of this subproject is to enhance the technical capacity in operational forecasting and advancement in weather service delivery in the region. A meeting (17–18 September, 2010) was held in Tokyo, Japan, to develop a strategy for preparing an implementation plan for this subproject.

4.4.12 The Commission noted that, among the main challenges for the SWFDP, is the need for very short-range forecasting (including the first 12 hours) tools, especially to address the rapid onset of localized severe thunderstorms that produce heavy precipitation and strong winds, in the

absence of adequate real-time observational networks, especially without weather radar coverage. It encouraged continued coordination between the SG-SWFDP and the CBS Expert Team on Satellite Utilization and Products (ET-SUP), to explore collaboration related to training, satellite information (data and products) and dissemination mechanisms to support the SWFDP. The Commission also agreed that WMO would provide input to the annual meeting of the Coordination Group on Meteorological Satellites, in relation to SWFDP developments, suggesting possible collaboration on improved uptake by forecasting centres of satellite products and on satellite dissemination of SWFDP-needed products.

4.4.13 The Commission agreed that building capacity, especially in human skills and competencies, and adequate tools including innovative technology (like high-performance computing), are essential and needed in Developing and Least Developed Countries.

Strategy for Severe Weather Forecasting Demonstration Project (SWFDP)

4.4.14 The Commission noted that EC-LXII had recognized the need for ensuring the long-term sustainability of the benefits gained with the SWFDP and had requested CBS to develop a strategy for the SWFDP. The Commission agreed with the strategy as presented in Annex XII to the present report, with the following comments:

- The SWFDP is clearly a success story, and it should be seen as a model for advancing the GDPFS and service delivery worldwide.
- The transition to operations is critically dependent on accessing sustainable funding, in particular from extrabudgetary sources.
- New products, such as those coming from promising research, should be carefully assessed in advance, and be provided with product description and accuracy information, and guidance on usage.

4.4.15 The Commission agreed that as part of a strategy for SWFDP, the successful elements of mature projects (for example in southern Africa) need to make a transition into routine operations. In this regard, the SG-SWFDP developed an additional project phase entitled: “Continuing Development Phase”, (referred to as “Phase 4”), when the project has developed sufficiently its framework through its initial phases for it to be fully assumed under the responsibility of the respective regional associations including the raising of necessary resources to sustain the project. The Commission requested the Secretariat and relevant programmes to maintain their strong support to regional subprojects in their transition to “Phase 4”.

4.4.16 The Commission agreed that the criteria for transitioning of the SWFDP to operational status should be clearly defined and requested the SG-SWFDP to develop these criteria in consultation with participating centres and the relevant regional bodies.

4.4.17 The Commission recommended that training activities within the framework of the SWFDP should ideally be carried out regularly (e.g. annually) and opportunistically with other training activities, to cover new developments and the normal cycling of new operational weather forecasters in the forecasting centres. The Commission further recommended that support for ongoing training within regional associations be provided in the form of regular “train the trainer” workshops with contribution from the global centres and RSMCs, and requested the Secretary-General to provide assistance in this regard.

4.4.18 The Commission noted the importance of sustainability of education and training for the SWFDP as it passes from pilot phase to operational phase. The Commission further noted the example of the CGMS-WMO Virtual Laboratory for Satellite Meteorology as a partnership between the satellite operators and a number of training institutes to promote and deliver education and training in Satellite Meteorology. The Commission recommended that the Chair of the SG-SWFDP create a small ad hoc task group to investigate the feasibility of modelling a Virtual Laboratory for

SWFDP along the lines of the Virtual Laboratory for Satellite Meteorology and to report to the CBS MG on the outcomes of the feasibility study.

4.4.19 The Commission recognized there was a significant increase of resources required to support multiple and simultaneously running projects, both in terms of funding and people, including commitments made by global and regional centres, and coordination and support by the Secretariat. The Commission expressed its appreciation to the Secretariat for its success in mobilizing resources from the World Bank to synergistically support the SWFDP project for eastern Africa. It stressed that the EC-LXII (2010) request to expand the SWFDP could only be realized with a successful strategy for resource mobilization to support these projects.

4.4.20 The Commission urged the Secretary-General to investigate possible extrabudgetary sources of funding to support the implementation of sustainable SWFDP projects, consistent with the Strategy, including training and capacity-building activities, overall coordination and management of the SWFDP, and the transition of mature projects into routine operations.

Very short-range forecasting

4.4.21 The Commission recalled that a suitable blending of the use of real-time observational data sets and nowcasting methods, with high-resolution NWP outputs is possible to address this forecasting range (the first 12 hours), and agreed that the table of possible blending approaches (WMO-No. 1040), should be further developed or applied, for example in relation to SWFDP projects where clear requirements have been identified, for example in guidance to flash flood forecasting.

Extended and long-range forecasting

4.4.22 The Commission recalled its request regarding the review of compliance of Global Producing Centres (GPC) of Long-Range Forecasts against the designation criteria, and noted that all 12 GPCs were providing forecast products and verification information. While it was concerned that some GPCs were not fully compliant with the designation criteria, the Commission requested the ET-ELRF to review the list of mandatory criteria to make sure that they properly and realistically address the most essential aspects of GPC functions.

4.4.23 The Commission recalled that EC-LXII had urged all GPCs to make their hindcasts available to users.

4.4.24 The Commission noted that the ET-ELRF had been contributing to a number of activities that support the foundation of the Global Framework for Climate Services (GFCS), including: the role of GPCs and associated Lead Centres (LCs) in the Climate Services Information System (CSIS) component of the GFCS; the designation of Regional Climate Centres (RCCs) as part of the GDPFS; the formation of a joint CCl-CBS Expert Team on RCCs; and the use of GPCs' and LCs' products in the preparation of regional consensus forecasts at RCOFs. The Commission noted that the ET-ELRF had reviewed the description and role of GPCs in the WMO draft Position Paper, and requested that their comments and suggestions be conveyed to the drafting team for GFCS.

4.4.25 The Commission noted that the proposed WMO Global Seasonal Climate Update (GSCU) would summarize the current status (monitoring) and the expected future behaviour (prediction) of major general circulation features and large-scale oceanic anomalies around the globe (e.g., ENSO, North Atlantic Oscillation, Indian Ocean Dipole, etc.) and discuss likely impacts on continental-scale temperature and precipitation patterns. The Commission welcomed this initiative and noted that further developed GPC and LC products would help to assist the preparation of GSCUs, including: new LC-LRFMME probability products, verification of LC-LRFMME multi-model products and possible centralized calculation of verification scores for individual GPC products. The Commission therefore urged the GPCs and LCs to review the feasibility of, and make progress in these developments.

4.4.26 The Commission noted that RCCs were being encouraged to make use of the set of verification scores of the Standardized Verification Scores of Long-Range Forecasts (SVSLRF), and concluded that the Manual on the GDPFS, Part II, Attachment II.8, required some revision since it currently addressed only requirements on GPCs. In addition, it agreed that Level 3 verification scores should no longer be mandatory for GPCs as such scores are more meaningful when generated at regional level. In this regard, the Commission recommended an amendment to the Manual on the GDPFS, Attachment II.8 on these and LRF-related matters, as found in Annex 1 to Recommendation 7 (CBS-Ext.(10)).

4.4.27 The Commission noted that, in the context of the GFCS, some GPCs would be expected to play an important role in providing global climate predictions from seasonal to longer time-scales. It noted with appreciation that GPC Exeter is prepared to contribute at this stage by coordinating international collaboration in, and reviewing research on decadal prediction, to report back to CBS (via DPFS) on the potential for multi-annual prediction, in coordination with CCl. The Commission agreed, in response to the request of EC-LXII, to an additional item in the Terms of Reference for the ET-ELRF in this regard, as follows:

> Review research on initialized predictions for timescales longer than seasonal and report on potential for operational predictions to CBS and CCl.

4.4.28 The Commission noted that the Commission for Climatology had developed a new procedure for the designation of RCCs and RCC-Networks for climate sensitive areas that fall within the responsibilities of more than one regional association (e.g. Polar Regions), and in this regard the Commission recommended an amendment to the Manual on the GDPFS, as found in Annex 4 to Recommendation 7 (CBS-Ext.(10)).

Probabilistic forecasting and Ensemble Prediction Systems and applications

4.4.29 The Commission, while noting significant advances in operational EPS systems, encouraged development of probabilistic forecasting to support early warning of severe and high impact weather as among the highest priority, including propagating forecasts of meteorological parameters into impact models, in contributing to disaster risk reduction.

4.4.30 The Commission noted that, in predicting severe weather events it is essential to take account of their low probabilities of occurrence in order to make effective use of the NWP/EPS forecasts and to ensure that alerts and warnings are reliably issued. To be fully effective, this requires a fundamental change of thinking whereby alerts, watches and even warnings become more probabilistic in nature to represent the risks associated with high-impact weather and related phenomena. Effective communication to users of warnings and of the meaning of low probabilities of high-impact events is essential to ensure their effective use. In this context, the Commission suggested that DPFS and PWS collaborate in addressing this issue.

4.4.31 The Commission agreed that periodic training of weather forecasters is needed in the use of EPS products, specifically in the prediction of dangerous weather phenomena, to improve warning programmes and services.

4.4.32 The Commission requested the DPFS to continue its work on drafting a series of notes upon which guidance on how to use EPS in routine forecasting process could be further developed by trainers and forecasters.

4.4.33 The Commission recalled that a single window of verification information for global EPS is provided by the Lead Centre for EPS Verification, hosted by JMA (Japan), and requested all EPS producing centres to provide verification data to the Lead Centre. It also noted that no centre was able to provide precipitation verification based on observations, and that a possible alternative to allow some comparisons of precipitation scores could be possible, by for example, using short-range precipitation forecasts or satellite estimated precipitation data to validate medium-range forecasts. In order to further improve the EPS verification, the Commission recommended an amendment to the Manual on the GDPFS, as found in Annex 2 to Recommendation 7 (CBS-Ext.(10)).

NWP forecast verification for deterministic NWP

4.4.34 The Commission recalled its request to review the existing standard for deterministic NWP verification as defined in the Manual on the GDPFS, Volume I, Part II, Attachment II.7, Table F, and agreed that performing NWP without verification is inconsistent with Quality Management principles, and does not provide necessary quality information to forecasters. The Commission agreed that some essential parts of the recommended actions for verification should be made mandatory, and that efficient and systematic verification systems should be run in real-time to accumulate and produce information, for quick availability, especially for use by operational centres as well as model developers.

4.4.35 The Commission noted that various aspects of the verification system required updating, including the need for clearer specifications and guidance on how to ensure a consistent implementation by all the global NWP Centres. The Commission agreed with the updated standard verification system that was developed and in this regard recommended an amendment to the Manual on the GDPFS, as found in Annex 2 to Recommendation 7 (CBS-Ext.(10)).

4.4.36 While noting that the updated standard verification system included mandatory aspects for verification, and that the updated system should be included in the Manual on the GDPFS as a new Appendix, the Commission nevertheless agreed that all sections related to NWP verification (deterministic, EPS and LRF) should remain together, and in their current location in an Attachment in the Manual. These sections will later be relocated into a suitable location within the new structure of the revised Manual, when adopted, while respecting mandatory and non-mandatory functions.

4.4.37 The Commission noted that to ensure consistency between results from different centres, that a common climatology should be used for those scores requiring climatology, and that the ECMWF Re-Analysis – (ERA) interim climatology was the recommended choice. The Commission suggested that the agreed-upon climatology should be made available for WMO Members for implementing their respective standard verification systems.

4.4.38 The Commission emphasized the importance of providing training to NWP centres, including GPCs and RCCs, to facilitate the implementation of verification requirements and best practices, as stated in the Manual on the GDPFS, so as to promote and ensure coordinated verification activities across these centres.

4.4.39 The Commission, recalling its request for the establishment of a Lead Centre(s) for Deterministic NWP Verification (LC-DNV), agreed with the list of functions for such a Lead Centre, and in this regard recommended an amendment to the Manual on the GDPFS, as found in Annex 2 to Recommendation 7 (CBS-Ext.(10)).

4.4.40 The Commission was pleased to receive a briefing from, and the offer of ECMWF to act as Lead Centre for Deterministic NWP Verification, and agreed that it met the requirement as included in the list of Lead Centre functions, and recommended its designation.

Emergency Response Activities – Atmospheric Transport Modelling (ATM)

4.4.41 The Commission, recalling the recommendation by CBS-XIV, noted that a plan was developed for the migration of the distribution of RSMC products from facsimile to e-mail/Internet distribution. The implementation will commence this year, and would be completed in 2011. The Commission however pointed out that the facsimile distribution should be continued for a certain period, in particular for regions where Internet capabilities were still limited.

4.4.42 The Commission noted a number of improvements over time and experience, including with the International Atomic Energy Agency (IAEA), to the existing RSMC products and therefore proposed: (1) the establishment of a lower cut off limit to display results on charts for time integrated air concentrations and for total deposition; and (2) the addition of two total accumulated

deposition maps valid at t+24 and t+48 hours, and recommended an amendment to the Manual on the GDPFS, as found in Annex 3 to Recommendation 7 (CBS-Ext.(10)).

4.4.43 The Commission noted that WMO had received correspondence from Austria wherein it indicated its intention to carry out the operational responsibilities for an RSMC with Activity Specialization in Atmospheric Transport Modelling in Backtracking, following successful demonstration of its capabilities during numerous tests in conjunction with the CTBTO. In this context, the Commission, following a briefing on the capabilities and proposal of NMC Vienna, agreed to designate it as RSMC Vienna, and recommended an amendment to the Manual on the GDPFS to add RSMC Vienna to the list of RSMCs with this Activity Specialization, as found in Annex 3 to Recommendation 7 (CBS-Ext.(10)).

4.4.44 The Commission recalled the request by the Executive Council to review the WMO Technical Note 170, entitled: "Meteorological and Hydrological Aspects of Siting and Operations of Nuclear Power Plants", and concluded that only a few sections of the publication that concerned CBS were out of date. It recommended these sections be thoroughly reviewed in order to contribute to an updated document that would be of greater relevance to users. At the same time the Commission noted that WMO continued its collaboration with the IAEA in relation to the current revision of its Safety Guide: "Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations", and noted an expert from the WMO Commission for Climatology was involved in this work.

Revised *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485)

4.4.45 The Commission recalled its request at CBS-XIV to undertake a comprehensive review of the Manual on the GDPFS, and noted that a major outcome of an expert meeting was the development of an outline for a new, revised Manual. The Commission agreed that the new Manual on the GDPFS should be based on the outline found in Annex XIII to the present report. The Commission also agreed that:

(a) Volume II of the Manual (Regional Aspects), which has no regulatory status for Members, should be discontinued; however a list of products and the possibility of designation of an RSMC(s) for Polar Regions should be retained and incorporated in Part II of the new Manual;

(b) A wiki, including participation by appropriate experts, could be used for the development of contents of the new Manual;

(c) Coordination with other WMO Programmes is required, primary with WIGOS and WIS to ensure that observational and data management aspects related to the GDPFS are included in the WIGOS and WIS regulatory documentation;

(d) The current version of the Manual should be maintained and kept in force in parallel with the development of the new Manual until its completion.

4.4.46 The Commission noted the appreciation expressed by the ICAO Observer that references to specific requirements by the ICAO International Airways Volcano Watch Operations Group (IAVWOPSG) and International Volcanic Ash Task Force (IVATF) for volcanic ash advisory centres (VAACs) had been included in the outline of the revised Manual on the GDPFS. In this context, the Commission noted that WMO support in this area continued to be critical for the development of the ICAO international airways volcano watch (IAVW).

WMO Sand and Dust Storm Warning and Advisory and Assessment System (SDS-WAS)

4.4.47 The Commission noted its continuing cooperation with the Commission for Atmospheric Sciences (CAS) to develop operational procedures and functions in the planned establishment of

two operational SDS-WAS regional centres as part of the SDS-WAS implementation plan, i.e., one for Asia and another for Europe/North Central Africa/ Middle East. The Commission requested its representatives to the ad hoc CAS-CBS task team on this matter to ensure that operational aspects of the planned system be developed in accordance with the GDPFS purpose and principles.

Future work programme including strategic direction for DPFS

4.4.48 The Commission noted that the structure of the OPAG on DPFS as adopted at CBS-XIV is maintained, while one addition point was added to the Terms of Reference for the ET-ELRF (see paragraph 4.4.27 above).

4.4.49 The Commission recommended that the Severe Weather Forecasting Demonstration Project (SWFDP), as a very effective project for both Disaster Risk Reduction and Capacity-building, be maintained under monitoring and guidance by the CBS Steering Group on SWFDP.

4.4.50 The Commission noted that the OPAG on DPFS developed a draft strategic direction for undertaking its activities in the future work programme, taking into account the WMO priorities. The Commission noted that this draft document is contained in the background material;

4.4.51 The Commission noted that the relevant section of the existing Manual on the GDPFS related to exchange of products between centres had been reviewed in line with the establishment and development of WIS, and therefore proposed an amendment to the Manual on the GDPFS, as found in Annex 5 to Recommendation 7 (CBS-Ext.(10)).

Capacity-building

4.4.52 The Commission agreed on the following guidelines, in relation to capacity-building, for the allocation of priorities for technical cooperation activities for the DPFS:

(a) Highest priority for establishing access at NMHSs to NWP/EPS products from advanced centres, for viewing and post-processing, and use as guidance for forecasting applications, in particular severe weather forecasting;

(b) Highest priority for automation of operational data-processing functions, including the processing of observations and post-processing of NWP outputs, for improvement of all weather forecasting applications, in particular for very short-range forecasting, including nowcasting;

(c) High priority for training on use of NWP products, in particular use of EPS products, and probabilistic forecasting methods, particularly in support of the SWFDP;

(d) High priority for training on operational data-processing, including on the implementation of post-processing of NWP products, running of a Limited Area Model, and NWP verification, where NMHS' capacity is insufficient.

(e) High priority for training in the use of LRF products issued by the GPCs.

4.4.53 The Commission recalled it had encouraged centres running global models to consider providing boundary conditions to NMCs running Limited Area Models (LAM), and as well assist in the evaluation and possibly providing the necessary technological infrastructure for undertaking an LAM implementation.

Quality Management Framework (QMF)

4.4.54 The Commission agreed that NWP Verification activities should be maintained across the DPFS as a quality assurance and management measure for the GDPFS.

4.4.55 The Commission noted that the new Manual would be developed in accordance with quality management principles, which would ensure its sustainability as part of the WMO Quality Management Framework.

4.5 DECISIONS FOR THE OPEN PROGRAMME AREA GROUP ON PUBLIC WEATHER SERVICES, INCLUDING CAPACITY-BUILDING AND THE QUALITY MANAGEMENT FRAMEWORK *(agenda item 4.5)*

4.5.1 Decisions related to Public Weather Services *(agenda item 4.5.1)*

4.5.1.1 This section presents decisions by CBS-Ext.(10) which would contribute to the achievement of WMO Expected Result (ER) 7, focusing on the Open Programme Area Group (OPAG) on Public Weather Services (PWS) in building skills and capacities in National Meteorological and Hydrological Services (NMHSs) to deliver weather and related services to the public and other users.

4.5.1.2 The Commission expressed its appreciation to Mr Gerald Fleming, Chair of the PWS OPAG, the members of the PWS expert teams and the Implementation Coordination Team (ICT) for their work during the intersessional period.

The WMO strategy for service delivery

4.5.1.3 The Commission welcomed the "WMO Guiding Principles for Service Delivery" (see Annex XIV to the present report) that had been endorsed during the sixty-second session of the WMO Executive Council (EC-LXII, Geneva, June 2010). It unanimously supported the action by the Secretary-General to develop the "WMO Strategy for Service Delivery" for adoption by the Sixteenth Session of WMO Congress (Cg-XVI, Geneva, May 2011) based on the said "Guiding Principles" and endorsed the elements of the Strategy that were presented during the Session. It noted that the Strategy was WMO-wide and applicable to all activities and programmes that had a role in delivering services to users. The Commission agreed on the urgent need for such a strategy to assist Members with their service delivery functions and mandates and strongly endorsed its presentation to Congress for adoption.

Implementation and coordination aspects of Public Weather Services

4.5.1.4 The Commission was briefed on the outcomes of the meeting of the PWS Implementation Coordination Team (ICT), which was held in Shanghai, China, 20–24 September 2010, and endorsed the deliverables proposed by the Team. It noted that the Chair of the Intercommission Task Team (ICTT) on Meteorological Services for Improved Humanitarian Planning and Response had participated for the first time at the ICT meeting. The ICTT had, according to the decision of CBS-XIV, been placed within the PWS OPAG. The Commission supported the outcomes and the proposed actions of the first meeting of the ICTT, presented by the Chair of the Task Team.

4.5.1.5 The Commission was informed that a main focus of the ICT had been the changing landscape within WMO as the effects of the Strategic Planning process worked their way through the organizational structures. Of particular importance to the PWS OPAG was the positioning of Service Delivery as one of the high priority key Strategic Thrusts of the Organization. The ICT discussed how the "WMO Strategy for Service Delivery" (see paragraph 4.5.1.3), currently in draft form, might best be reflected in the OPAG and the work of the Commission. The ICT had considered that, in time, a structure might evolve within WMO that would allow the work on improving Service Delivery to be seamlessly addressed across all time scales and all disciplines (weather, climate and water). As a first step, it decided to propose to CBS a restructuring of the expert teams within the PWS OPAG to align them with the proposed "WMO Strategy for Service Delivery".

4.5.1.6 The Commission supported the view of the ICT that the "WMO Strategy for Service Delivery" can be articulated through four connected components that represent the "services chain"; namely: user engagement, service design and development, service delivery, and evaluation and improvement. These components involve identifying users and understanding their needs; ensuring that user needs are met; producing, disseminating, and communicating the information (i.e., services) that are fit for purposes; and collecting user feedback and performance metric to evaluate and improve on services. The Commission noted that these four components are reflected in the draft of the "WMO Strategy for Service Delivery" and stressed that careful consideration was needed to be given to the type of personnel, skills and training required for each stage of the "services chain" indicated above.

4.5.1.7 The Commission agreed that in order to reflect this model within the PWS OPAG structure, the work of the three existing expert teams should be re-focused to reflect the urgent need for mainstreaming service delivery in the work of the OPAG. Accordingly, it strongly endorsed a structure proposed by the ICT along the following lines:

(a) Expert Team on PWS User Needs;

(b) Expert Team on PWS Services and Products;

(c) Expert Team on PWS Delivery;

(d) Expert Team on PWS Monitoring and Evaluation.

The Commission stressed the need for proper coordination to ensure that the new structure would work efficiently and without duplication of effort, either within the OPAG or between the work of the OPAG and that of regional associations. It further requested that Members with experience in service delivery should be actively engaged in the new structure to ensure the sharing of knowledge and experience that has been underlined as an important element of the Strategy.

4.5.1.8 Recalling that the draft CBS Operating Plan for 2012–2015 had already proposed the formation of one extra Expert Team to focus on Service Delivery, the Commission agreed that the proposed structure could map the work of the existing expert teams directly to the "WMO Strategy for Service Delivery" and requested that the PWS OPAG and the Secretariat work on defining the relationship between the responsibilities and terms of reference of the proposed new structure and the existing one.

4.5.1.9 The Commission noted the outcome of the ICT discussions on how to measure effectiveness, both of the work of the PWS OPAG and the PWS Programme, and that of the output of NMHSs to user groups. It noted that the Team had developed a number of strategies on how to improve the measurement and verification process. Considering that most NMHSs had appointed PWS Focal Points to provide an effective linkage with the PWS Programme and the user communities, the Commission requested that the network of these focal points be enlarged, and that greater engagement of this network with PWS activities be pursued, especially in the collection and sharing of information on progress achieved by Members in PWS activities. It further suggested that regional real or virtual (via video conferencing) workshops be conducted for the PWS Focal Points to keep them abreast of developments and topical issues relating to PWS.

Services and products improvement for Public Weather Services

4.5.1.10 The Commission strongly supported the outcomes of the meeting of the Expert Team on Services and Products Improvement (ET/SPI, Hong Kong, China, May 2010), focusing on improving products and services for key PWS user groups, especially in developing countries.

4.5.1.11 The Commission requested that strong emphasis continue to be put on communicating probabilistic forecasts and endorsed the work of the Team to develop a set of deliverables on this subject. These include an inventory of training materials for forecasters on communicating

uncertainty and probabilistic weather products; training materials based on WMO/TD-No. 1422, "Guidelines on Communicating Forecast Uncertainty"; and developing a special resource page on PWS Website. In addition to communicating the uncertainty, the Commission requested that attention be given to determining intrinsic forecast uncertainty and relating this to a deeper understanding of user requirements.

4.5.1.12 The Commission recalled the Learning-through-Doing (LTD) Projects of PWS (see paragraph 4.5.1.23) and endorsed the plan by ET/SPI to develop a PWS LTD Project in East Africa as part of the Severe Weather Forecasting Demonstration Project in the Lake Victoria region to improve service delivery to the identified key user groups in that region. It requested that a systematic monitoring and reporting system be included in the Project to document the improvements in delivering warnings and forecasts services as well as lessons learned, for application to other future projects.

4.5.1.13 Stressing the importance of gathering information on the state of service delivery and user perception as a basis for measuring and improving services, the Commission endorsed the actions taken by the Expert Team and PWS Programme to advance this work. This includes: collecting sample tried-and-tested user surveys from a number of NMHSs and circulating them to all NMHSs; posting the sample surveys on the PWS Website; and preparing a Summary Guide on the development and delivery of surveys by NMHSs. The Commission requested to be informed of the progress in this work and the resulting response of Members. It encouraged NMHSs to evaluate the performance of their meteorological services with a view to improving those services.

4.5.1.14 The Commission endorsed the actions proposed by the Expert Team to contribute to the PWS verification and evaluation aspects of SWFDP. These include collaboration with the METEOALARM verification group, and with the World Weather Research Programme/Joint Working Group on Forecast Verification Research (WWRP/JWGFVR).

4.5.1.15 The Commission requested continued support from the Expert Team in the further development of "WMO Strategy for Service Delivery" in collaboration with other mechanisms put in place by the PWS Programme to prepare the Strategy for presentation to Cg-XVI.

Communication, outreach and public education aspects of Public Weather Services

4.5.1.16 The Commission reviewed the outcomes of the meeting of the Expert Team on Communication, Outreach and Public Education Aspects of PWS (ET/COPE, Havana, Cuba, November 2009) and supported the focus of the work of ET/COPE namely: special attention to the needs of developing countries in building partnerships with media organizations; conducting user education and outreach; communicating uncertainty and confidence in forecasts; media attribution; and communicating with stakeholders.

4.5.1.17 The Commission stressed on the need for NMHSs to put in place strategies to develop and maintain effective media relationships, including the establishment of the capability to provide PWS information to TV, radio, newspaper and Internet providers. It noted the information provided by Oman about their newly installed state of the art TV studio to be linked directly to the national TV and most of the media outlets in the country as well as the request by Oman for other Members who had acquired similar systems to share their experiences. The Commission requested the Secretary-General to continue supporting efforts of Members in the effective application of communication technology and media presentations.

4.5.1.18 The Commission stressed the importance of "social media" communication methods such as Facebook, Twitter and Blogs in communicating forecasts and warnings, as they had demonstrated widespread popularity. It endorsed the work of the Expert Team in developing an "issues paper" to assist NMHSs with what they should consider when implementing these technologies, and requested to be kept informed of progress in this area.

4.5.1.19 The Commission commended the efforts of the PWS OPAG and the Secretariat in producing the set of 'How-to Guides' that the Expert Team had developed as summaries of a number of PWS guidelines, comprising:

(a) Communicating Forecast Uncertainty;

(b) Communication, Public Education and Outreach;

(c) Communicating with the Public;

(d) Using Surveys to Evaluate Services;

(e) Working with the Media.

The Commission requested wide circulation of these "Summary Guides" and encouraged NMHSs to consult them as well as the full guidelines on these subjects available on the PWS Website: http://www.wmo.int/pages/prog/amp/pwsp/publications_en.htm.

4.5.1.20 The Commission endorsed the work of the Expert Team to produce the following guidelines and requested their early publication:

(a) "Communicating the Social and Economic Benefits and Impacts of Public Weather Services";

(b) "Emerging Technologies and Social Media".

Recognizing the importance of these guidelines, and particularly that on "Communicating the social and Economic Benefits and Impacts of Public Weather Services" the Commission requested that when distributed, the said guideline be accompanied by a letter from the Secretary-General requesting that PRs distribute it to all relevant national agencies.

4.5.1.21 Noting that in developing countries the majority of populations lived in rural areas lacking access to weather information and warnings, the Commission reiterated its request to the ET/COPE to collaborate closely with the national and international implementers of the Radio and Internet (RANET) communication system.

Public Weather Services in support of disaster prevention and mitigation

4.5.1.22 The Commission reviewed the work of the Expert Team on PWS in Support of Disaster Prevention and Mitigation (ET/DPM), since its last meeting in Kuala Lumpur, May 2009. It welcomed the revamping of the World Weather Information Services (WWIS) Website (http://worldweather.wmo.int), making it Google Earth enabled to allow users to view city forecasts on a three-dimensional virtual globe and commended all the Web hosts (China, France, Germany, Italy, Oman, Portugal and Spain) and especially Hong Kong, China, for providing leadership in this Project. This new version was showcased in the MeteoWorld Pavilion at the Shanghai World Expo 2010, and was viewed by over 800,000 visitors during 184 days of the Expo. In view of the costs and resources required for this revamping by different languages hosts, the Commission considered that proper coordination should take place between Hong Kong, China and other hosts to ensure that the revamped versions of all languages are available prior to the official launch of this version. It also suggested that consideration be given to software developments that would minimize future work across all language versions. The Commission requested that coordination meetings of the WWIS host countries be maintained on a regular basis, noting that these meetings are supported by the participating host countries. Noting the growing number of Members contributing to WWIS, which currently stands at 124 supplying official weather forecasts for 1319 cities, and the increased visit rate to the Website, the Commission urged Members to increase the number of cities for which they supplied forecasts and to start participating in this project if they have not

already done so. The Commission welcomed the intention of India to substantially increase the number of cities that contribute forecasts to WWIS.

4.5.1.23 The Severe Weather Information Centre (SWIC) Website (http://severe.worldweather.wmo.int) was enhanced with the launch of a new service known as SWIdget in June 2010. It allows the users to select and display automatically in their personal computers weather warnings in different regions. At present, warnings of three participating NMHSs from Hong Kong, China; Macao, China; and Guam, United States are available in the beta version of the SWIdget. Plans are in hand to invite more NMHSs to participate and provide their official local severe weather warnings for this service. The Commission endorsed the creation of a partnership between WMO, Google and Hong Kong, China to promote access to official tropical cyclone warnings by the public and media. Through this partnership, the warnings on SWIC will always be ranked highest by the Google search engine. The Commission agreed that this was a significant breakthrough for WMO, as the source of official tropical cyclone warnings for Google users.

4.5.1.24 The Commission endorsed the PWS initiative in launching the "Register of WMO Members Warning Authorities" and noted that the introduction of the Register was an important step towards achieving a "single official voice for dissemination of weather warnings", a priority area identified by Members. It requested Members to ensure that they kept the Register updated. Noting that the Register is unlikely to be consulted by the public or the media, the Commission stressed the need for Members to assert their position as the single official voice for the provision of severe weather warnings by referring to their membership of this Register when asserting their authoritative role with respect to issuing warnings.

4.5.1.25 The Commission welcomed the preparation by the Expert Team of the "PWS Guidelines on Early Warning Systems and Application of Nowcasting in Warning Operations" based on the existing PWS Guidelines on "Integrating Severe Weather Warnings into Disaster Risk Management", WMO/TD-No. 1292, PWS-13. These "Guidelines" were prepared at the request of CBS-XIV that PWSP should continue its focus on assisting Members to improve their national PWS programmes by providing guidance on the application of new technology and scientific research in data acquisition and use, especially for nowcasting and multi-hazard warnings. The "Guidelines" have been prepared with focus on the development of a risk management action plan by NMHSs, with recommendations for NMHSs on the development of early warning systems and the application of nowcasting in warning. Similarly, the Commission endorsed the action to prepare the PWS Guidelines on "International and Cross-border Collaboration in the Warning Process", based on the existing PWS Guidelines on "Cross-Border Exchange of Warnings" WMO/TD-No. 1179, PWS-9. The Commission requested wide distribution of these publications in the printed form as well as through the PWS Website.

4.5.1.26 The Commission noted that EC had been informed of the work of the Secretariat Haiti Task Team that was set up following the Haiti earthquake disaster (12 January 2010). It commended the role of the PWS Programme to this work; which was helping to strengthen the capacity of Haiti National Meteorological Service (CNM) to disseminate forecasts and warnings to authorities, the public and international agencies operating in Haiti. This was achieved through actions initiated and/or coordinated by PWSP, among them the linking of the CNM official public website to the WWIS Website as well as informing United Nations Organizations and the Communications for Disaster affected Communities (CDC) of how to obtain official forecasts and warnings for airing on radio and sending on emails and on mobile phones through Short Message Services (SMSs) systems.

Social and economic applications of Public Weather Services

4.5.1.27 The Commission recalled that a significant component of the work of the PWS Programme concerned socio-economic issues surrounding public weather service delivery. These issues were increasingly impacting and becoming integrated into the work of the PWS OPAG. The Commission was pleased with the ongoing collaboration and interaction between the PWS OPAG, the World Weather Research Programme (WWRP) – Working Group on Societal and Economic

Research and Applications (SERA), and the WMO Forum: Social and Economic Applications and Benefits of Weather, Climate, and Water Services, allowing collaboration in social and economic aspects of PWS and reducing duplications. It requested that this collaboration be continued and strengthened.

4.5.1.28 The Commission welcomed the PWS Socio-economic Benefits of Weather, Climate and Water Services Website (www.wmo.int/socioec) which is a source for decision-support tools and case studies; for assessing, quantifying and demonstrating benefits of weather, climate and water services. It requested a revamping of this Website to allow a more streamlined structure of the resources available on the Website.

Public Weather Services demonstration projects

4.5.1.29 The Commission reviewed the substantial progress of the different Learning-Through-Doing (LTD) Projects being implemented by PWS Programme in RAs I, III and IV. These Projects have been established to strengthen the service delivery capability of NMHSs in Chile, Ethiopia, Madagascar, Panama and Peru. The focus for these Projects are mainly in the health sector, whereby Weather, Climate and Health Working Groups have been established to initiate and improve collaboration between the health sector and NMHSs. Agriculture and fisheries sectors have also benefited from similar partnerships with NMHSs in Chile and Peru.

4.5.1.30 The Commission was informed of the participation of PWS Programme in the planning and implementation of LTD Projects in Burkina Faso, Mali, Mauritania, Niger and Nigeria, funded by the Spanish Meteorological Service (AEMET), focusing on investigating the impact of weather and climate vector borne diseases. The Commission requested the Secretary-General to continue supporting ongoing LTD Projects as well as new projects initiated by the PWS OPAG addressing critical areas of delivering PWS to different user sectors and the public. The Commission requested that LTD projects be initiated in other WMO regions as well, in particular in the South Western part of RA II.

4.5.1.31 The Commission strongly supported the continued integration of the PWS component in SWFDP Projects, to ensure the strengthening of the capabilities of the participating NMHSs in dissemination and communication of warnings and forecasts as well as assessing and evaluating the benefits derived from enhanced services. PWS is a major component of SWFDP in East Africa, Southern Africa, South East Asia, and the South West Pacific. In the East African SWFDP, the PWS component will focus on delivery of warning and forecast services to enhance the security of lives and livelihoods of farmers and fishermen in and around Lake Victoria, benefiting Kenya, Uganda and the United Republic of Tanzania. The South East Asia SWFDP covers Cambodia, Lao People's Democratic Republic, Thailand and Viet Nam. The Commission commended the collaboration between the OPAGs on Data-processing and Forecasting Systems and PWS in relation to these projects, and requested that they continue to work closely together in assisting Members.

4.5.1.32 The Commission was pleased with the progress of the SWFDP in Southern Africa and the positive impact the Project had had on service delivery, including: developing communication strategies and methodologies; coordinating with primary users and partners such as the media, disaster community, and the public; monitoring and evaluation of users' feedback concerning severe weather services; and public education and outreach.

4.5.1.33 The Commission endorsed the strong engagement of the PWS OPAG with the WMO Demonstration Project on the Shanghai Multi-Hazard Early Warning Services (M-HEWS) and in particular, the World Expo Nowcasting Services (WENS) Demonstration Project (2008–2011). It recalled the objectives of the WENS Demonstration Project, which included demonstrating how nowcasting applications can enhance multi-hazard early warning services using the opportunity of the Shanghai 2010 World EXPO. The Commission commended the Project which had resulted in high levels of satisfaction registered with forecasts and warnings of heavy rain and thunderstorms. The Commission requested that a full report be prepared and published on WENS and that the

results of WENS be shared with other developing countries interested in Nowcasting through an international workshop in 2011 marking the conclusion of the Project.

Capacity-building activities and technical cooperation

4.5.1.34 The Commission reiterated its call to the PWS Programme to continue its efforts in capacity-building, especially for developing countries and Least Developed Countries (LDCs). It noted that the PWS OPAG was working on establishing the competencies required within NMHSs for delivering PWS to users as well as compiling a list of available experts that can be called upon to assist with PWS training activities. It requested close collaboration between the OPAG and the Education and Training (ETR) Office in WMO in this work. The Commission also considered the benefits of attachment of personnel from NMHSs to recognized centres of excellence for the purpose of on-the-job training, and visits by experienced staff from those centres to NMHSs to assist with capacity development in those countries.

4.5.1.35 Emphasizing the importance of training in the area of socio-economic benefits of meteorological services, the Commission was pleased to note that the Training Workshop on the Assessment of Socio-economic Benefits of Meteorological and Hydrological Services (Nanjing, China, September 2009) had been organized by PWS and benefited participants from RAs I, II and V. It also noted that the Workshop on Achieving Benefits of Enhanced Service Delivery by National Meteorological Services in Eastern and Southern Africa had been planned to take place in the United Republic of Tanzania in early 2011. The Commission requested that similar training events be organized by PWSP for other WMO Regions.

4.5.1.36 The Commission strongly supported the following guidelines for the allocation of priorities for the Public Weather Services:

(a) Highest priority for enhanced Internet access for NMHSs as a communications tool to ensure: access to data and products from producing centres, so as to allow preparation of tailor made products to meet local user requirements and their dissemination to all users as a means of improving the delivery of weather services, and promotion of the use of official consistent information from NMHSs;

(b) Highest priority for fixed and mobile communications systems such as mobile telephones, pagers/short message system, fax-on-demand, and RANET for the dissemination of public weather warnings and forecasts;

(c) Highest priority for computer-based meteorological workstations to allow, through forecaster interaction, the creation of new or enhanced products for users aimed at enhanced service delivery;

(d) Highest priority for TV/media presentation systems comprising high-performance computing and communications hardware, peripherals and software, video equipment for television production, as well as the related training of staff;

(e) Highest priority for training related to delivery of user-centric PWS that included training in user and customer consultation and outreach, media skills (writing and presentation), product design, and public awareness;

The Commission encouraged close collaboration with OPAG on ISS in addressing communication and internet access issues raised in (a) above.

Quality Management Framework

4.5.1.37 The Commission supported the recommendation by EC-LXII (Geneva, June 2010) to establish a Pilot Project for QMS implementation in the WMO Secretariat and agreed that it would bring potential benefits in terms of more cost-effective and responsive Secretariat services

and processes. It agreed that this was in-line with WMO special emphasis on service delivery. Noting the leading role of the PWS Programme in the implementation of the WMO Strategy for Service Delivery (see paragraph 4.5.1.3), the Commission requested that QMS be mainstreamed in PWS activities.

4.5.1.38 The Commission noted the plans to produce a generic guide fit for all WMO Programmes, defining the procedural and organizational requests. Such a guide would also include NMHSs Quality Manuals and related manuals for accreditation, safety management, occupational health and safety management and environmental management as best practice examples. The Commission encouraged its members to cooperate closely with the Secretariat in contributing, exchanging and using such examples.

4.5.2 Decisions related to Disaster Risk Reduction *(agenda item 4.5.2)*

4.5.2.1 The Commission recalled that CBS-XIV (Dubrovnik, Croatia, 2009) established a Task Team on Meteorological Services for Improved Humanitarian Planning and Response (hereafter referred to as Humanitarian Task Team) under the OPAG on PWS. It was informed that following a brainstorming session on "Meteorological Services for Improved Humanitarian Contingency Planning and Response", held at the WMO Secretariat, on 17 April 2009, which initiated the process for the assessment of the needs of humanitarian agencies for meteorological, hydrological and climate information products and services, the chair of the OPAG on PWS, in coordination with the president of CBS, liaised with the presidents of the Commissions for Climatology (CCl) and Hydrology (CHy), who designated experts from these Commissions to the Humanitarian Task Team. The president of CBS, in consultation with the presidents of CCl and CHy, approved the revised Terms of Reference of the Humanitarian Task Team. The Commission noted the outcomes and recommendations of the first meeting of the Humanitarian Task Team, which was held at the WMO Headquarters, from 31 August to 2 September 2010, including a number of concrete actions such as the identification of pilot projects engaging the WMO operational network of Regional Specialized Meteorological Centres (RSMCs) and Regional Climate Centres (RCCs) for the development of prototype products and services to support humanitarian agency's emergency contingency planning, preparedness and response.

4.5.2.2 With regards to item 2 of the Terms of Reference of the Humanitarian Task Team, the Commission was informed of a meeting of senior executives and staff of WMO and the United Nations Office for Coordination of Humanitarian Affairs (UN-OCHA), in 2005. This meeting discussed, among other DRR issues, the PWS initiative in the 1990s to facilitate provision of meteorological assistance and information from the National Meteorological Centres (NMCs) and Regional Specialized Meteorological Centres (RSMCs) that would support relief operations of the United Nations Department of Humanitarian Assistance (DHA), the predecessor UN-OCHA. The meeting concluded that though this initiative was highly appreciated, it had not been operationally followed as the details for the products and services as well as the mechanism for the delivery of information to UN-OCHA were not operationally determined. Furthermore, the meeting indicated the need for the establishment of a systematic approach for the identification of the needs of humanitarian agencies and development of products and services by the NMHSs and RSMCs that could be disseminated through the humanitarian agencies information systems. The Commission recognized that in times of crises there was a strong need for an effective mechanism that ensured provision of official information and warnings to humanitarian agencies based on clear operational procedures. In this regard, the Commission agreed that the Humanitarian Task Team was well placed to develop such a mechanism to ensure effective communication of information and warnings to humanitarian agencies in times of crises and for their contingency planning.

4.5.2.3 The Commission recognized that while hydrological and meteorological disasters stress affected NMHSs, in many cases they also lead to the further development of core DRR-related capacities as lessons are learnt and incorporated into operational practices. It was informed that the DRR Programme is building linkages to the United Nations Flash Appeal process and the UNDP-World Bank-European Union Post Disaster Needs Assessment (PDNA) processes to realize

funding opportunities for the strengthening and modernization of the NMHSs as part of the reconstruction of the disaster affected countries. In this regard, the Commission noted effective coordination by the WMO Secretariat with Members and the United Nations and international partners, following major disasters such as the January 2010 Earthquake in Haiti and the 2010 floods in Pakistan. The Commission was informed that these efforts had focused on: (i) addressing the immediate needs to restore and strengthen operational capabilities for the provision of meteorological information and warning; and (ii) medium- to long-term development and strengthening of the meteorological and hydrological services of the affected country. The Commission stressed that in order to provide quick and effective response, WMO could benefit from an effective coordination and response mechanism engaging the Secretariat and Members. In this regard, the Commission noted the need to:

(a) Identify a roster of experts, with relevant expertise, from Member's NMHSs that would be available to participate in WMO Secretariat-coordinated missions to the affected countries to identify capacity development needs and develop strategies for the strengthening and modernization of the affected NMHSs. In this regard, the Commission noted the need to consult with other relevant Commissions to define the expertise needed for assessing basic capacities spanning meteorological, hydrological and climate observing networks, telecommunications, forecasting and related training. The Commission further noted that these assessments are critical for the purpose of developing proposals that could be submitted to the PDNA processes and respective governments for funding;

(b) Develop guidelines (i) to assist Members in assessing their core, DRR-related basic system capacities, including observations, telecommunications and forecasting and related human resources development; and (ii) to assist humanitarian organizations that are rapidly deployed in disaster areas to make best use of the products and services that can be, and are provided through the WMO community. The Commission agreed to consult with relevant Commissions to determine the mechanism for the development of such guidelines.

4.5.2.4 The Commission noted emergence of issues that have implications not only to humanitarian agencies, but also to the broader DRR community. In particular, in light of the needs of DRR stakeholders (humanitarian, development agencies at international and regional levels), RSMCs and Regional Climate Centres (RCCs) play a critical role in the development of meteorological, hydrological and climate products. In this regard, the Commission noted the need to review the criteria for, and operational capabilities of, RSMCs with geographical specialization to ensure that the need for production and delivery of DRR-related meteorological, hydrological and climate products and services is fully addressed. The RSMCs should be able to work in the context of DRR requirements (for example, as identified through national/regional DRR projects underway in Southeast Europe, Southeast Asia, Central America and the Caribbean and relevant mechanisms such as the Humanitarian Task Team) and Global Data-processing and Forecasting System (GDPFS) criteria. The Commission requested the CBS Coordinator on Disaster Risk Reduction to work with the WMO Secretariat to explore opportunities for identifying basic DRR products and services through the rolling review of requirements (RRR) process as the next step forward.

4.5.2.5 The Commission was informed that with regards to the Task Team on "Standard Guidelines for Meteorological Hazards" little progress has yet to be made. In this regard, and recognizing the new structure of the Commission for Climatology, which has established a Task Team on Data Rescue, the work of this Task Team will need to be closely coordinated with CCl. The Commission requested that CBS Management Group consider the best mechanisms by which this work might be carried forward in cooperation with the appropriate experts in CCl.

4.5.2.6 The Commission agreed to appoint a Disaster Risk Reduction Focal Point as a part of the Humanitarian Task Team to work with Secretariat to develop strategy for the consistent collection and dissemination of data and information relating to meteorological and hydrological disasters.

5. REVIEW OF THE TERMS OF REFERENCE OF THE COMMISSION *(agenda item 5)*

5.1 The Commission noted that the Executive Council expected CBS to review its terms of reference as regards its alignment with the WMO results-based management approach and overall Organization objectives and Strategic Thrusts. The Commission also noted that presidents of technical committees had considered the guidance provided by the Executive Council on this matter and recommended a change to the general Terms of Reference of technical commissions which was endorsed by the Executive Council for recommendation to Congress for approval.

5.2 The Commission reviewed its specific Terms of Reference, agreed on the changes as given in Recommendation 8 (CBS-Ext.(10)) – Terms of Reference of the Commission for Basic Systems and recommended to submit them to Congress for approval.

6. REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE COMMISSION AND RELEVANT EXECUTIVE COUNCIL RESOLUTIONS *(agenda item 6)*

In accordance with established practice, the Commission examined those resolutions and recommendations adopted prior to the present session which were still in force and adopted Resolution 1 (CBS-Ext.(10)) – Review of previous resolutions and recommendations of the Commission for Basic Systems and Recommendation 9 (CBS-Ext.(10)) – Review of resolutions of the Executive Council based on previous recommendations of the Commission for Basic Systems or concerning the Commission.

7. OUTCOMES OF THE TECHNICAL CONFERENCE ON DEMONSTRATION OF END-TO-END SERVICES *(agenda item 7)*

7.1 The Commission welcomed the report contained in Annex XV to the present report on the Technical Conference on End-to-End Service Delivery (TECO-E2E), which was held from 19 (p.m.) to 20 November 2010 in conjunction with CBS-Ext(10), and expressed appreciation to all the participants, especially those who brought important user perspectives to the conference. The Commission appreciated that the GEO Secretariat had demonstrated the complementary role of GEOSS in ensuring that earth observations and information are available and accessible to meet the needs of a broader community of users and had highlighted many areas of active WMO engagement in GEOSS, in collaboration with other GEO Members and Participating Organizations.

7.2 The Commission was pleased that the TECO-E2E had emphasized the key role of users and their requirements through all aspects of CBS work programmes and that the presentations and panel discussions had so effectively showed the end-to-end approach of CBS. The TECO-E2E had demonstrated the roles and work programmes of the OPAGs and how they span the chain from user requirements through to user satisfaction, noting that services are only of value to users if they fulfil a need, whether it be real or perceived. The Commission especially welcomed that the Severe Weather Forecasting Demonstration Project (SWFDP) in Africa was featured as a very practical and successful exemplar of the CBS end-to-end approach.

7.3 The Commission noted that TECO-E2E had captured some important perspectives on users and how their requirements are gathered and met at all steps along the end-to-end chain and agreed that it was appropriate to characterize the relationship between users, CBS, other technical commissions and regional associations, and NMHSs as a continuing cycle of development and improvement, leading to evolution and growth.

7.4 While appreciating the successes achieved and the strong backbone support provided by CBS for the end-to-end monitoring, analysis, forecast and warning services of its Members, at national, regional and global scales, the Commission agreed that there is potential to improve the way that CBS works and delivers support to Members, including support for a one-stop shop approach to seamless service delivery as required by users. Accordingly, the Commission took close note of the following opportunities for improvement identified by the TECO-E2E in its report and requested its Management Group, and the OPAG Co-chairs as appropriate, to consider how they could be built into working arrangements and work programmes of the Commission:

- Rebalance the workload involved in updating the RRR databases between the expert teams within OPAG-IOS and strengthen the link to the regional associations.
- Strengthen the collaboration across the OPAGs in order to improve the way non-NWP requirements are captured in the RRR.
- Establish formal links to various OPAGs and ETs in other technical commissions to further develop the way in which “observing system capabilities” are represented in the RRR databases.
- Publish guidance on the use of WIS that is suitable for non-technical users.
- Identify the service levels needed for the different WIS-related services, and include these in Rolling Reviews of Requirements and monitoring procedures.
- Clarify the data policies that Programmes in all commissions will need WIS to support.
- Retain the principles applied in the SWFDP development so far – realism, pragmatism, and also ambition and commitment of the various people and services involved.
- Do not jeopardize the SWFDP by wanting to do too much too quickly.
- Continue to build on the SWFDP model, paying particular attention to ensuring sustainability, and progressively extending the range of targeted applications to transfer the benefits of the SWFDP to other user sectors in society.
- The four elements of the services chain (user needs, services and products, delivery, and monitoring and evaluation) would be better represented through a re-organization of the PWS OPAG.
- The OPAG-PWS should address the changing role of the forecaster and the implications for the skills and competencies needed and thus for training and capacity-building.
- Recognizing the need to identify both internal and external users, the PWS OPAG should work with the Chairs of the other OPAGs within CBS to streamline service delivery within the work of the Commission.
- Contribute to improved support for DRR as a cross-cutting “user”, when appropriate in partnerships with other technical commissions and other Organizations, by initiating a process to analyse strengths and weaknesses of existing institutional mechanisms in order to ensure optimal use of resources and proper coordination and by initiating work to quantify the contribution that weather, water and climate services make to disaster reduction.

7.5 The Commission expressed thanks to the organizers of the TECO-E2E and agreed with the sentiment captured in the report, that the Commission needs to build skills to understand and meet evolving user needs and capabilities, and that this can only happen if we put users first and last in all our endeavours.

8. ANY OTHER BUSINESS *(agenda item 8)*

8.1 The Commission noted the important and longstanding contribution of Dr Eva Červená to the development and implementation of WMO codes included in the WMO Manual on Codes. Dr Eva Červená, at present chair of the RA VI Task Team on Regional Migration to TDCF, provided support and advice that were instrumental in the implementation of data representation systems by many NMHSs, in particular within the framework of the migration from Traditional Alphanumerical Codes (TAC) to Table-Driven Code Forms (TDCF). The Commission invited its president to provide Dr Eva Červená with a special certificate of appreciation for her contribution.

8.2 Recognizing the increasing emphasis on service delivery within WWW, that the work of CBS encompasses three service-driven programmes (PWS, DPFS and DRR) and that the systems which are at the core of CBS are increasingly focused on delivering user needs and services, the Commission requested that its Management Group consider a change of name to become the Commission for Basic Systems and Services.

8.3 The Commission noted with appreciation the arrangements made during the session for scientific lectures. The Commission thanked Mr Lars Peter Riishojgaard (United States) and by Mr Jochen Dibbern (Germany) for their excellent lectures on the following themes:

- “Economic value of weather forecasting” by Mr Lars Peter Riishojgaard (United States).
- ”EUCOS, the EUMETNET Composite Observing System” by Mr Jochen Dibbern (Germany).

9. DATE AND PLACE OF THE FIFTEENTH SESSION *(agenda item 9)*

The Commission did not receive any declaration of intent to host the fifteenth session of CBS that is proposed to be held in the fourth quarter of 2012. It was noted that the date and place of that session shall be determined by the president of the Commission after consultation with the Secretary-General according to General Regulation 187.

10. CLOSURE OF THE SESSION *(agenda item 10)*

The extraordinary session of the Commission for Basic Systems was closed at 11:25 a.m. on 24 November 2010.

RESOLUTIONS ADOPTED BY THE SESSION

Resolution 1 (CBS-Ext.(10))

REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE COMMISSION FOR BASIC SYSTEMS

THE COMMISSION FOR BASIC SYSTEMS,

Noting the actions taken on the resolutions and recommendations adopted by the Commission prior to its extraordinary session in 2010,

Decides:

(1) To keep in force Resolutions 2 (CBS-Ext.(98)), 1 (CBS-XII), 1 (CBS-Ext.(06)), 1 (CBS-XIV) and 2 (CBS-XIV);

(2) To keep in force Recommendations 1 (CBS-XIV), 4 (CBS-XIV) and 10 (CBS-XIV);

(3) Not to keep in force other resolutions and recommendations adopted before its extraordinary session in 2010.

RECOMMENDATIONS ADOPTED BY THE SESSION

Recommendation 1 (CBS-Ext.(10))

AMENDMENTS TO THE *MANUAL ON CODES* (WMO-No. 306), INTRODUCTION CHAPTER OF VOLUMES I.1 AND I.2

THE COMMISSION FOR BASIC SYSTEMS,

Noting:

(1) Resolution 1 (Cg-XV) – Technical Regulations of the World Meteorological Organization,

(2) Resolution 2 (Cg-XV) – World Weather Watch Programme for 2008–2011,

(3) The *Manual on Codes* (WMO-No. 306),

Considering the requirements for:

(1) Fast-track procedure for the adoption of amendments to the *Manual on Codes*,

(2) Procedure for the adoption of amendments to the *Manual on Codes* between sessions of the Commission,

(3) Procedure for the adoption of amendments to the *Manual on Codes* during sessions of the Commission,

Recommends that the procedures for amending the *Manual on Codes* defined in the annex to the present recommendation be applied from 1 July 2011;

Requests the Secretary-General to arrange for the inclusion of these procedures in the Introduction chapter of Volumes I.1 and I.2 of the *Manual on Codes*;

Authorizes the Secretary-General to make any consequent purely editorial amendments to the *Manual on Codes* – Introduction chapter of Volumes I.1 and I.2.

Annex to Recommendation 1 (CBS Ext.(10))

AMENDMENTS TO THE PROCEDURES FOR AMENDING THE *MANUAL ON CODES* (WMO-NO. 306), VOLUMES I.1 AND I.2

Editorial note: Meanings of marks below are as follows.

Text — No changes
Text — Addition or modification
~~Text~~ — Deletion or modification
Text — Move from other article
~~Text~~ — Move to other article

PROCEDURES FOR AMENDING THE *MANUAL ON CODES*

1. General validation and implementation procedures

1.1 Proposal of amendments

Amendments to the *Manual on Codes* must be proposed in writing to the WMO Secretariat. The proposal shall specify the needs, purposes and requirements and include information on a contact point for technical matters.

1.2 Drafting recommendation

The Inter-Programme Expert Team on Data Representation and Codes (IPET-DRC), supported by the Secretariat, shall validate the stated requirements (unless it is consequential to an amendment to the WMO Technical Regulations) and develop a draft recommendation to respond to the requirements, as appropriate.

1.3 Date of implementation

~~A draft recommendation of the ET-DRC must be validated. A draft recommendation of the ET-DRC must be endorsed by the Implementation/Coordination Team on Information Systems and Services (ICT-ISS) of the Open Programme Area Group on Information Systems and Services (OPAG-ISS).~~ The IPET-DRC should define a date of implementation in order to give sufficient time to the WMO Members to implement the amendments after the date of notification; the IPET-DRC should document the reasons to propose a time span of less than six months except for the fast track procedure.

1.4 Procedures for approval

After a draft recommendation of the IPET-DRC is validated in accordance with the procedure given in section 6 below, depending on the type of amendments, the IPET-DRC may select one of the following procedures for the approval of the amendments:

- Fast-track procedure (see section 2 below);
- Procedure for the adoption of amendments between CBS sessions (see section 3 below);
- Procedure for the adoption of amendments during CBS sessions (see section 4 below).

1.5 Urgent introduction

Regardless of above procedures, as an exceptional measure, the following procedure accommodates urgent user needs to introduce new entries in BUFR/CREX tables A, B and D, code and flag tables of BUFR, CREX and GRIB edition 2 and Common Code tables.

(a) A draft recommendation developed by IPET-DRC shall be validated according to 6.1, 6.2 and 6.3 below.

(b) The draft recommendation for pre-operational use, which can be used in operational data and products, shall be approved by the chairs of IPET-DRC and OPAG-ISS, and the president of CBS. The list of pre-operational entries is kept on-line on the WMO web server;

(c) Pre-operational entries need to be approved by one of the procedures in 1.4 for operational use.

1.6 Version number

The version number of the master table will be incremented.

1.7 Issuing updated version

Once amendments to the *Manual on Codes* are adopted, an updated version of the relevant part of the Manual shall be issued in the four languages: English, French, Russian and Spanish. The Secretariat will inform all WMO Members of the availability of a new updated version of that part at the date of notification mentioned in 1.3.

2. Fast-track procedure

2.1 Scope

The fast-track procedure can be used for additions to BUFR or CREX Tables A, B, and D with associated code tables or flag tables, to code or flag tables or templates in GRIB and to common tables C.

2.2 Endorsement

~~An ET-DRC draft recommendation must be validated in accordance with the procedures given in section 6 below.~~ Draft recommendations developed by the IPET-DRC, including a date of implementation of the amendments, must be endorsed by the chair of OPAG-ISS. ~~The filling of reserved and unused entries in the existing code and flag tables is considered as minor adjustments, and will be done by the Secretary-General in consultation with the president of CBS. For other types of amendments, the English version of the draft recommendation, including a date of implementation, should be distributed to the focal points for codes and data representation matters for comments, with a deadline of two months for the reply. It should then be submitted to the president of CBS for adoption on behalf of the Executive Council (EC).~~

2.3 Approval

2.3.1 Minor adjustments

The filling of reserved and unused entries in the existing code and flag tables, and Common Code tables is considered as minor adjustments, and will be done by the Secretary-General in consultation with the president of CBS.

2.3.2 Other types of amendments

For other types of amendments, the English version of the draft recommendation, including a date of implementation, should be distributed to the focal points for codes and data representation matters for comments, with a deadline of two months for the reply. It should then be submitted to the president of CBS for adoption on behalf of the Executive Council (EC).

2.4 Frequency

The implementation of amendments approved through the fast track procedure can be twice ~~shall normally be limited to one per~~ a year in May and November. ~~If the Chair/co-Chair of ET-DRC and OPAG-ISS agree that an exceptional situation exists, a second fast track implementation can be initiated.~~

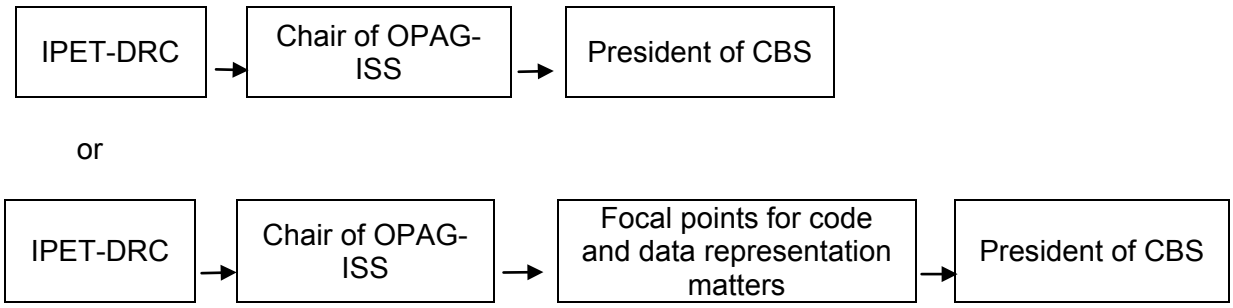

Figure 1 – Adoption of amendments by fast track procedure

3. Procedure~~s~~ for the adoption of amendments between CBS sessions

3.1 Approval of draft recommendation

For the direct adoption of amendments between CBS sessions~~, as a first step~~, the ~~ET-DRC submits its~~ draft recommendation developed by the IPET-DRC, including a date of implementation of the amendments, shall be submitted to the chair of OPAG-ISS and president and vice-president of CBS for approval. ~~In a second step, upon approval of the~~

~~president of CBS, the Secretariat sends the recommendation in the four languages (English, French, Russian and Spanish), including a date of implementation of the amendments, to all WMO Members for comments to be submitted within two months; WMO Members are invited to designate a focal point responsible to discuss any comments/disagreements with the ET-DRC. If the discussion between the ET-DRC and the focal point cannot result in an agreement on a specific amendment by a WMO Member, this amendment will be reconsidered by the ET-DRC. Those WMO Members not having replied within the two months following the dispatch of the amendments are implicitly considered as having agreed with the amendments. In a third step, once amendments are agreed by WMO Members, and after consultation with the Chair and co-Chair of the OPAG-ISS and the president and vice-president of CBS, the Secretariat notifies at the same time the WMO Members and the members of the Executive Council of the approved amendments and of the date of their implementation.~~

3.2 Circulation to Members

~~In a second step, u~~Upon approval of the president of CBS, the Secretariat sends the recommendation in the four languages (English, French, Russian and Spanish), including a date of implementation of the amendments, to all WMO Members for comments to be submitted within two months following the dispatch of the amendments.

3.3 Agreement

Those WMO Members not having replied within the two months following the dispatch of the amendments are implicitly considered as having agreed with the amendments.

3.4 Coordination

WMO Members are invited to designate a focal point responsible to discuss any comments/disagreements with the IPET-DRC. If the discussion between the IPET-DRC and the focal point cannot result in an agreement on a specific amendment by a WMO Member, this amendment will be reconsidered by the IPET-DRC.

3.5 Notification

~~In a third step, o~~Once amendments are agreed by WMO Members, and after consultation with the chair of the OPAG-ISS and the president and vice-president of CBS, the Secretariat notifies at the same time the WMO Members and the members of the Executive Council of the approved amendments and of the date of their implementation.

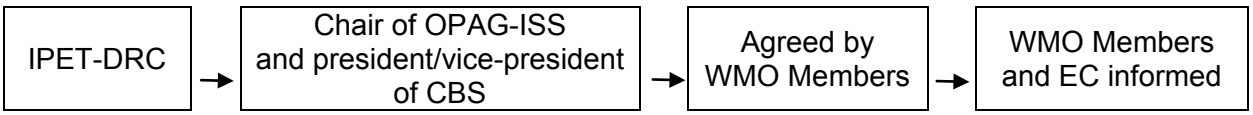

Figure 2 – Adoption of amendments between CBS sessions

4. Procedure~~s~~ for the adoption of amendments during CBS sessions

For the adoption of amendments during CBS sessions, the IPET-DRC submits its recommendation, including a date of implementation of the amendments, to the Implementation/Coordination Team on Information Systems and Services (ICT-ISS) of the Open Programme Area Group on Information Systems and Services (OPAG-ISS) ~~ICT-ISS~~. The recommendation is then submitted to a CBS session and then to an EC session.

5. Procedure~~s~~ for the correction of existing entries in the BUFR and CREX tables

5.1 Introducing a new descriptor

If an erroneous specification of an entry is found in an operational BUFR or CREX ~~E~~element descriptor or ~~S~~sequence descriptor, a new descriptor should preferably be added to the appropriate table through the fast-track procedure or the procedure for adoption of

amendments between CBS sessions. The new descriptor should be used instead of the old one for encoding (especially if it concerns data width). An appropriate explanation shall be added to the notes of the table to clarify the practice along with the date of the change. This situation is considered a minor adjustment according to ~~2.2~~2.3.1 above.

5.2 Correcting erroneous specification

As an exceptional measure for erroneous entries in Table B, if it is found absolutely necessary to correct an erroneous specification of an existing entry by changing its specification, the following rules shall apply:

5.2.1 The name and unit of an element descriptor shall remain unchanged except for minor clarifications.

5.2.2 Scale, reference value and bit width may be corrected to required values.

5.2.3 Such a change will be submitted through the fast-track procedure.

~~5.2.4 The version number of the master will be incremented.~~

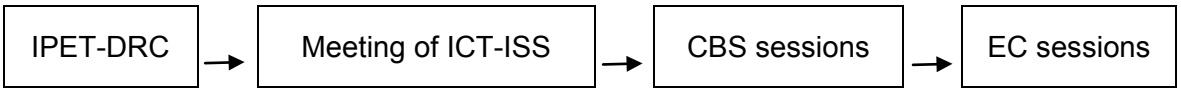

Figure 3 – Adoption of amendments during CBS sessions

6. Validation procedure~~s~~

6.1 Documentation of need and purpose

The need for, and the purpose of, the proposal for changes should be documented.

6.2 Documentation of result

This documentation must include the results of validation testing of the proposal as described below.

6.3 Testing with encoder/decoder

For new or modified WMO code and data representation forms, proposed changes should be tested by the use of at least two independently developed encoders and two independently developed decoders which incorporated the proposed change. Where the data originated from a necessarily unique source (for example, the data stream from an experimental satellite), the successful testing of a single encoder with at least two independent decoders would be considered adequate. Results should be made available to the IPET-DRC with a view to verifying the technical specifications.

~~7. Urgent introduction of new descriptors or entries in BUFR, CREX and GRIB edition 2 tables~~

~~As agreed by CBS (see the Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session (2002) of the Commission for Basic Systems (WMO-No. 955), 6.2.66 of the general summary), a three-step mechanism for the introduction of new descriptors or entries in BUFR, CREX and GRIB edition 2 tables accommodates urgent user needs, as follows:~~

~~(a) Approval (by the chair of ET-DRC, the chair of OPAG-ISS and the president of CBS) of allocated entries after an expression of requirements. The list of allocated entries awaiting validation is kept on-line on the WMO web server;~~

~~(b) After validation (according to 6.1, 6.2 and 6.3 above), declaration of pre-operational use (after approval by the chair of ET-DRC, the chair of OPAG-ISS and the president of CBS). The list of pre-operational entries is kept on-line on the WMO web server;~~

~~(c) Finally, adoption of the amendments in accordance with the procedures detailed in sections 2, 3 or 4 above.~~

Recommendation 2 (CBS-Ext.(10))

AMENDMENTS TO THE *MANUAL ON CODES* (WMO-No. 306), VOLUME I.1

THE COMMISSION FOR BASIC SYSTEMS,

Noting:

(1) Resolution 1 (Cg-XV) – Technical Regulations of the World Meteorological Organization,

(2) Resolution 2 (Cg-XV) – World Weather Watch Programme for 2008–2011,

(3) The *Manual on Codes* (WMO-No. 306), Volume I.1,

Considering the requirements for amendments to aeronautical codes resulting from corresponding changes in International Civil Aviation Organization ICAO Amendment 75 of Annex 3 – Meteorological Service for International Air Navigation/WMO Technical Regulations [C.3.1],

Recommends that the amendments to FM 15-XIV METAR, FM 16-XIV SPECI and FM 51-XIV TAF, as defined in the annex to the present recommendation, be adopted for use from 2 November 2011;

Requests the Secretary-General to arrange for the inclusion of these amendments to Volume I.1 of the *Manual on Codes*;

Authorizes the Secretary-General to make any consequent purely editorial amendments to the *Manual on Codes* – Volume I.1.

Annex to Recommendation 2 (CBS Ext.(10))

AMENDMENTS TO FM 15-XIV METAR, FM 16-XIV SPECI and FM 51-XIV TAF

Amend the titles of METAR and SPECI:

FM 15–XIV Ext. METAR Aerodrome routine meteorological report (with or without trend forecast)

FM 16–XIV Ext. SPECI Aerodrome special meteorological report (with or without trend forecast)

Amend the code form of METAR and SPECI:

{ **METAR** or **SPECI** } **COR** CCCC YYGGgg**Z** **NIL** **AUTO** dddff**G**$f_m f_m$ { ~~**KMH** or~~ **KT** or **MPS** } $d_n d_n d_n$**V**$d_x d_x d_x$

{ VVVV $V_N V_N V_N V_N D_v$ ~~or~~ ~~VVVV**NDV**~~ or **CAVOK** } { **R**$D_R D_R$/$V_R V_R V_R V_R$i or **R**$D_R D_R$/$V_R V_R V_R V_R$**V**$V_R V_R V_R V_R$i } w´w´ { $N_s N_s N_s h_s h_s h_s$ or **VV**$h_s h_s h_s$ or **NSC** or **NCD** }

$T'T'/T'_dT'_d$ **Q**$P_HP_HP_HP_H$ **RE**w´w´ { **WS R**D_RD_R or **WS ALL RWY** } (**W**T_sT_s/SS´) (**R**$D_RD_R/E_RC_Re_Re_RB_RB_R$)

{ (TTTTT TTGGgg dddff**G**f_mf_m { ~~**KMH** or~~ **KT** or **MPS** { VVVV or **CAVOK** { w´w´ or **NSW** { $N_sN_sN_sh_sh_sh_s$ or **VV**$h_sh_sh_s$ or **NSC**
or **NOSIG**)

(**RMK** . . . . .)

Amend the Regulations 15.5 to 15.6.2:

15.5 **Groups** dddff**G**f_mf_m { ~~**KMH** or~~ **KT** or **MPS** } $d_nd_nd_n$**V**$d_xd_xd_x$

15.5.1 The mean true direction in degrees rounded off to the nearest 10 degrees from which the wind is blowing and the mean speed of the wind over the 10-minute period immediately preceding the observation shall be reported for dddff followed, without a space, by one of the abbreviations ~~KMH,~~ KT or MPS, to specify the unit used for reporting wind speed. Values of wind direction less than 100° shall be preceded by 0 and a wind from true north shall be reported as 360. Values of wind speed less than 10 units shall be preceded by 0. However, when the 10-minute period includes a marked discontinuity in the wind characteristics, only data after the discontinuity shall be used for obtaining mean wind speed and maximum gust values, and mean wind direction and variations of the wind direction, hence the time interval in these circumstances shall be correspondingly reduced.

Notes:

(1) ~~KMH,~~ KT and MPS are the standard ICAO abbreviations for ~~kilometres per hour,~~ knots and metres per second, respectively.

(2) The ~~unit of wind speed used is determined by national decision. However, the~~ primary unit prescribed in ICAO Annex 5 for wind speed is the metre per second (MPS)~~kilometre per hour (KMH),~~ with the knot (KT) permitted for use as a non-SI alternative unit until a termination date is decided.

(3) A marked discontinuity occurs when there is an abrupt and sustained change in wind direction of 30° or more, with a wind speed of 5 m s^{-1}~~20 km h^{-1}~~ (10 kt) or more before or after the change, or a change in wind speed of 5 m s^{-1}~~20 km h^{-1}~~ (10 kt) or more, lasting at least two minutes.

15.5.2 In the case of variable wind direction, ddd shall be encoded as VRB when the mean wind speed is less than 1.5 m s^{-1} (3 knots) ~~(2 m s^{-1} or 6 km h^{-1})~~. A variable wind at higher speeds shall be reported only when the variation of wind direction is 180° or more or when it is impossible to determine a single wind direction, for example when a thunderstorm passes over the aerodrome.

15.5.3 If, during the 10-minute period preceding the observation, the total variation in wind direction is 60° or more but less than 180° and the mean wind speed is 1.5 m s^{-1} (3 knots) ~~(2 m s^{-1} or 6 km h^{-1})~~ or more, the observed two extreme directions between which the wind has varied shall be given for $d_nd_nd_n$**V**$d_xd_xd_x$ in clockwise order. Otherwise this group shall not be included.

15.5.4 "Calm" shall be coded as 00000 followed immediately, without a space, by one of the abbreviations ~~KMH,~~ KT or MPS to specify the unit, used normally for reporting wind.

15.5.5 If, during the 10-minute period preceding the observation, the maximum wind gust speed exceeds the mean speed by 5 m s^{-1} (10 knots) ~~(5 m s^{-1} or 20 km h^{-1})~~ or more, this maximum speed shall be reported as **G**f_mf_m immediately after dddff, followed

immediately, without a space, by one of the abbreviations ~~KMH,~~ KT or MPS to specify the units used for reporting wind speed. Otherwise the element **G**$f_m f_m$ shall not be included.

Note: It is recommended that the wind measuring systems should be such that peak gusts should represent a three-second average.

15.5.6 For wind speeds of 100 units or greater, the exact number of wind speed units shall be given in lieu of the two-figure code ff or $f_m f_m$. When the wind speed is 50 m s^{-1} (100 knots) or more ~~(50 m s^{-1} or 200 km h^{-1})~~, the groups ff and $f_m f_m$ shall be preceded by the letter indicator P and reported as P49MPS (P99KT)~~P99 KT (P49 MPS or P199 KMH)~~.

Note: There is no aeronautical requirement to report surface wind speeds of 50 m s^{-1} ~~200 km h^{-1}~~ (100 kt) or more; however, provision has been made for reporting wind speeds up to 99 m s^{-1} ~~399 km h^{-1}~~ (199 kt) for non-aeronautical purposes, as necessary.

15.6 **Groups** VVVV ~~VVVV**NDV**~~ $V_N V_N V_N V_N D_v$

Note: The coding of visibility is based on the use of the metre and kilometre, in accordance with the units specified in ICAO Annex 5.

15.6.1 The group VVVV shall be used to report prevailing visibility. When the horizontal visibility is not the same in different directions and when the visibility is fluctuating rapidly and the prevailing visibility cannot be determined, the group VVVV shall be used to report the lowest visibility. ~~When visibility sensors are used and they are sited in such a manner that no directional variations can be given, the abbreviation NDV shall be appended to visibility reported.~~

15.6.2 ***Directional variation in visibility*** $V_N V_N V_N V_N D_v$

When the horizontal visibility is not the same in different directions and when the minimum visibility is different from the prevailing visibility, and less than 1 500 metres or less than 50 per cent of the prevailing visibility, and less than 5000 metres, the group $V_N V_N V_N V_N D_v$ shall also be used to report the minimum visibility and, when possible, its general direction in relation to the aerodrome reference point indicated by reference to one of the eight points of the compass. If the minimum visibility is observed in more than one direction, the D_v shall represent the most operationally significant direction.

Amend the Regulation 15.7.4.2:

15.7.4.2 The mean value of the runway visual range over the 10-minute period immediately preceding the observation shall be reported for $V_R V_R V_R V_R$. However, when the 10-minute period includes a marked discontinuity in the RVR (for example, sudden advection of fog, rapid onset or cessation of an obscuring snow shower), only data after the discontinuity shall be used for obtaining mean RVR values and variations thereof, hence the time interval in these circumstances shall be correspondingly reduced.

Notes:
(1) See Regulation 15.7.5.
(2) Any observed value which does not fit the reporting scale in use should be rounded down to the nearest lower step in the scale.
(3) A marked discontinuity occurs when there is an abrupt and sustained change in runway visual range, lasting at least two minutes, consistent with the issuance of aerodrome special meteorological reports (SPECI) ~~selected special reports~~ given in Technical Regulation [C.3.1.] 4.3.3.

Amend the Regulation 15.8.4:

15.8.4 Intensity shall be indicated only with precipitation, precipitation associated with showers and/or thunderstorms, funnel cloud, duststorm or sandstorm. If the intensity of the phenomena reported in the group is either light or heavy, this shall be indicated by the

appropriate sign (see Code table 4678 and specially Note (5)). No indicator shall be included in the group when the intensity of the reported phenomenon is moderate.

Amend the Regulation 15.8.15:

15.8.15 The letter abbreviation FG shall be used when the obstruction to vision consists of water droplets or ice crystals (fog or ice fog). For w´w´= FG to be reported without the qualifiers MI, BC, PR or VC, the visibility reported in the group VVVV shall be less than 1 000 metres.

Amend the Regulation 15.8.19:

15.8.19 The letter abbreviation SQ shall be used to report squalls when a sudden increase in wind speed is observed of at least 8 m s^{-1} (16 knots) ~~(32 km h^{-1}, 8 m s^{-1})~~, the speed rising to 11 m s^{-1} (22 knots) ~~(44 km h^{-1}, 11 m s^{-1})~~ or more and lasting for at least one minute.

Amend the Regulation 15.14.12:

15.14.12 Inclusion of significant forecast weather w'w', using the appropriate abbreviations in accordance with Regulation 15.8, shall be restricted to indicate:

(1) the onset, cessation or change in intensity of the following weather phenomena:
– Freezing precipitation;
– Moderate or heavy precipitation (including showers);
– Duststorm;
– Sandstorm;
– Thunderstorm (with precipitation)
– Other weather phenomena – given in Code table 4678 as agreed by the meteorological authority and air traffic services authority and operators concerned

(2) the onset or cessation of the following weather phenomena:
– Freezing fog;
– Ice crystals;
– Low drifting dust, sand or snow;
– Blowing dust, sand or snow;
– Thunderstorm (without precipitation);
– Squall;
– Funnel cloud (tornado or waterspout).

Amend the title of TAF:

FM 51–XIV Ext. TAF Aerodrome forecast

Amend the code form of TAF:

{ **TAF AMD** or / **TAF COR** or / **TAF** } CCCC YYGGgg**Z** { **NIL** or $Y_1Y_1G_1G_1/Y_2Y_2G_2G_2$ } { dddff**G**f_mf_m or **CNL** } { ~~**KMH**~~ ~~or~~ **KT** or **MPS** }

{ VVVV or **CAVOK** w'w' { $N_sN_sN_sh_sh_sh_s$ or **VV**$h_sh_sh_s$ or **NSC** } }

(**TX**$T_FT_F/Y_FY_FG_FG_F$**Z** **TN**$T_FT_F/Y_FY_FG_FG_F$**Z**)

{ { **PROB** C_2C_2 or / **PROB** C_2C_2 TTTTT / or TTTTT } YYGG/$Y_eY_eG_eG_e$ / or / TTYYGGgg } dddff**G**f_mf_m { ~~**KMH**~~ ~~or~~ **KT** or **MPS** } { VVVV or **CAVOK** { w'w' or **NSW** } { $N_sN_sN_sh_sh_sh_s$ or **VV**$h_sh_sh_s$ or **NSC** } }

Amend the Regulations 51.3 and 51.3.1:

51.3 **Group** dddff**G**$f_m f_m$ { ~~**KMH** or~~ **KT** or **MPS**

51.3.1 The mean direction and speed of the forecast wind shall be indicated by dddff immediately followed, without a space, by one of the letter code indicators ~~KMH,~~ KT or MPS, as the case may be.

Notes:

(1) ~~KMH,~~ KT and MPS are the standard ICAO abbreviations for ~~kilometres per hour,~~ knots and metres per second, respectively.

(2) The ~~unit of wind speed used is determined by national decision. However, the~~ primary unit prescribed in ICAO Annex 5 for wind speed is the metre per second (MPS)~~kilometre per hour (KMH),~~ with the knot (KT) permitted for use as a non-SI alternative unit until a termination date is decided ~~– subject to a decision which is currently under review by ICAO~~.

Amend the Regulations 51.3.3 and 51.3.4:

51.3.3 ddd shall normally be encoded as VRB only when the mean wind speed is less than 1.5 m s^{-1} (3 knots) ~~(2 m s^{-1} or 6 km h^{-1})~~. A variable wind at higher speeds shall be indicated only when it is impossible to forecast a single wind direction.

51.3.4 When it is forecast that the maximum wind speed will exceed the mean speed by 5 m s^{-1} (10 knots) ~~(5 m s^{-1} or 20 km h^{-1})~~ or more, the maximum wind speed shall be indicated by adding **G**$f_m f_m$ immediately after dddff.

Note: If after a change group the wind is reported again, **G**$f_m f_m$ should be included, or not, in accordance with these same criteria.

Amend the Regulation 51.5.1:

51.5.1 Inclusion of significant forecast weather w'w', using the appropriate abbreviations in accordance with Regulation 15.8, shall be restricted to indicate:

(1) the occurrence, cessation or change in intensity of the following weather phenomena:
– Freezing precipitation;
– Moderate or heavy precipitation (including showers);
– Duststorm;
– Sandstorm;
– Thunderstorm (with precipitation);

(2) the occurrence or cessation of the following weather phenomena:
– Ice crystals;
– Freezing fog;
– Low drifting dust, sand or snow;
– Blowing dust, sand or snow;
– Thunderstorm (without precipitation);
– Squall;
– Funnel cloud (tornado or waterspout).
– Other weather phenomena – given in code table 4678 shall be included as agreed by the meteorological authority with the air traffic services authority and operators concerned.

Amend the Regulations 51.6.1.3 and 51.6.1.4:

51.6.1.3 The cloud group shall be repeated to indicate different layers or masses of cloud forecast. The number of groups shall not exceed three, except that cumulonimbus clouds and/or towering cumulus clouds, when forecast, shall always be included.

51.6.1.4 The selection of forecast layers or masses of cloud to be included shall be made in accordance with the following criteria:

1st group:	the lowest individual layer (mass) of any amount, to be indicated as FEW, SCT, BKN or OVC;
2nd group:	the next individual layer (mass) covering more than two oktas, to be indicated as SCT, BKN or OVC;
3rd group:	the next higher individual layer (mass) covering more than four oktas, to be indicated as BKN or OVC;
Additional groups:	Cumulonimbus clouds (CB) and/or towering cumulus clouds when forecast, if not already included in one of the three groups above.

The order of inclusion of the groups shall be from lower to higher levels.

Amend the Regulations 51.6.1.6:

51.6.1.6 Types of forecast clouds other than cumulonimbus clouds and towering cumulus clouds shall not be given. Cumulonimbus clouds and towering cumulus clouds when expected shall be indicated by appending the letter abbreviations CB and TCU, respectively to the cloud group without a space. In case CB and TCU are forecast with the same height of cloud base, the cloud amount shall be the sum of the CB and TCU amounts and the cloud type given as CB.

Amend the Regulation 51.6.3:

51.6.3 Cloud information shall be limited to cloud of operational significance, i.e. cloud below 1500 metres (5 000 ft) or below the highest minimum sector altitude, whichever is greater, and Cumulonimbus and/or towering cumulus whenever forecast. In applying this limitation, when no Cumulonimbus and no towering cumulus and no cloud below 1 500 m (5 000 ft) or below the highest minimum sector altitude, whichever is greater, are forecast, and CAVOK is not appropriate, the abbreviation NSC shall be used.

Amend the Regulation 51.7:

51.7 **Code word CAVOK**

When it is expected that the following conditions will apply simultaneously, the code word **CAVOK** shall be included in place of the groups VVVV, w´w´ and $N_sN_sN_sh_sh_sh_s$ or **VV**$h_sh_sh_s$:

(a) Visibility: 10 km or more;
(b) No cloud below 1 500 metres (5 000 ft) or below the highest minimum sector altitude, whichever is greater, and no cumulonimbus and no towering cumulus;
(c) No significant weather phenomena (see Code table 4678).

Note: See note under Regulation 15.10.

Amend the Regulation 51.10.1:

51.10.1 To indicate forecast maximum and minimum temperatures expected to occur at the time indicated by $Y_FY_FG_FG_F$**Z**, the letter indicator TX for the maximum forecast temperature and TN for the minimum forecast temperature shall precede T_FT_F without a space. Up to a maximum of four temperatures shall be included, i.e. two maximum temperatures and two minimum temperatures.

Amend the SYMBOLIC LETTERS ff and f_mf_m:

ff Wind speed, in units indicated by i_w.
(FM 12, FM 13, FM 14, FM 18, FM 22)
(1) If wind speed is 99 units or more, see Regulation 12.2.2.3.3.

— Wind speed, in ~~kilometres per hour or~~ knots or metres per second.
(FM 15, FM 16, FM 51)

(2) For wind speeds of 100 units or more, see Regulations 15.5.6 or 51.3.5, as appropriate.

— Wind speed, in knots.
(FM 45)
(3) For wind speeds of 100 units or more, see Regulation 45.3.6.2.

— Wind speed, in units indicated by i_u.
(FM 63, FM 64)

$f_m f_m$ Maximum wind speed, in ~~kilometres per hour or~~ knots or metres per second.
(FM 15, FM 16, FM 51)
(4) See Note (1) under ff (second specification).

Amend the Note (5) to Code table 4678:

(5) Intensity shall be indicated only with precipitation, precipitation associated with showers and/or thunderstorms, duststorm or sandstorm, and funnel clouds.

Recommendation 3 (CBS-Ext.(10))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL TELECOMMUNICATION SYSTEM* (WMO-No. 386), VOLUME I, PART II

THE COMMISSION FOR BASIC SYSTEMS,

Noting:

(1) Resolution 1 (Cg-XV) – Technical Regulations of the World Meteorological Organization,

(2) Resolution 2 (Cg-XV) – World Weather Watch Programme for 2008–2011,

(3) The *Manual on the Global Telecommunication System* (WMO-No. 386), Volume I – Global Aspects, Part II,

Recommends that the *Manual on the Global Telecommunication System*, Volume I, Global Aspects – Part II, be amended as given in the annexes to the present recommendation, with effect from 2 November 2011;

Requests the Secretary-General to make the amendments, as given in the annexes to the present recommendation, to the *Manual on the Global Telecommunication System*, Volume I – Global Aspects, Part II;

Authorizes the Secretary-General to make any consequent purely editorial amendments to the *Manual on the Global Telecommunication System*.

Annex 1 to Recommendation 3 (CBS-Ext.(10))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL TELECOMMUNICATION SYSTEM* (WMO-No. 386), VOLUME I

PART II – OPERATIONAL PROCEDURES FOR THE GLOBAL TELECOMMUNICATION SYSTEM

Attachment II-5

– To allocate T1=X to "Common Alert Protocol (CAP) messages" in replacement of "GRID regional use"; the current allocations of T_2A_1 A_2ii are deleted and new allocations of T_2A_1 A_2 will be further studied

– To add the following allocation in Table C6

T_1T_2 A_1	ii	Data type	TAC correspondence	Data Category/ Sub-Category Common Code Table C13
IOZ		Deep ocean tsunameter		031/007

– To replace the following allocations for ozone data in Tables C6 and C7:

	$T_1T_2A_1$	Data type	Data category/subcategory
Table C6 - BUFR	ISE	Ozone measurement at surface	008/000
Table C7 - CREX	KSE	Ozone measurement at surface	008/000
Table C6 - BUFR	IUE	Ozone vertical sounding	008/001
Table C7 - CREX	KUL	Ozone vertical profile	008/001

By the new following allocations (the modifications/additions are marked written in blue):

	$T_1T_2A_1$	Data type	Data category/subcategory
Table C6 - BUFR	ISE	Measurement of surface ozone	008/000
Table C7 - CREX	KSE	Measurement of surface ozone	008/000
Table C6 - BUFR	IUE	Ozone vertical sounding	008/001
Table C7 - CREX	**KUE**	Ozone vertical sounding	008/001
Table C6 - BUFR	**IUL**	Total ozone	008/002
Table C7 - CREX	KUL	Total ozone	008/**002**

Annex 2 to Recommendation 3 (CBS-Ext.(10))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL TELECOMMUNICATION SYSTEM* (WMO-No. 386), VOLUME I

PART II – OPERATIONAL PROCEDURES FOR THE GLOBAL TELECOMMUNICATION SYSTEM

Section 2.12.1:

2.12.1 The transmission protocols for use on the GTS shall be elements of procedures as specified in ~~ITU-T Recommendation X.25 and~~ the Transmission Control Protocol/Internet Protocol (TCP/IP).

Section 2.12.2 (entire section 2.12.2 and subsections removed)

~~2.12.2 ITU-T Recommendation X.25 procedures~~
~~The methods and elements of ITU-T Recommendation X.25 procedures to be used in the GTS are as outlined below, and are given in Attachment II-13.~~

~~Note: References to OSI layers are taken from the Reference Model of Open Systems Interconnection (OSI) given in International Standard ISO 7498 and ITU-T Recommendation X.200.~~

~~2.12.2.1 Physical layer (ITU-T Recommendation X.25, physical layer, paragraph 1/OSI layer 1)~~
~~The provisions given in ITU-T Recommendation X.25, paragraph 1, shall be applied to point-to-point circuits and the interface between the data terminal equipment (DTE) and data circuit terminating equipment (DCE).~~

~~2.12.2.2 Link layer (ITU-T Recommendation X.25, data link layer, paragraph 2/OSI layer 2)~~
~~The following provisions shall be applicable only to point-to-point circuits between centres of the GTS:~~
~~Frame structure: The frame format shall be as described in Table 1/X.25, with the following parameters:~~
~~Address field: one octet; Control field: one octet.~~
~~Note: The extended control field of two octets or more needs further study.~~
~~Information field: 259 octets, 131 octets optional subject to bilateral agreement between centres concerned.~~
~~Elements of procedure: The elements of procedure shall be as described in section 2.3, "LAPB elements of procedures", of ITU-T Recommendation X.25.~~
~~Description of the procedures: The description of the procedures shall be as described in section 2.4, "Description of the LAPB procedures", of ITU-T Recommendation X.25.~~
~~It is recommended that WMCs and RTHs should take the role of DTE or DCE and NMCs should take the role of DTE, by bilateral agreement between centres concerned.~~
~~System parameters shall be as follows:~~
~~Timer T1 : T1 > Transmission time for three frames + two-way signal propagation time over the link + maximum time for processing one frame in a specific receiving centre.~~
~~Note: Examples of values of Timer T1 with processing time of ten milliseconds are as follows:~~
~~Cable links: 9600 bit/s: 0.4 s 4800 bit/s: 0.8 s 2400 bit/s: 1.6 s~~
~~Satellite links: 9600 bit/s: 1.2 s 4800 bit/s: 1.6 s 2400 bit/s: 2.4 s~~
~~Maximum number of transmissions N2:10~~
~~Number of outstanding frames k : 2 ≤ k ≤ 7~~
~~Note: International Standard ISO 7776 – Information processing systems – Data communication – High-level data link control procedures – Description of the X.25 LAPB-compatible DTE data link procedures, describes the X.25 layer 2 procedures as viewed by the DTE for DTE to DCE operation and for DTE to DTE operation without an intervening packet-switched network.~~

~~2.12.2.3 Network layer (ITU-T Recommendation X.25, packet layer, sections 3, 4, 5.1 to 5.5/OSI layer 3)~~
~~The packet layer of ITU-T Recommendation X.25 shall be used in accordance with the procedures for permanent virtual circuit (PVC) and virtual call (VC) services.~~
~~The maximum length of the user data field shall be 256 octets or optionally 128 octets.~~
~~Window size W : 2 ≤ W ≤ 7 depending on type of communication circuit and system equipment.~~
~~One or more logical channels (PVC and/or VC) should be established between two adjacent centres. Multiplexing provided by logical channels (PVCc and/or VCs) should be used in preference to multiplexing provided at the physical layer (e.g. by V.29 modems). The recommended procedures for the use of VCs – also called switched virtual circuits (SVCs) – are given in Attachment II-14.~~
~~Note: One or more PVC and/or VC could be used between non-adjacent centres by multilateral agreement.When the transport layer procedures have not been implemented, "more data mark" (binary element M) shall be used to identify the sequence of packets containing the complete message.~~
~~Note: International Standard ISO 8208 – Information processing systems – Data communication – X.25 Packet layer protocol for data terminal equipment, describes the X.25 packet layer procedures as viewed by theDTE for DTE to DCE operation and for DTE to DTE operation without an intervening packet-switched network.~~

~~2.12.2.4 Transport layer (OSI layer 4)~~
~~A transport protocol should be employed in accordance with ITU-T Recommendation X.224. When implemented, the class 2 procedures, including those for multiplexing, explicit flow control and expedited data transfer, shall be used. Class~~

ATTACHMENT II-6

Paragraph "TYPE 3" (II-6/2)

The structure of the text for this message type has two specific classes using two different formats in the request text. This addressed message type is for use between nodes of the GTS. To use the CLASS 1 formatted request form, the nodes of the GTS must be adjacent nodes. To use the CLASS 2 formatted request form, the nodes of the GTS do not have to be adjacent to each other. The request/reply type message is for the acquisition of data at the bulletin level and the bulletin is assumed to exist already. If it is sent on an ~~X.25 virtual channel~~ a connection established for the exchange of alphanumeric data, then the T1T2 option of BM is recommended; and if, the X.25 virtual channel was established for binary data exchange, then the T1T2option of BI is recommended. If there is only one virtual channel between nodes for both alphanumeric and binary data exchange, it is recommended to use the T1T2 option of BI as a default. The use of the T1T2 option of BM would be used on all GTS links using character protocols (i.e. BAUDOT or ERROR CONTROL PROCEDURES), as all addressed messages and request/reply responses are alphanumeric.

Paragraph "Choice 1" (II-6/2)

1. Format for an alphanumeric connection ~~virtual channel or for any non-binary GTS link~~.

2. Format for a binary connection ~~virtual channel on X.25 GTS links~~.

Paragraph "Choice 2" (II-6/2)

1. Format for an alphanumeric connection ~~virtual channel or for any non-binary link.~~

2. Format for a binary connection ~~virtual channel on X.25 GTS links~~.

Paragraph "CLASS 2" (II-6/3)

CLASS 2. Request for a bulletin – can be sent to any centre on the GTS. There is only one choice for the form of the text of the request. The form is always alphanumeric, however, the T1T2 option of BM is to be used for all requests for alphanumeric messages, and the T1T2 option of BI is to be used for all requests for binary messages, as all returned responses will use the same T1T2 for the heading type to facilitate proper routing ~~when X.25 or equivalent links are required~~.

Examples – CLASS 2 (II-6/3, II-6/4)

• Used for a non-binary connection ~~X.25 virtual channel~~

[…]

• Used for a binary connection ~~X.25 virtual channel only~~

Note at the bottom of ATTACHMENT II-6 (II-6/5)

Note: Connections ~~Limitation circuits or virtual channels~~ with priority queues must guard against confusion when selecting and responding to sequence number requests for transmission.

ATTACHMENT II-9

Subtitle of II-9 and following (II-9/1)

I. Coded or non coded digital facsimile transmission procedures between centres on a network connection ~~channel equipped for X.25 procedures~~
1. The structure of the message, containing a bit oriented product for transmission on GTS links ~~conforming to the provisions of ITU-T Recommendation X.25~~, should be as follows:

[…]

~~This message should be transmitted according to the procedures conforming to ITU-T Recommendation X.25, given in Part II, paragraph 2.12~~.

ATTACHMENT II-13 (the entire text is removed and replaced by the text below. See background document CBS Ext.(10) BM4.3(4) for old text)

NOT USED

ATTACHMENT II-14 (the entire text is removed and replaced by the text below. See background document CBS Ext.(10) BM4.3(4) for old text)

NOT USED

ATTACHMENT II-15 [See Annex 3 to Recommendation 3 (CBS-Ext.(10)) for recommended text]

ATTACHMENT II-16

Title

PROCEDURES FOR TRANSMITTING AND COLLECTING METEOROLOGICAL BULLETINS ~~ON THE INTERNET~~ USING E-MAIL AND WEB

Background

[…]

The following guidelines describe practices for sending both data collection bulletins and binary meteorological bulletins via e-mail while minimizing security ~~issues~~ risks.

[…]

~~Format of messages~~ Guidelines for sending meteorological bulletins via electronic mail on the Internet

1. The main body of e-mail should use charset (character encoding) which is understandable by receiving centres. If e-mail client software can be configured, “US-ASCII” or “UTF-8” is suggested where there is no bilateral arrangement.

~~1~~2. The sender should be reminded, however, that not all of transmittable characters are acceptable to the GTS. The main body of e-mail messages should use only characters defined in International Alphabet No. 5. Use of other characters especially NO-BREAK SPACE is discouraged for interoperability reasons. It is recommended that the meteorological bulletin should be contained in the main body of the e-mail message; as an option it may be contained in an attachment.

~~Note: ‘Attachments’ are a part of an e-mail message that are separate from the main body of the mail message, and that their display/storage is normally contingent upon some further action of the user.~~

3. The “From:” header field should be previously agreed with receiving centre.

4. The “Subject:” header field is recommended to be either:
   (a) the AHL if the email message contains a single meteorological bulletin; or
   (b) a <security string> previously agreed with receiving centre.

~~2~~5. It is recommended that only a single bulletin should be sent in each e-mail message. However, receiving centres may agree to accept multiple meteorological bulletins per e-mail message to a maximum of five.

~~3~~6. The meteorological bulletin(s) can be sent either as text in the main body of the e-mail message, or in the attachment(s) of the e-mail message, but not in both. Text data should be sent in the main body of the email message. Binary data can only be sent in the attachment(s). Attachments should be encoded in Base64 (MIME standard).

7. When (a set of) meteorological bulletin(s) is sent in t~~T~~he main body of an e-mail message should follow the following format: <Meteorological Bulletin>

[…]

8. When (a set of) meteorological bulletin(s) is sent in attachments, the attachments must be in a format agreed with receiving centre. One possible format is described in “Accumulating messages into files” of Attachment II-15. The main body should be blank.

~~5~~9. The total size of e-mail message including all attachments should not exceed 2 Megab~~B~~ytes or as specified in a bilateral agreement. Attachments should be coded in Base64 (MIME standard).

~~6. The e-mail header “Subject:” field either:~~
~~(a) May contain the AHL if the e-mail message contains a single meteorological bulletin;~~
~~(b) Or a pre-defined <security string>~~

Example

```
From: NMCAAAAA <NMCAAAAA@meteo.fr>
To: RTHcollector <RTHcollector@meteo.zz>
Subject: SMFW01 NWBB 270000

SMFW01 NWBB 270000
AAXX 27004
91753 32481 51008 10331 20259 40078 58017 83202
  333 20263 59018 83816 84078=
91754 01581 51812 10287 20245 40092 58017 60034 70182 85200
  333 20256 59016 60017 85820=
NNNN
```

Information which is part of the e-mail header

Text in the main body of the e-mail message or in the attachment

Guidelines for e-mail-to-GTS gateways
~~Security considerations~~

1. ~~E-mail is inherently insecure.~~ To minimize security risks ~~issues~~, ~~all e-mail input should be pre-authorized by means of a list of valid source e-mail addresses at the receiving site. The receiving centre should only process GTS-related e-mails from the pre-defined list of e-mail addresses. That is,~~ the receiving centre should validate the e-mail message header “From:” field against previously-agreed list of source addresses before sending bulletins to GTS. ~~To avoid problems with e-mail messages containing manipulated “From”-fields,~~

2. If receiving and sending centres ~~may optionally~~ agree to implement <security strings> > it should be placed in the message header “Subject:” field or the previously agreed field~~. If <security strings> are agreed on, and GTS message(s) are included in attachment(s), then the main body of the e-mail message can only contain the <security string>.~~

3. The receiving centre should ~~validate the "Subject" field for~~ the AHL ~~or the pre-agreed string~~ found in the "Subject:" header field (if it is not <security string>) or extracted from meteorological bulletin(s) such as main body.

~~4~~2. No automatic acknowledgements or replies should be sent from the receiving centres.

~~5~~3. It is recommended to use specific mail accounts for receiving GTS data transfer with bilaterally agreed names and not to receive GTS data in personal mailboxes.

~~6~~4. A problem with some e-mail exchanger applications is that by default they operate as an "open-relay", which is exploited for sending unsolicited bulk e-mail. An open-relay occurs, for example, if site A.COM accepts mail from B.NET destined for C.ORG. This means that spammers can use A.COM's mail system to distribute their e-mails. Centres should ensure that they do not operate as an open-relay.

7. To minimize the risk of operational trouble, the receiving centre should understand and decode all MIME standard multipart structure and Content-Transfer-Encodings (namely Base64 and Quoted-Printable). When sending text bulletins intended for global distribution, the gateway should ensure the content is in ITU International Reference Alphabet. For example, NO-BREAK SPACE (hexadecimal code A0 or C2 A0 in many charsets) can be replaced by ordinary SPACE (20).

Security considerations

E-mail is inherently insecure. In order to minimize the risk of unauthorized message submission, this guideline recommends that e-mail-to-GTS gateways:

(1) Validate "From:" address, and

(2) Validate <security-string> in "Subject:"

Hence it is advised that the agreed e-mail address and/or <security-string> are treated as secret by both sending and receiving centres.

~~*Example*~~

~~From: NMCAAAAA <NMCAAAAA@meteo.fr>~~
~~To: RTHcollector <RTHcollector@meteo.zz>~~
~~Subject: SMFW01 NWBB 270000~~

} ~~*Information which is part of the e-mail header*~~

~~SMFW01 NWBB 270000~~
~~AAXX 27004~~
~~91753 32481 51008 10331 20259 40078 58017 83202~~
~~333 20263 59018 83816 84078=~~
~~91754 01581 51812 10287 20245 40092 58017 60034 70182 85200~~
~~333 20256 59016 60017 85820=~~
~~NNNN~~

} ~~*Text in the main body of the e-mail message or in the attachment*~~

Annex 3 to Recommendation 3 (CBS-Ext.(10))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL TELECOMMUNICATION SYSTEM* (WMO-No. 386), VOLUME I

ATTACHMENT II-15

RECOMMENDED PRACTICES AND PROCEDURES FOR THE IMPLEMENTATION, USE AND APPLICATION OF TCP/IP ON THE GTS

Text – No changes
Text – Addition or modification
~~Text – Deleted~~
Text – Move from other article
~~Text – Move to other article~~

FOREWORD

~~The strategic direction for development of the GTS, as endorsed by CBS, has since the early eighties, been based on the OSI standards, especially the ITU-T recommendation X.25. However, CBS now considers that the TCP/IP protocols as used on the Internet, should replace X.25 for supporting GTS operations in the future.~~

~~The change in strategic direction has evolved within the CBS in recent years. It has occurred for various reasons, including the expanding functional needs of the various WMO programs and the evolution of the Internet and its supporting technical standards, as a dominant force in the information technology industry, supplanting the OSI standards in many areas.~~

~~The transition to TCP/IP is considered appropriate because:~~

~~(a) Vendor support for X.25 technology is declining and becoming more expensive due to industry concentration on TCP/IP;~~

~~(b) TCP/IP supports numerous application utilities available off the shelf, which offer solutions to information communications needs of Members, such as file transfer, Web browsers, electronic mail and future applications such as multimedia communications;~~

~~The transition to TCP/IP is considered appropriate because:~~

~~(a) Vendor support for X.25 technology is declining and becoming more expensive due to industry concentration on TCP/IP;~~

~~(b) TCP/IP supports numerous application utilities available off the shelf, which offer solutions to information communications needs of Members, such as file transfer, Web browsers, electronic mail and future applications such as multimedia communications;~~

~~(c) TCP/IP provides connectivity between Members in a more flexible and versatile manner than the X.25 based equivalent.~~

Over the years, the GTS has evolved tremendously. Various protocols were used including X.25 in the recent years. Most GTS links have now been converted to the industry standard TCP/IP, either using direct point-to-point links or more sophisticated networks.

~~These benefits equate to~~ The use of TCP/IP protocols and associated procedures continue to deliver direct savings in financial and human resource costs to Members by:

~~(a) Reduced~~ Reducing costs for communications equipment purchase and maintenance; and

~~(b) Reduced~~ Reducing software development work through use of industry standard software systems.

Considerable efforts have been applied in defining the framework for applying TCP/IP to the GTS and for the orderly transition from the OSI/X.25 based origin of the GTS. Furthermore, it is understood that TCP/IP will be the basis for all new telecommunication functions implemented in support of the WMO Information Systems (WIS).

Procedures are defined to ensure that the primary function of the GTS in carrying real time operational traffic with minimum delay is preserved. ~~Also,~~ The issue of securing the GTS from interference from the Internet and other networks is also addressed in general terms. Reliance must however be placed on all Members with a TCP/IP based connection to the GTS, who are also connected to the Internet and other networks, to implement and maintain thorough security practices.

This Attachment ~~was originally written as the culmination of work undertaken by CBS during 1997 and 1998. The TCP/IP procedures have since been implemented by most national Centres. The opportunity has been taken to capture the practical experiences gained in the use of TCP/IP and update material accordingly. In addition, a World Wide Web resource has been set-up which gives further details of the technical implementation of many of the concepts and procedures introduced within this Attachment.~~ and the information related to this topic which is available on the WMO

World Wide Web pages, provide details of the technical implementation of many of TCP/IP procedures for the GTS. ~~This~~ The information is available on the WMO web pages at:

http://www.wmo.int/pages/prog/www/manuals.html
http://www.wmo.int/pages/prog/www/documents.html

Members are strongly advised to take account of the adoption of the TCP/IP based strategy for the future development of GTS, in planning the future development of systems within their national Centres.

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INTRODUCTION

Historical perspective

The GTS at present is predominantly used to support the message switching application using message exchange in WMO format. This exchange is done using:

- ~~The~~ TCP/IP protocols~~, suite~~
- limited OSI transport service based on point to point X.25;

and is supplemented by broadcasts.

This implementation is adequate for the legacy application of message switching but it ~~is recognized that it~~ requires continuous improvements to fully support the various WMO programs and ~~the new requirements of~~ WIS. For example, the GTS should support:

- Distributed Data Bases (DDB);
- Data exchange between non adjacent centres;
- Exchange of information that cannot readily be handled by message switching systems (MSSs).

Purpose of this Attachment

This Attachment is intended to assist Centres to implement Transmission Control Protocol/Internet Protocol (TCP/IP) based services on the GTS. Throughout this document, it is understood that the implementation of TCP/IP protocols include all essential protocols that are normally part of the TCP/IP protocol suite, as described in the Internet Engineering Task Force (IETF) reference

documents RFC1122 and RFC1123. These documents are available from the IETF website at: http://www.ietf.org/.

The aim of this Attachment is to describe those aspects of the application of TCP/IP that apply specifically to the GTS to meet new requirements and also the long established routine data exchange undertaken by Message Switching Systems (MSSs). The Attachment takes account of the technical evolution of the GTS from an X.25 based network, and maintains the philosophy that Centres continue to be autonomous as far as possible. It is recognized that the timing for implementation of new systems is determined by individual Members in the light of their available resources and relative priorities, but it is also understood that new WIS functionality is expected to be achieved mostly via TCP/IP protocols.

This Attachment does not cover fundamentals of TCP/IP but focuses on those aspects that are essential for successful application on the GTS. Such aspects include appropriate use of the GTS compared with the Internet, co-existence of the GTS and the Internet, IP and X.25 and Autonomous System addressing, router management, TCP/IP application services (such as FTP) and fault management. ~~The Attachment also gives an overview of recommended security practices with TCP/IP, but does not address security issues and practices in detail, this being a highly complex subject in itself. Some references on TCP/IP and on computer security are given in Appendix 4.~~

Information Technology Security (ITS) is an important consideration in the design and operation of networks today. A ~~more~~ comprehensive discussion on security can be found in the "WMO Guide on Information Technology Security", which is available on the WMO website at: http://www.wmo.int/pages/prog/www/manuals.html.

Relationship of the Internet and GTS

The Internet has grown rapidly in capacity, penetration and diversity of applications. ~~As well, day to day performance of the Internet, which used to be recognized as a weakness, is now reaching acceptable levels of reliability~~ Its bandwidth greatly exceeds that of the GTS and it could potentially take over some functions of the GTS. Although day to day performance of the Internet used to be a recognized weakness, recent experience shows that in many countries, its reliability has reached acceptable levels. It should be noted however that the very nature of the Internet will always mean that no one can build a system using the Internet for which specific service levels can be guaranteed. The Internet is the result of the amalgamation of numerous telecommunication systems, for which no operator has complete responsibility.

It is therefore recognized that the internet can be used as:
An underlying technology for some components of the GTS in special conditions,
As a backup to the GTS; and
As a complement to the GTS.

Table 1. Usage of GTS and Internet

Communication Component	*Underlying Technologies*	*Function*
GTS	Dedicated links, high availability network clouds, VPN via Internet for backup or when no other technology is available	Delivery of time critical communication for weather, water and climate operations
Internet	As provided by supplier	Communication for less critical requirements and possibly for large volumes of data

Coexistence with the Internet also brings some special security problems that must be addressed to ensure the GTS can fulfil its function. In particular, the networks must be engineered in such a way that the GTS is protected from general Internet traffic and is secured against inappropriate use and unauthorized access. For example, the use of IP and dynamic routing protocols such as BGP4 (Border Gateway Protocol) on the GTS will have to be managed in such a way as to allow communication between non-adjacent Centres only with the knowledge and concurrence of all intermediate Centres. Otherwise there is a danger that large amounts of GTS capacity could be consumed by non-routine traffic, to the detriment of real time operational data exchange.

Evolution of the GTS

The use of the ISO/ITU standard X.25 was adopted by WMO in the early 1980's to facilitate the exchange of data and products encoded in WMO binary code forms (GRIB, BUFR etc) and to act as a base for higher level OSI applications. Although OSI was regarded at the time as the strategic direction for the evolution of data communications, this has changed. Today, there is no doubt TCP/IP protocols are the most accepted and widespread protocols for exchange of data.

TCP/IP is appropriate because:

(a) it is the dominant protocol suite in everyday use being now packaged with virtually all implementations of Unix and many PC operating systems;

(b) it offers a wide range of standard applications (file transfer, electronic mail, remote logon, World Wide Web, etc.) that will greatly reduce the need for the WMO community to develop special procedures and protocols as it has had to do in the past.

(c) it provides useful features such as automatic alternate routing (in a meshed network) which could improve the reliability of the GTS.

~~This Attachment however takes account of the fact that centres have based plans and developed systems in line with the OSI standards, particularly X.25, as endorsed by WMO and specified in the Manual on GTS. The transition to TCP/IP based services must continue in an orderly fashion from the X.25 based links in such a way that operation of the GTS is not disrupted or put at risk.~~

~~The Attachment provides for this by defining procedures for:~~

~~(a) An interim hybrid based on:~~

~~(i) Carrying TCP/IP based services over an X.25 network service; or~~

~~(ii) Carrying X.25 data over IP based network service via directly connected routers;~~

~~(b) Subsequent transition to pure IP utilizing directly connected routers, together with TCP/IP based application services, such as TCP sockets or File Transfer Protocol (FTP).~~

~~The transition to the second step (pure IP) is desirable because:~~

~~(a) Operating TCP/IP over X.25 may not provide expected throughput because of router processing overheads involved in packet encapsulation of IP frames within X.25 packets. This appears to become worse as line speeds increases. Limited tests which have been done between Centres in Region VI indicate efficiency less than 70 per cent at 64Kbps;~~

~~(b) The management and maintenance activities required for the X.25 network and associated packet switches can be avoided;~~

~~(c) Carrying X.25 over IP requires use of proprietary features of specific router brands.~~

~~In order to move to pure IP, it is necessary to modify MSSs at each Centre to make use of TCP/IP services such as FTP and Sockets. This is covered in some detail in Chapter 4.~~

Other related issues

Many Centres now have experience of TCP/IP on the GTS. Experience has shown that the main technical issues, which need to be addressed to establish widespread use of TCP/IP on the GTS, are:

1.1 agreed methods for the message switching application to use TCP/IP either directly or via higher level applications e.g. FTP;

1.2 an agreed file naming convention and standard for metadata associated with files;
1.3 a community wide Naming and Addressing agreement.

It is the aim of this Attachment to make some progress with these issues, some of which lie in the domain of Data Management as much as Telecommunications. It must also be recognised that overall, the existing GTS is not a homogenous network in the true sense of the word, but a collection of regional networks and discrete point-to-point links. Also managed networks using Frame Relay and MPLS (Multi Protocol Label Switching) technology are now part of the GTS. These developments introduce new issues regarding multi lateral co-operation in operating the GTS. While these issues are raised, they are beyond the scope of this Attachment.

PRINCIPLES GOVERNING THE USE OF TCP/IP ON THE GTS

Basic Concepts

The exchange of information using the standards proposed by the WMO uses a layer model for telecommunication. These layers can be divided in 2 groups:

(a) The lowest layers are more or less the 7 layers of the OSI Model (http://en.wikipedia.org/wiki/OSI_model). These layers are the standard TCP/IP protocol stack;

(b) The top layers are the WMO Message Switching System (MSS) applications.

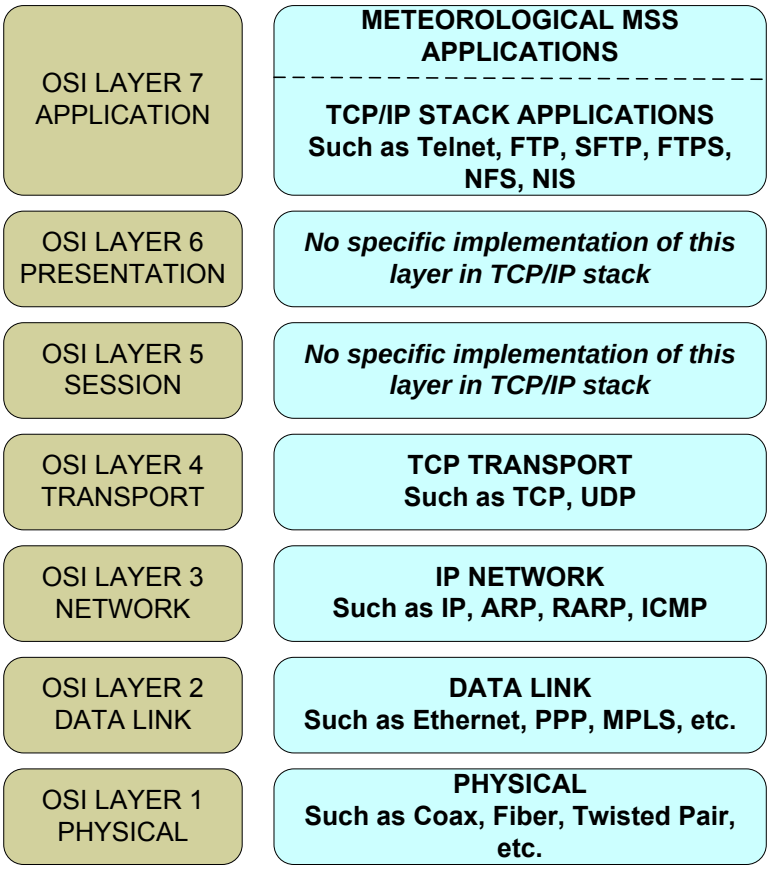

Figure 2.1.1 Layer Model for Telecommunications

The introduction of TCP/IP does not remove the need for some Meteorological MSS telecommunication components. They are still required to properly route the weather and environmental data based on standard $T_1T_2A_1A_2ii$ data designators (the WMO standard data designators are given in Attachment II-5) or based on standard file naming (described later in this attachment).

The protocols in rest of the TCP/IP protocol stack are used to actually deliver the messages to a given location in the world. When a message is transmitted, the MSS applications prepare the message and decide where the information should be sent. The information is then encapsulated in the TCP/IP protocol stack layers and it is the bottom layers that actually deliver the messages to their destination.

The TCP/IP protocol suite is an enabler to:

(1) Simplify interconnectivity between computer systems by allowing several telecommunication technologies to be integrated into a coherent network which may include automatic redundant backup routes,

(2) Lower costs by providing standard telecommunication solutions,

(3) Build modern applications not just limited to strict, fixed store and forward traffic rules.

~~However, some care must be taken to address the counter effects of these benefits and in particular, more flexibility in interconnection and in applications comes at the price of less control on where traffic can go. For example, a general purpose link to a GTS cloud network might get flooded with less critical traffic requested by a site that doesn't normally request data through a given link. It may also mean that traffic has trouble reaching its destination because there are several ill-defined routes (through both the GTS and the Internet) to get there.~~

It should be noted that both the top layers (MSS applications) and bottom layers (TCP/IP protocol stack) use addresses and routing. These addresses are different from layer to layer. Also the routing is different. The MSS layers use $T_1T_2A_1A_2ii$ data designators and country codes for addresses. The routing is a manual configuration based on the particular data needs of each Centre.

Overall topology of interconnection

A general view of the possible interconnectivity between Centres is given in Figure 2.2.1.

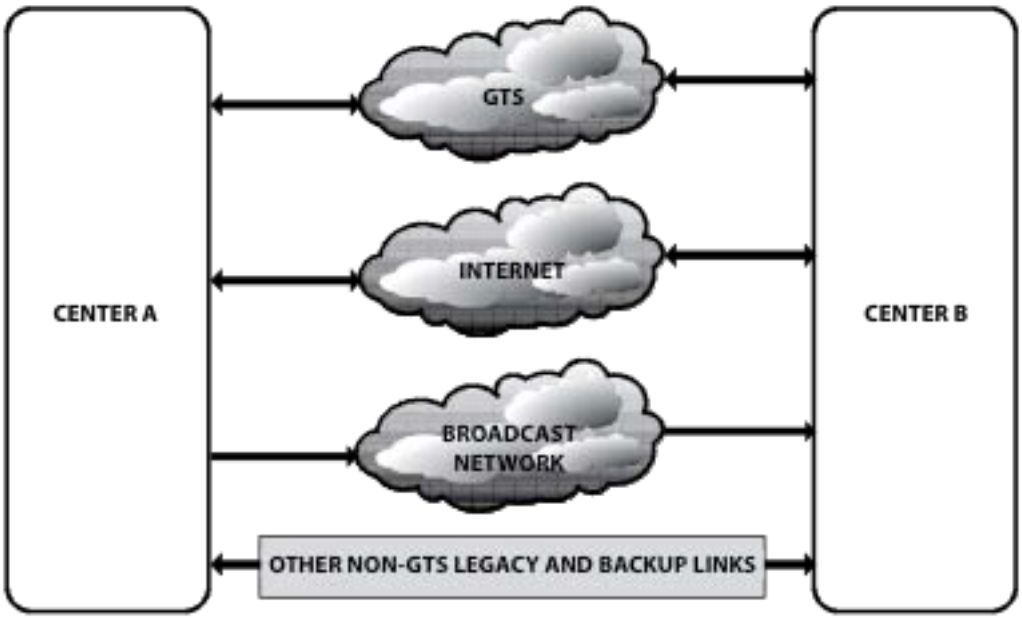

Figure 2.2.1. Possible interconnectivity between Centres

This picture shows that there are many ways to interconnect Centres. The functions carried out by a particular Centre will dictate which telecommunication systems and technologies that Centre will need to support.

The GTS, Internet and Broadcast Network are separate physical networks. Each provides different levels of security, service and redundancy. They should therefore be used for different purposes and different traffic types. They should also be kept as separate networks. This in particular is discussed further later on in this attachment.

It should be noted that the Internet as a network is also used in a second manner. Specifically, CBS has expressed the view that the use of Internet for GTS links can be considered in circumstances where they are cost effective, offer an acceptable level of service and where adequate security measures are implemented. In general, the same principles for routing and security apply where Internet links are used instead of dedicated links. This special configuration requires special devices and protocols and is a particular configuration of Virtual Private Networks (VPN). Further details applying to the use of Internet based links, especially related to small GTS Centres, are given in Appendix 4.

Since most Centres and most telecommunication systems already use TCP/IP, the interconnection using the various networks becomes a fairly simple task. However, some care must be taken to address the counter effects of these benefits and in particular, more flexibility in interconnection and in applications comes at the price of less control on where traffic can go. For example, a general purpose link to a GTS cloud network might get flooded with less critical traffic requested by a site that doesn't normally request data through a given link. It may also mean that traffic has trouble reaching its destination because there are several ill-defined routes (through both the GTS and the Internet) to get there.

This care can be achieved through traffic control and segregation, which would address three basic issues:

(a) traffic management (ensuring timely delivery of critical data, controlling limited bandwidth availability in some areas)
(b) security (protecting centres from unwanted threatening events)
(c) routing coherence (ensuring that the overall resulting network can deliver traffic without difficulty to any given location)

~~To achieve traffic control and segregation, there are several important aspects to consider:~~

~~(a) IP addressing: using universally recognizable and coherent network addresses so that all systems only have one unique reference number, which is valid not only within the GTS but across the Internet and any other network which may eventually be interconnected to the GTS;~~
~~(b) IP network routing rules: using a common set of routing protocols and rules to ensure that any traffic can be consistently sent to its destination without delay or confusion;~~
~~(c) Zoning of each Centre's network elements: creating different network zones with different security levels, to isolate a Centre's critical elements from publicly available areas and ensuring that data can still flow between zones of differing security levels.~~

In order to properly manage the interconnections of Centres and networks, the following elements are essential responsibilities of all Centres:

(a) Ensure that proper TCP/IP addressing is used and properly configured to maintain network integrity and to uniquely identify all components;
(b) Ensure that proper TCP/IP routing is used and properly configured to direct traffic on the correct network and to prevent traffic from going where it shouldn't.
(c) Ensure that networks are separated from each other. Networks can also be divided in various security zones. Different networks and zones must not allow unfiltered routing and traffic to traverse their boundaries. Security gateways (such as firewall devices or routers using access lists) must be used to control the borders if networks must be interconnected.
(d) Ensure that only proper traffic is allowed on any given network to control the volume of data and prevent link flooding.

The following sections discuss these elements in detail.

~~Overall topology of interconnection~~
~~A general view of the possible interconnectivity between Centres using the GTS and the Internet is given in Appendix 1, as well a typical data flows.~~

~~Actual device configuration details to implement these functions in the Cisco family of routers are given in Appendix 2.~~

TCP/IP addressing

Centres must use officially registered IP addresses issued by the Internet Assigned Numbers Authority (IANA) or the relevant Regional Internet Registry. Official IP addresses are required for all systems which communicate through any inter-organizational network, including the GTS (in particular the Main Telecommunication Network (MTN) and the Internet.

Since it is recognized that official IP addresses sometimes difficult to obtain in certain areas of the world, some compromise options have been developed to mitigate this problem.

Appendix 7 describes IP addresses in further detail and the recommended options for the use of IP addresses over the GTS.

If Centres use private IP addresses or non-official addresses on their internal networks, then Network Address Translation (NAT) must be adopted for any hosts requiring to communicate over the GTS or the Internet.

A sufficient number of official addresses must be obtained to correspond to the number of hosts required to communicate externally, and the type of NAT supported by the Centre's access router. If static NAT is adopted, then a one to one correspondence of internal and official addresses is required. If dynamic NAT is used, then there can be more internal addresses than official addresses, with the router allocating the pool of official addresses dynamically as necessary.

Private addresses must not be visible on the GTS or Internet. Figure 2.3.1 shows simplified examples of allowable and non allowable arrangements.

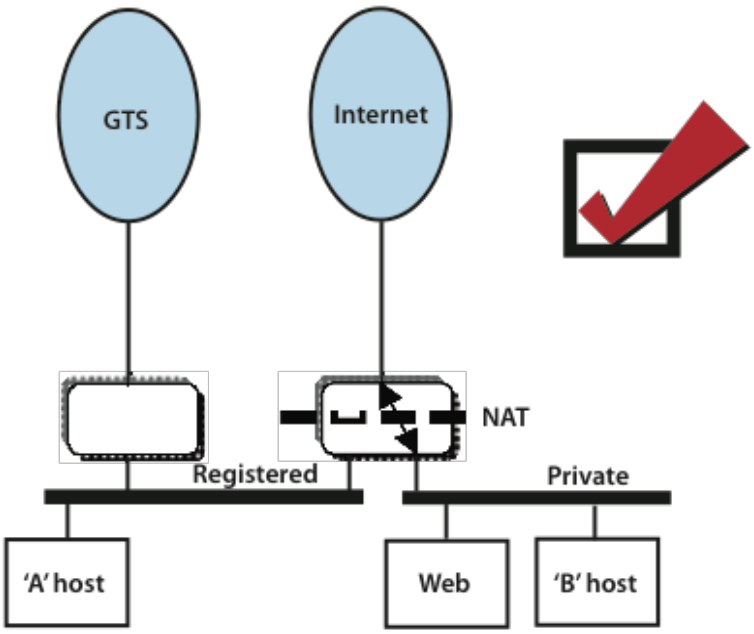

Figure 2.3.1 (a) (Allowed)

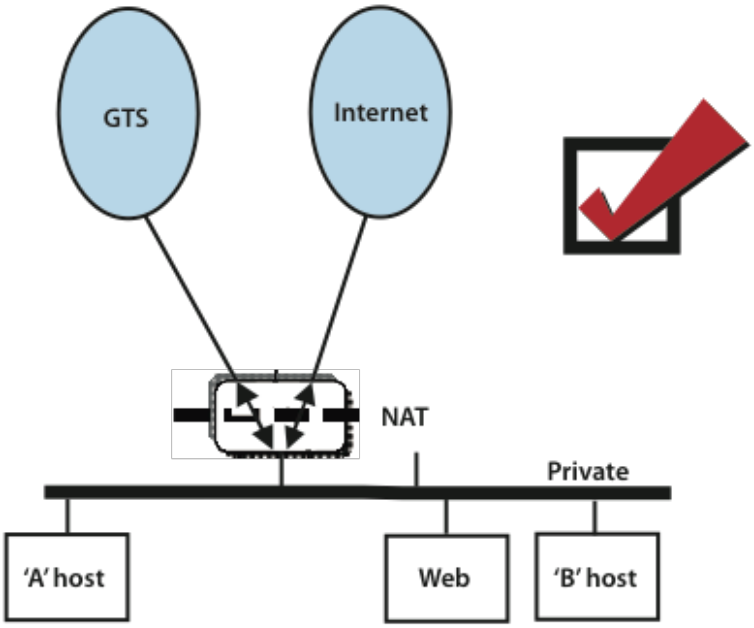

Figure 2.3.1 (b) (Allowed)

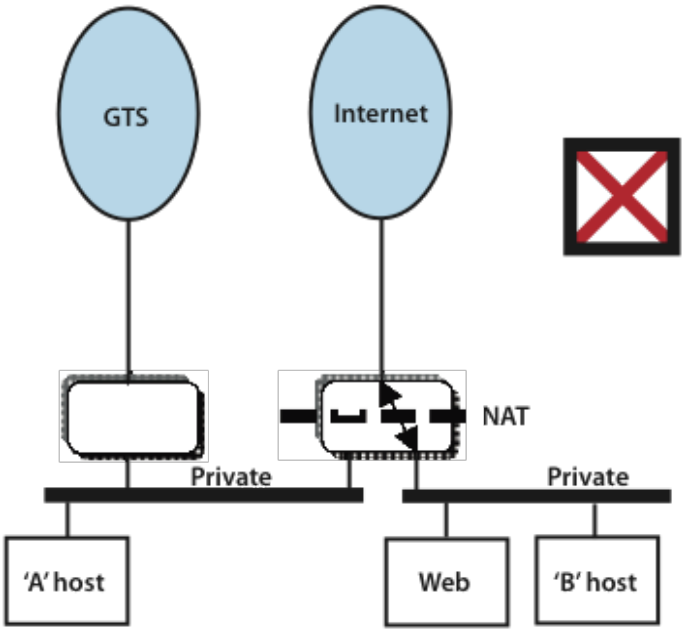

Figure 2.3.1 (c) (Not Allowed)

Summary of tasks to ensure proper use of IP on the GTS

Use only official IP addresses for external communication on the GTS.

(b) Establish an IP connection with one or more Centres. This connection will be pure IP using PPP as a level 2 protocol on the link, or a proprietary protocol such as Cisco HDLC by bilateral agreement. Configure dynamic routing with BGP (unless you are a Centre with only one GTS connection and have agreed with your neighbouring Centre to use static routing).

(c) Check the barrier (security gateway) between Internet and the GTS (prevent routing from the Internet to the GTS.)

(d) Filter incoming and outgoing traffic in accordance with the requirements described above.

~~Traffic management~~

~~Traffic management is an area which is unfortunately not limited to networks, but also involves data management and application configurations. Several groups are therefore involved in this matter.~~

~~In general, it can be said that some applications such as file transfer, World Wide Web have potential to place heavy loads on the limited bandwidth circuits that comprise the GTS. Limits need to be applied to ensure that the GTS carries only important traffic such as the real time data and products currently exchanged on the GTS plus data to be carried to fulfil new requirements such as Distributed Data Bases (DDBs), and routinely exchanged large data files such as satellite imagery.~~

~~Less important traffic such as ad hoc file exchange, e-mail, general World Wide Web and suchlike should be carried on the Internet. To protect the GTS, the full capabilities of TCP/IP connectivity and information exchange must be restricted. In practical terms, TCP/IP traffic carried on the GTS could be restricted on the basis of:~~

~~(a) Protocol type (e.g. FTP, HTTP, SMTP etc);~~
~~(b) Originating and destination IP address;~~
~~(c) A combination of the above.~~

~~If the measures adopted are to be successful, it is necessary that they be:~~

~~(a) Not confined to a single router brand since it cannot be assumed that all centres will have the same brand of router; and~~
~~(b) Be reasonably straightforward to configure, so that there is minimum risk that configuration errors or omissions will endanger the GTS.~~

~~Security issues and segregation of Internet and GTS traffic~~

~~Any Centre which has a TCP/IP based GTS connection and a connection to the Internet, is a potential weak point where the GTS could be exposed to deliberate or inadvertent interference through unwanted traffic or unauthorised connection to GTS hosts.~~

~~Centres are strongly encouraged to implement protective barriers such as firewall systems on the connection of their Centre with the Internet. It is important that every practical step is taken to prevent accidental or deliberate use of GTS links or unauthorised access to GTS Centres, by Internet users.~~

~~When setting up IP on the GTS, it is vital to ensure that the GTS does NOT become part of the Internet or an unintended transmission path for Internet traffic. Each Centre must consider the GTS and the Internet as two separate networks and ensure that inappropriate flow of traffic from one to the other cannot occur. This will ensure that the GTS is used only for transferring bona fide meteorological data between authorised hosts.~~

~~Some basic principles for implementing basic security measures for the GTS are shown in figure A1.2 in Appendix 1. It illustrates in a general way, how a Centre with TCP/IP connection to the GTS and an Internet connection might be set up. Functions to be implemented include:~~

~~(a) Allowing only GTS designated hosts to communicate through the GTS router;~~
~~(b) Blocking access to GTS designated hosts through the firewall and Internet router;~~
~~(c) Firewall allows only approved hosts on the Internet to access B hosts and then, only for approved applications such as FTP;~~
~~(d) Prevention of access to A hosts from Internet via B hosts.~~

~~The actual choice of routers and firewall and the setting up of these will require expertise in the design and configuration of networking and security systems. It is not intended here, to provide detailed coverage of security system implementation and management as it is a large and complex topic. It is simply emphasised that it is important that every Centre should implement the best practical security measures, appropriate to its system complexity and capabilities. Some additional material relevant to small Centres is given in Appendix 4.~~

~~In addition to network security measures, it is vital that good security practices are followed in the management of all hosts in a Centre. Computer security is a complex subject in itself and Centres are encouraged to study this in depth and apply appropriate practices. Some references in computer security are given in Appendix 5. As a bare minimum, good password practices should be followed in the management of all host machines in a Centre. Some recommended practices are given in Appendix 6.~~

Routing and traffic management

Routing algorithms

In order to be able to send a packet, every host, router or equipment connected on an IP network must have a routing table. The table tells the system where to send the packet. This may be achieved by:

(a) Static routing; or

(b) Dynamic routing.

Static routing

With static routing, every required destination and next hop must be entered in the routing tables by the system administrator. Alternatively, a default route can be declared, although this option is mainly applicable to sites with only one connection to the outside world. If a default route is set up, filters must be established to ensure that only authorised hosts can access the GTS.

Whenever a new Centre is connected to the GTS with IP protocol, the site managers of all other IP capable Centres must add the new address to their routing tables. This might become a major task as IP connectivity spreads over the GTS.

Dynamic routing

With dynamic routing, the routing information is automatically exchanged between routers. This enables the network to learn new addresses and to use alternative paths under fault conditions in a partially meshed network topology. The initial set-up of dynamic routing may be somewhat more complex, but the ongoing management task is greatly reduced.

Use of dynamic routing requires selection of an appropriate routing protocol to operate over the links of the GTS. The protocol must be an exterior gateway protocol (e.g. EGP, BGP) as opposed to an interior gateway protocol (such as IGRP, RIP, OSPF) because interior gateway protocols are intended for use within a single management domain. The GTS is an aggregation of many separate management domains. As such, it is necessary to select a gateway protocol that can be autonomously managed by each Centre to implement routing and hence traffic flow, consistent with its particular requirements.

Two exterior gateway protocols are defined by RFCs – EGP and BGP (now release 4 – RFC 1771). As the GTS is not a tree structure, setting up routing with EGP may be difficult.

BGP can distribute subnetted routes. This feature might be very useful for the GTS. Instead of propagating host-based routes or full network routes, routing can be based on subnetted networks. Instead of declaring hosts eligible to use the GTS, a Centre could declare a full subnet of eligible hosts. In that case, the routing information consists of just an IP address and a subnet mask. For

example, if a Centre has a class C addresses 193.168.1.0, by declaring that the subnet 193.168.1.16 with mask 255.255.255.248 is allowed to use the GTS, all hosts with IP address 193.168.1.17 to 193.168.1.22 will be routable on the GTS.

~~Registered and private addresses~~
~~It is recommended that Centres strive to use officially registered IP addresses issued by the Internet Assigned Numbers Authority (IANA) or the relevant Regional Internet Registry. Official IP addresses are required for all systems which communicate through the Internet. Their use is also strongly recommended for systems which communicate on any inter-organization network, including of course the GTS.~~

~~Since it is recognized that official IP addresses sometimes difficult to obtain in certain areas of the world, some compromise options have been developed to mitigate this problem. Appendix 7 describes IP addresses in further detail and the recommended options for the use of IP addresses over the GTS.~~
~~If Centres use private IP addresses on their internal networks, then Network Address Translation (NAT) must be adopted for any hosts requiring to communicate over the GTS or the Internet.~~

~~A sufficient number of official addresses must be obtained to correspond to the number of hosts required to communicate externally, and the type of NAT supported by the Centre's access router. If static NAT is adopted, then a one to one correspondence of internal and official addresses is required. If dynamic NAT is used, then there can be more internal addresses than official addresses, with the router allocating the pool of official addresses dynamically as necessary. The documentation for the Centre's access router should be consulted to ascertain the NAT support provided.~~
~~Private addresses must not be visible on the GTS or Internet. Figure 2.1 shows simplified examples of allowable and non allowable arrangements.~~

~~Figure 2.1 (a) (Allowed)~~
~~Figure 2.1 (b) (Allowed)~~
~~Figure 2.1 (c) (Not allowed)~~

~~Implementation of GTS links via Internet~~
~~CBS has expressed the view that the use of Internet for GTS links can be considered in circumstances where they are cost effective, offer an acceptable level of service and where adequate security measures are implemented. In general, the same principles for routing and security described above, apply where Internet links are used instead of dedicated links. Further details applying to the use of Internet based links, especially related to small GTS Centres, are given in Appendix 4.~~

~~Summary of tasks to ensure proper use of IP on the GTS~~
~~Use only official IP addresses for external communication on the GTS.~~
~~Establish an IP connection with one or more Centres. This connection will be pure IP using PPP as a level 2 protocol on the link, (or a proprietary protocol such as Cisco HDLC by bilateral agreement) or IP over X.25 (RFC 1356). In this case use X.121 addresses as defined in Chapter 3. Configure dynamic routing with BGP (unless you are a Centre with only one GTS connection and have agreed with your neighbouring Centre to use static routing).~~

~~Check the barrier between Internet and the GTS (prevent routing from the Internet to the GTS).~~
~~Filter incoming and outgoing traffic in accordance with the requirements described above.~~

Recommended routing method

Based on consideration of the above factors the BGP4 routing protocol should be used between Centres on the GTS, unless an alternative is bilaterally agreed on individual links. Examples of BGP4 set-up for the Cisco router family are given in Appendix 2.

Network Segregation and Zoning

Any Centre which has a TCP/IP based GTS connection and a connection to another TCP/IP network is a potential weak point where the GTS could be exposed to deliberate or inadvertent interference through unwanted traffic or unauthorised connection to GTS hosts.

Centres are strongly encouraged to implement protective barriers such as security gateways on the connection of their Centre with the Internet. It is important that every practical step is taken to prevent accidental or deliberate use of GTS links or unauthorised access to GTS Centres, by Internet users.

When setting up IP on the GTS, it is vital to ensure that the GTS does NOT become part of the Internet or an unintended transmission path for Internet traffic. Each Centre must consider the GTS and other TCP/IP networks (such as the Internet) as separate networks and ensure that inappropriate flow of traffic from one to the other cannot occur. This will ensure that the GTS is used only for transferring bona fide meteorological data between authorised hosts.

To achieve traffic control and segregation, there are several important aspects to consider:

(a) IP addressing: using universally recognizable and coherent network addresses so that all systems only have one unique reference number, which is valid not only within the GTS but across the Internet and any other network which may eventually be interconnected to the GTS

(b) IP network routing rules: using a common set of routing protocols and rules to ensure that any traffic can be consistently sent to its destination without delay or confusion

(c) Zoning of each Centre's network elements: creating different network zones with different security levels, to isolate a Centre's critical elements from publicly available areas and ensuring that data can still flow between zones of differing security levels

Figure 2.2.1 illustrates in a general way, how a Centre with TCP/IP connection to the GTS and an Internet connection might be set up. This setup also infers that certain security function must be implemented. Functions to be implemented include:

- allowing only GTS designated hosts to communicate through the GTS router;
- blocking access to GTS designated hosts through the security gateway and Internet router;
- security gateway allows only approved hosts on the Internet to access B hosts and then, only for approved applications such as FTP;
- prevention of access to A hosts from Internet via B hosts.

In addition to network security measures, it is vital that good security practices are followed in the management of all hosts in a Centre. Computer security is a complex subject in itself and Centres are encouraged to study this in depth and apply appropriate practices. The Information Technology (IT) Security Guide available at

http://www.wmo.int/pages/prog/www/documents.html

provides information on basic essential security practices.

Traffic management

Traffic management is an area which is unfortunately not limited to networks, but also involves data management and application configurations. Several groups are therefore involved in this matter.

In general, it can be said that some applications such as file transfer, World Wide Web have potential to place heavy loads on the limited bandwidth circuits that comprise the GTS. Limits need to be applied to ensure that the GTS carries only important time critical and operations critical traffic such as the real time data and products currently exchanged on the GTS.

Less important traffic such as ad hoc file exchange, e-mail, general World Wide Web and such should be carried on the Internet. To protect the GTS, the full capabilities of TCP/IP connectivity and information exchange must be restricted. In practical terms, TCP/IP traffic carried on the GTS could be restricted on the basis of

(a) protocol type (e.g. FTP, HTTP, SMTP etc);
(b) originating and destination IP address;
(c) a combination of the above.

If the measures adopted are to be successful, it is necessary that they be:

1. not confined to a single router brand since it cannot be assumed that all centres will have the same brand of router; and
(d) be reasonably straightforward to configure, so that there is minimum risk that configuration errors or omissions will endanger the GTS.

IMPLEMENTATION GUIDELINES

IP Addressing

~~Addressing for Direct IP~~
~~The preferred connection for the future is to use direct IP links. Centres already using IP over X.25 should consider updating the links to use direct IP. This transition should be considered in the near future.~~ Figure 3.2 illustrates how a pair of Centres has agreed to implement a direct IP connection using the first available pair of 'host' numbers using the 193.105.178.0 network as an example.

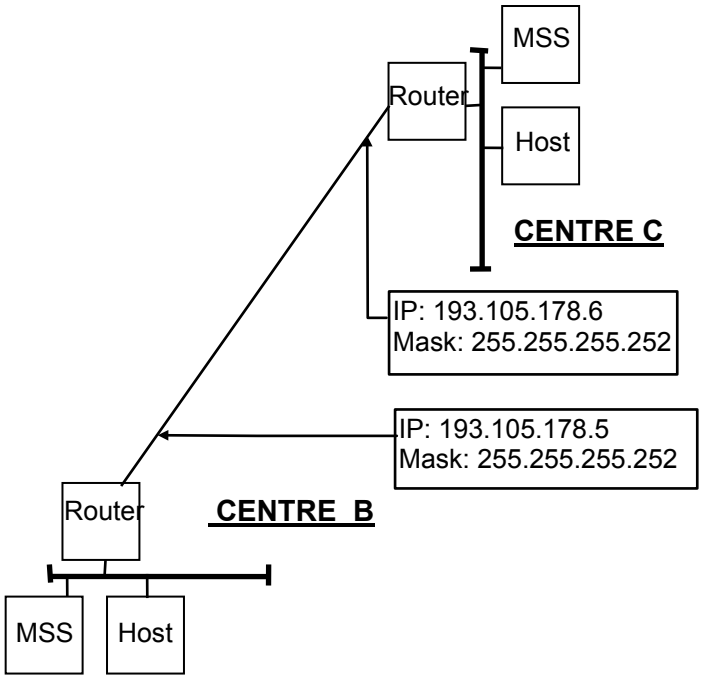

Figure 3.2. Direct IP link between centres B and C

Allocation of class C addresses for direct IP links

Routers have to be connected by links having unique subnet numbers. To achieve this, a Class C address is used (for example 193.105.178.0) with a mask of 255.255.255.252. This provides 62 subnets each with 2 hosts. These two host numbers are allocated to the ends of the link connecting the routers between the two Centres. The lowest useable network number is 193.105.178.4, with host addresses of 193.105.178.5 and 6. The next network number is 193.105.178.8, with host addresses of 193.105.178.9 and 10, followed by:
193.105.178.12, with host addresses of 193.105.178.13 and 14, followed by
193.105.178.16, with host addresses of 193.105.178.17 and 18, followed by
193.105.178.20, with host addresses of 193.105.178.21 and 22, and so on, up to
193.105.178.248, with host addresses of 193.105.178.249 and 250.

~~Addressing for X.25 over IP~~
~~Where two Centres have a common brand of Router (e.g. Cisco), and the traffic is mostly IP with some X.25, it may be appropriate to carry the X.25 over the directly connected routers as shown for the link between Centre B and Centre C in Figure 3.3. The X.25 packets are carried within IP packets over the serial link between the routers, which may be a proprietary HDLC protocol, or a standard protocol such as PPP. This functionality requires that routers in each Centre contain X.25 packet switching software and that the X.25 route details are included in the router configuration. Examples of typical configurations are given in Appendix 2.~~

~~Figure 3.3 — Combination of IP over X.25 and X.25 over IP~~

TCP/IP Routing

Autonomous System Numbers

The use of BGP4 as the recommended dynamic routing protocol for the GTS (Chapter 2) requires allocation of Autonomous System (AS) numbers to each GTS Centre.

The use of BGP requires introduction of the concept of the Autonomous System (AS)[1]. Each GTS Centre manages an AS number to enable the Centre to adopt BGP with neighbouring centres. In addition to addressing, this chapter shows allocation scheme of AS numbers.

The Internet Assigned Numbers Authority (IANA), through RFC1930, has reserved the block of AS numbers 64512 through 65535 for private use (not to be advertised on the global Internet). This provides 8 groups of 128 AS numbers to be assigned to GTS Centres, satisfying the current and foreseeable future needs of the GTS. The AS numbers will be assigned as follows:

MTN centres and reserve	64512 to 64639
Centres within RA I	64640 to 64767
Centres within RA II	64768 to 64895
Centres within RA III	64896 to 65023
Centres within RA IV	65024 to 65151
Centres within RA V	65152 to 65279
Centres within RA VI	65280 to 65407
Antarctic	65408 to 65471
*Private use by GTS Centres	65472 to 65535

* These AS numbers are for national use and are not to be advertised on the GTS.

Implementation details

In order to implement IP services, Centres need to know certain details regarding IP addressing at other Centres on the GTS. The following diagram and associated tables explain in detail, the information required at various Centres:

~~Figure 3.4 — IP over X.25 network~~
~~Table 3.4A. IP and X.121 addresses to be known at Centre A~~
~~Table 3.4B. IP and X.121 addresses to be known at Centre B~~
~~Table 3.4C. IP and X.121 addresses to be known at Centre C~~
~~Table 3.4D. IP and X.121 addresses to be known at Centre D~~

[1] An Autonomous System is defined in RFC1630 as “a set of routers under a single technical administration, using an interior gateway protocol and common metrics to route packets within the AS, and using an exterior gateway protocol to route packets to other ASs.”

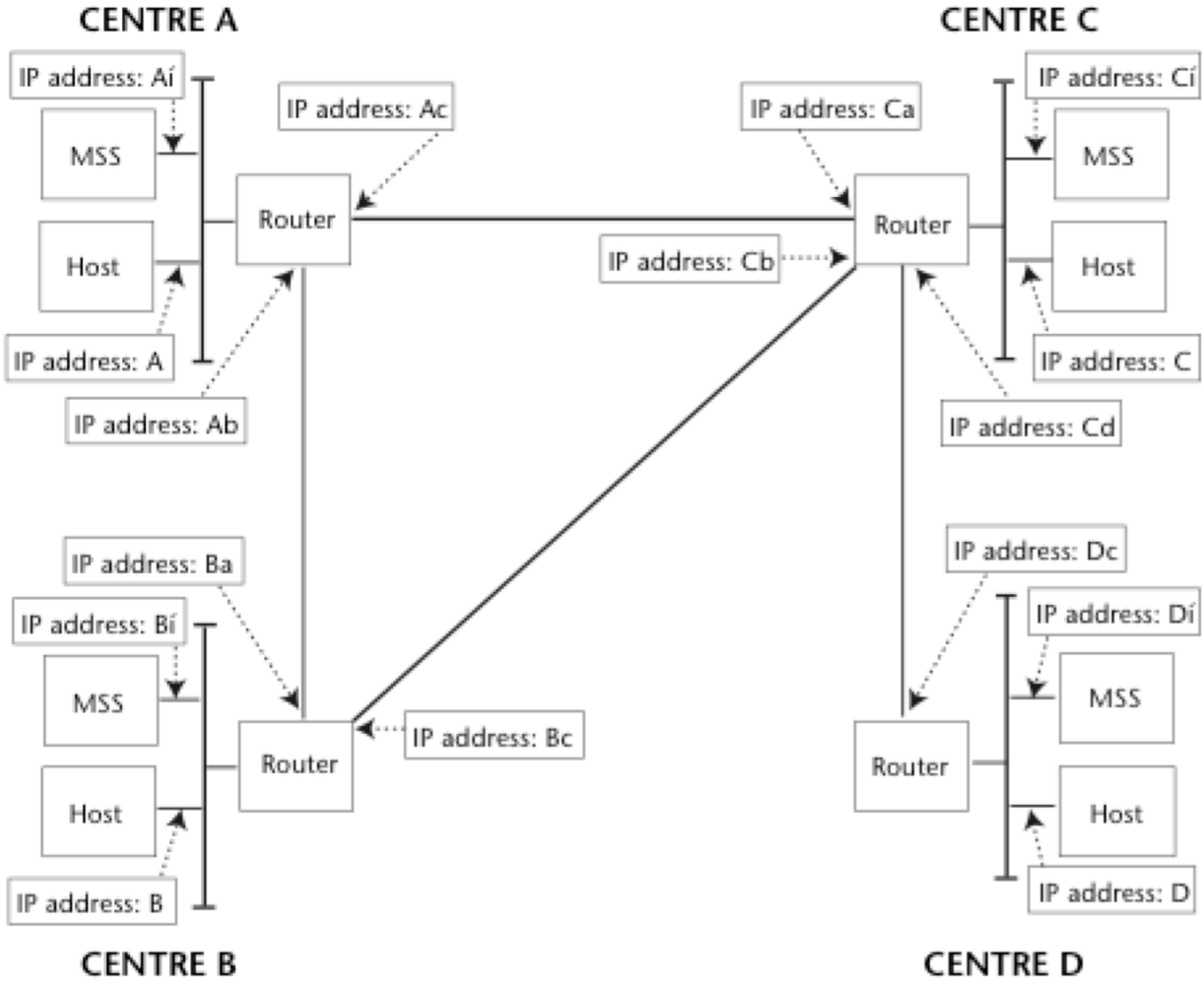

Figure 3.5. Direct IP Network

Table 3.5a. IP address to be known at CENTRE A

Destination	IP addresses to be known		Suitable route
	for communication between ends	for communication between Routers	
CENTRE B (Host to host)	IP address : B	IP address : Ba	CENTRE A – CENTRE B
CENTRE C (Host to host)	IP address : C	IP address : Ca	CENTRE A – CENTRE C
CENTRE D (Host to host)	IP address : D	IP address : Ca	CENTRE A – CENTRE C – CENTRE D (Host [A] – Router [A] – Router [C] – Router [D] – Host [D]) [x] : CENTRE x
CENTRE B (MSS to MSS)	IP address : B’	IP address : Ba	CENTRE A – CENTRE B
CENTRE C (MSS to MSS)	IP address : C’	IP address : Ca	CENTRE A – CENTRE C
CENTRE D (MSS to MSS)	IP address : D’	IP address : Ca	CENTRE A – CENTRE C – CENTRE D

Table 3.5b. IP address to be known at CENTRE B

Destination	IP addresses to be known		Suitable route
	for communication between ends	for communication between Routers	
CENTRE A (Host to host)	IP address : A	IP address : Ab	CENTRE B – CENTRE A
CENTRE C (Host to host)	IP address : C	IP address : Cb	CENTRE B – CENTRE C
CENTRE D (Host to host)	IP address : D	IP address : Cb	CENTRE B – CENTRE C – CENTRE D
CENTRE A (MSS to MSS)	IP address : A’	IP address : Ab	CENTRE B – CENTRE A
CENTRE C (MSS to MSS)	IP address : C’	IP address : Cb	CENTRE B – CENTRE C
CENTRE D (MSS to MSS)	IP address : D’	IP address : Cb	CENTRE B – CENTRE C – CENTRE D

Table 3.5c. IP address to be known at CENTRE C

Destination	IP addresses to be known		Suitable route
	for communication between ends	for communication between Routers	
CENTRE A (Host to host)	IP address : A	IP address : Ac	CENTRE C – CENTRE A
CENTRE B (Host to host)	IP address : B	IP address : Bc	CENTRE C – CENTRE B
CENTRE D (Host to host)	IP address : D	IP address : Dc	CENTRE C – CENTRE D
CENTRE A (MSS to MSS)	IP address : A’	IP address : Ac	CENTRE C – CENTRE A
CENTRE B (MSS to MSS)	IP address : B’	IP address : Bc	CENTRE C – CENTRE B
CENTRE D (MSS to MSS)	IP address : D’	IP address : Dc	CENTRE C – CENTRE D

Table 3.5d. IP address to be known at CENTRE D

Destination	IP addresses to be known		Suitable route
	for communication between ends	for communication between Routers	
CENTRE A (Host to host)	IP address : A	IP address : Cd	CENTRE D – CENTRE C – CENTRE A
CENTRE B (Host to host)	IP address : B	IP address : Cd	CENTRE D – CENTRE C – CENTRE B
CENTRE C (Host to host)	IP address : C	IP address : Cd	CENTRE D – CENTRE C
CENTRE A (MSS to MSS)	IP address : A’	IP address : Cd	CENTRE D – CENTRE C – CENTRE A
CENTRE B (MSS to MSS)	IP address : B’	IP address : Cd	CENTRE D – CENTRE C – CENTRE B
CENTRE C (MSS to MSS)	IP address : C’	IP address : Cd	CENTRE D – CENTRE C

~~Figure 3.6 — Coexistence of direct IP with IP over X.25~~
~~Table 3.6A. IP and X.121 addresses to be known at Centre A~~
~~Table 3.6B. IP and X.121 addresses to be known at Centre B~~
~~Table 3.6C. IP and X.121 addresses to be known at Centre C~~
~~Table 3.6D. IP and X.121 addresses to be known at Centre D~~
~~Figure 3.7 — Coexistence of direct IP, IP over X.25 and X.25 over IP~~
~~Table 3.7A. IP and X.121 addresses to be known at Centre A~~
~~Table 3.7B. IP and X.121 addresses to be known at Centre B~~
~~Table 3.7C. IP and X.121 addresses to be known at Centre C~~
~~Table 3.7D. IP and X.121 addresses to be known at Centre D~~

Management and allocation of addresses and AS numbers

~~X.25 addresses~~
~~The framework described above allows Centres full autonomy in allocating X.25 numbers. The WMO Secretariat will maintain a current list of X.25 addresses which Centres have allocated for use on the GTS. Centres are requested to notify the Chief of the Information and Telecommunication System Division of the Observing and Information Systems Department, WMO Secretariat by e-mail or fax of X.25 addresses allocated.~~

IP addresses

IP addresses should be acquired or agreed on as per the instructions in Appendix 7.

GTS nominated host/network addresses

Host and subnet IP addresses for use with GTS nominated Centres should be notified to WMO as described above.

AS numbers

AS numbers for use on the GTS will be co-ordinated and issued by the WMO Secretariat as required. Centres should direct their requests for AS numbers to WMO as described above.

Publication of addresses and AS numbers

The WMO will publish updated lists of addresses and AS numbers in the monthly WWW Newsletter and will also make these lists available in ASCII text form for access by FTP on the WMO web server and in World Wide Web format at http://www.wmo.int/pages/prog/www/ois/Operational_Information/RtngCat_en.html

GTS DATA EXCHANGE METHODS ~~ADAPTING MESSAGE SWITCHING SYSTEMS TO TCP/IP~~

Introduction

~~Although there are new requirements emerging, for the time being GTS usage is dominated by the traditional Message Switching application, which has been developed to use X.25 packet switching. We now need to consider how best to migrate the message switching task to use TCP/IP to satisfy the new requirements by providing "Internet like" facilities on the GTS, and to stay aligned with IT industry trends.~~

~~Additionally, migration of Message Switching Systems (MSS) to use TCP/IP means that X.25 infrastructure can be removed, greatly simplifying the technology of the GTS by moving to a pure IP network rather than a mixture of IP and X.25.~~

~~There are two possible technical approaches to this problem, one using TCP Sockets and the other FTP. In the long term the FTP approach is thought to be the most strategically attractive but may~~

~~require more work to implement in operational Message Switching Systems. It may suit some Centres to adopt an approach based on TCP Sockets as the first step towards a TCP/IP based GTS.~~

~~The transition of the MSSs to TCP/IP does not imply any change in the basic store and forward architecture of the GTS. It is envisaged that the store and forward architecture, with automatic on forwarding based on routing tables, will remain. However, the adoption of FTP means there is an additional option for data exchange to be achieved through bilateral arrangements, by the use of FTP retrieve initiated by the receiving centre.~~

There are three data exchange methods defined for use on the GTS. The first two are for the exchange of traditional GTS messages. The third is for the exchange of other data.

For traditional GTS messages (those with TTAAII CCCC) the two standards are based on:
(1) TCP/IP sockets
(2) FTP

Centres are able to choose between these standards by bilateral agreement.

Other data may also be exchanged on the GTS using a separate standard based on FTP.

TCP Sockets based data exchange

~~TCP Socket is an approach which is highly suitable for a programmatic implementation to provide regular exchange of messages. As such it should simply be regarded as an alternative protocol to X.25. A centre will be required to produce MSS application programs capable of transmitting and receiving via a TCP socket. Centres with current applications capable of driving an X.25 virtual circuit should be able to very quickly and simply produce a sockets version by changing a few system calls (see Appendix 3 for sample programs). The programming work involved is minimal and more importantly all other areas of the MSS such as queuing, routing, data management, operator interfaces etc. remain unchanged because the communication exchange is still based on the traditional message.~~

~~The protocol defined here, is based on the assumption that the physical circuit over which the data is to be transmitted has low error rate and is subject to interruptions rarely. On such circuits, the TCP protocol can be expected to deliver error free data. However, some GTS circuits may not be of sufficient quality for the standard TCP socket to function reliably. The development of special protocols for use on low quality circuits may be studied further.~~

~~Loss of data may occur if the TCP session is lost. This may be due to MSS hardware, application or communications failure. A special case of this is when a Centre with more than one MSS switches from the primary to the backup systems. Recommendations to avoid this problem are given below.~~

~~One useful feature of the X.25 based communication that is not available using TCP sockets, is the ability to detect start and end of message by reference to the M bit in the X.25 packet header. No such bit or any equivalent feature exists in TCP. Therefore, to enable receiving centres to detect end of message, each message is preceded with an 8 character string giving the message length, plus two characters indicating message type (binary, alphanumeric or fax). Thereafter the message is structured within an SOH/ETX envelope as for exchange via X.25.~~

The TCP socket standard involves establishing a connection from the sender to the receiver and for GTS messages to be sent preceded by two control fields. The first field contains the message length and the second is a 2 character field indicating message type (binary, alphanumeric or fax). The third field is the actual GTS message contained within a standard GTS SOH/ETX envelope. The receiving centre uses the message length to determine where each incoming message begins and ends.

The GTS TCP socket protocol does not guarantee end to end delivery and data may be lost if the link or one of the Message Switching Systems fails.

The complete data structure is illustrated in figure 4.1. Note that the message length does not include the length of the first two fields (message length and type). The message length must always be eight characters long and include leading zeroes as required. The message type field should be encoded using ASCII characters BI for binary, AN for alphanumeric, and FX for facsimile. ~~All new connections established must begin with a message length and type structure.~~

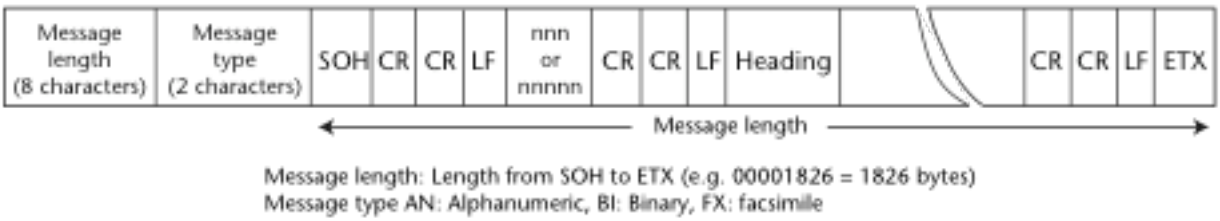

Figure 4.1 Message structure for Socket exchange applications

The rules for use of TCP/IP socket exchange can be summarised as:

1. All new connections must start from a new message.
2. Each message is preceded by a message length field of eight ASCII characters and a message type field of two ASCII characters.
3. Message length is counted from SOH to ETX inclusive and must contain leading zeroes as necessary.
4. Message type must be encoded as BI for binary, AN for alphanumeric or FX for facsimile.
5. Receiving centres will check synchronization as follows:
   - Check that the first 8 characters are ASCII numeric
   - Check that the 9th and 10th characters are BI, AN or FX
   - Check that the 11th character is SOH
   - Check that the last character is ETX.
6. If synchronization is lost the receiver shall break the connection using the following sequence of TCP user primitives:
   - ~~S~~*shutdown* (to make sure that all data in the TCP send buffer has been transferred)
   - ~~C~~*close*.
7. It is recommended to use separate sockets for ASCII and binary messages, and separate connections for sending and receiving. The sender should always be responsible for establishing the connection.
8. Once a connection is established, it should be maintained.
9. If there should be a need to close a socket, the procedure should be as follows:
   - ~~S~~*shutdown* (to make sure that all data in the TCP send buffer has been transferred)
   - ~~C~~*close*.
10. This procedure should also be used when a MSS is being shutdown.
11. If the receiving side receives a new unexpected connection request on a port for which it has an established socket, the old socket should be closed and the new socket accepted.
12. TCP/IP Service/Port numbers for these connections will be decided by bilateral agreement. The use of reserved ports (1 to 1023) should be avoided. The use of ports above 10000 is recommended.
13. To reduce the amount of data lost if an established connection fails, the TCP send and receive buffer sizes can be adjusted. The recommended value for the buffer size is 4KByte, however this value may be agreed on a bilateral basis.
14. To enable detection of message loss, the use of the channel sequence number, (CSN) is mandatory. When using the CSN to check for missing messages, the WMO request/repeat procedures should be used to recover these. It may be useful to automate this mechanism

to avoid delays caused by manual interaction. In order to minimize data loss it is strongly recommended that Centres implement a 5 character long CSN in the future.

15. The channel sequence number 000 (or 00000 respectively) should indicate an initialization, and should not cause retransmission requests.

FTP Procedures and File Naming Convention

Introduction

FTP (File Transfer Protocol) is a convenient and reliable method for exchanging files, especially large files. The protocol is defined in RFC 959.

The main issues to be considered are:

1. Procedures for accumulating messages into files so as to minimize FTP overheads with short messages (applies only to existing message types);
2. File naming conventions for existing message types (existing AHL);
3. File naming conventions for new messages types (no existing AHL);
4. File renaming;
5 Use of directories;
6. Account names and passwords;
7. FTP sessions;
8. Local FTP requirements;
9. File compression.

Accumulating messages into files

One of the problems with using FTP to send traditional GTS messages is the overhead if each message is sent in a separate file. To overcome this problem, multiple messages in the standard GTS message envelope should be placed in the same file according to the rules set out below. This method of accumulating multiple messages applies only to messages for which AHLs have been assigned.

Centres have the option of including or deleting the Starting Line and End of Message strings and indicating which option they are using via the format identifier (refer points 2 and 4 below).

1. Each message should be preceded by an 8 octet message length field (8 ASCII characters). The length includes the Starting Line (if present), AHL, text and End of Message (if present).

2. Each message should start with the currently defined Starting Line and AHL as shown in figure 4.2.

3. Messages should be accumulated in files thus:
   (a) Length indicator, message 1 (8 characters);
   (b) Format identifier (2 characters);
   (c) Message 1;
   (d) Length indicator, message 2 (8 characters);
   (e) Format identifier (2 characters);
   (f) Message 2;
   (g) And so on, until the last message;
   (h) If necessary, and subject to bilateral agreement, a 'dummy' message of zero length may be inserted after the last real message, to assist with end of file detection in certain MSS systems. This requirement does not exist in most cases and need only be implemented where necessary, and agreed between centres.

4. Format identifier (2 ASCII characters) has the following values:-
   (a) 00 if Starting Line and End of Message strings present;

(b) 01 if Starting Line and End of Message strings absent (not preferred, to be discontinued).

5. The sending centre should combine messages in the file for no more than 60 seconds to minimize transmission delays; this limit should be set to a value depending upon the characteristics of the link. However the file should be sent immediately when a GTS Priority 1 message (as defined in section 2.11.1 of the Manual on GTS) is added to the file.

6. The sending centre should limit the number of messages in a file to a maximum of 100; this limit should be set to a value depending upon the characteristics of the link.

7. The format applies regardless of the number of messages, i.e. it applies even if there is only one message in the file.

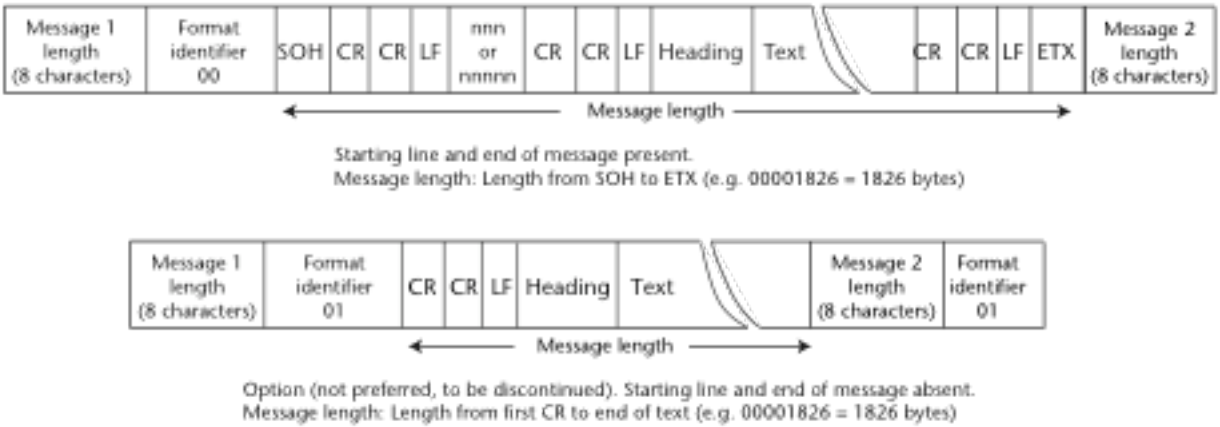

Figure 4.2 Structure of a typical message in a file

File naming conventions for existing message types (existing AHL)

The file naming convention is:

CCCCNNNNNNNN.ext

where:

CCCC is the international four letter location identifier of the sending Centre, as defined in WMO publication No. 9, Volume C;

NNNNNNNN is a sequential number from 1 to 99999999 generated by the sending Centre for each data type determined by **ext**; 0 is used for (re-) initialization; Through bilateral agreement, Centres may use NNNN instead of NNNNNNNN in case of limitation on filename length.

ext is

‘ua’ for urgent alpha numeric information
‘ub’ for urgent binary information
‘a’ for normal alpha numeric information
‘b’ for normal binary information
‘f’ for facsimile information

Note: Where, through bilateral agreement, Centres allow alphanumeric and binary data in the one file, the b or ub extent shall be used.

General file naming conventions

The following file naming convention should be implemented with a transition period not exceeding 2008. The implementation date is subject to review by CBS.

The procedure is based on transmission of file pairs, one file being the information file and the other being the associated metadata file. The concept of file pairs allows the communications function to be implemented independently of data management requirements for structure of metadata, yet provides for the carriage of whatever metadata is required. It is not compulsory to always have a .met file, such as when the information file itself is self-specifying or when a single .met file can describe several information files (for example as in the case of same data type for different times). There is always however a clear relation between the Information File Name and the Metadata File Name, which should only differ from their Extension field and possible wildcards. File names for new message types (no existing AHL) shall follow the following format. It should be noted that file names for existing message types (existing AHL) can also follow the following format.

The File Name format is a predetermined combination of fields, delimited by the _ (underscore) character except for the last 2 fields, which are delimited by the . (period) character.

Each field can be of variable length, except for the Date/time stamp field which is predetermined.

The order of the fields is mandatory.

The File Name fields are as follows:

pflag_productidentifier_oflag_originator_yyyyMMddhhmmss[_freeformat].type[.compression]

where the mandatory fields are:

pflag is a character or combination of characters indicating how to decode the **productidentifier** field. At this time, the **pflag** field has only the following acceptable value:

Table 4.1 Accepted pflag values

pflag	Meaning
T	The **productidentifier** field will be decoded as a standard $T_1T_2A_1A_2$ii data designator (The WMO standard data designators are given in Attachment II-5)
A	The **productidentifier** field will be decoded as a standard Abbreviated Heading, including BBB as appropriate, space characters being discarded, e.g. $T_1T_2A_1A_2$iiCCCCYYGGgg[BBB]
W	WMO Product Identifier
Z	Originating centre's local product identifier
TM	The **productidentifier** field will be decoded as a standard $T_1T_2A_1A_2$ii data designator (The WMO standard data designators are given in Attachment II-5). The file will contain the metadata corresponding to the related "T" file.
AM	The **productidentifier** field will be decoded as a standard Abbreviated Heading, including BBB as appropriate, space characters being discarded, e.g. $T_1T_2A_1A_2$iiCCCCYYGGgg[BBB]. The file will contain the metadata corresponding to the related "A" file.
WM	WMO Product Identifier. The file will contain the metadata corresponding to the related "W" file.
ZM	Originating centre's local product identifier. The file will contain the metadata corresponding to the related "Z" file.

productidentifier is a variable length field containing information that describes the nature of the data in the file. The productidentifier field should be decoded according to the pflag.

The WMO Product Identifier to be used with **pflag** = W shall be decoded as follows:

<location indicator>,<data designator>,<free description>,<International date-timegroup>,<BBB modification header>

The WMO Product Identifier is composed of two parts:

- the "static part" for description of the product and
- the "optional part" to define the time stamp and status of the product (correction, amendment).

The WMO Product Identifier is not case sensitive. These two parts are defined as follows:

Static part: <location indicator>,<data designator>,<free description>

- <location indicator> defines the producer: Country, organization and the production centre; The country shall be represented by the official ISO 3166 standard 2 letter code. Example: <gb-metoffice-exeter>. Each field shall be separated by "-" symbol. The ISO 3166 standard 2-letter code xx shall be used for international organizations and shall therefore be the two first characters of the location indicator of international organizations, e.g. "xx-eumetsat-darmstadt", "xx-ecmwf-reading".

- <data designator> specifies the type of data with reference to the categories and subcategories defined in the Common Table C-13 of the *Manual on Codes*, e.g. <SYNOP>, <TAF>, <MODEL>, <RADAR>, <SATELLITE>, etc. When the type of data is a composite type, use the sign "+" for concatenation.

- <free description> is determined by the production centre to characterize the product.

Optional part: [,<International date-time group>,<BBB modification header>]

- <International date-time group> is a YYYYMMDDHHMMSS time stamp of the product, full format without substitution characters (only decimal digits). This field is optional because it can be recovered from the file name field: yyyyMMddhhmmss

- <BBB modification header> is a complementary group with a similar purpose as the current BBB group of AHL

Note: In order to facilitate the identification of each field of the product identifier, the static part, as well as the optional part if used, shall comprise two symbols "," separating the fields. Each field shall not contain any symbol ",". If a field is empty, no character shall be inserted between the relevant field delimiters "_" or ",".

oflag is a character or combination of characters indicating how to decode the **originator** field. At this time, the **oflag** field has only the following acceptable value:

Table 4.2 Accepted oflag values

oflag	Meaning
C	The **originator** field will be decoded as a standard CCCC country code

originator is a variable length field containing information that states where the file originated from. The **originator** field should be decoded according to the **oflag**

yyyyMMddhhmmss is a fixed length date and time stamp field. The interpretation of this field should be in accordance with the standard rules set for specific data description and types. Therefore it may have various significance such as date of creation or the file, or date of collection of data. If a particular date and time stamp field is not specified, it should be

replaced by a `-` (minus) character. For example: ------311500-- represents a stamp that specifies only the day (31st), hours (15) and minutes (00). If there are no rules for a specific data type, this field should represent the date and time of creation of the file by the originator.

Type is a variable length field that describes the general format type of the file. Although this information could be considered somewhat redundant to the **productidentifier** field, it is kept as such for industry accepted standard compatibility. It should be noted that the delimiter before the type field is a . (period). This is to help parse the file name for fields, since the **freeformat** field could make use of further _ (underscore) to delimit subfields.

Table 4.3 Accepted type values

type	Meaning
met	The file is a metadata file pair which describes the content and format of the corresponding information file with the same name
tif	TIFF file
gif	GIF file
png	PNG file
ps	Postscript file
mpg	MPEG file
jpg	JPEG file
txt	text file
htm	HTML file
bin	a file containing data encoded in a WMO binary code form such as GRIB or BUFR
doc	a Microsoft Word file
wpd	a Corel WordPerfect file
hdf	HDF file
nc	NetCDF file
pdf	Portable Document Format file
xml	XML format files (data or metadata)

And the non mandatory fields are:

freeformat is a variable length field containing further descriptors as required by a given originator. This field can be further divided in sub-fields. Originating countries should strive to make their **freeformat** descriptions available to others.

compression is a field that specifies if the file uses industry standard compression techniques

Table 4.4 Accepted compression values

compression	Meaning
Z	The file has been compressed using the Unix COMPRESS technique
zip	The file has been compressed using the PKWare zip technique
gz	The file has been compressed using the Unix gzip technique
bz2	The file has been compressed using the Unix bzip2 technique

Maximum file name length: Although no maximum length is specified for the entire file name, the mandatory fields shall not exceed 63 characters (including all delimiters) to allow processing by all international systems.

Character set: The filenames shall be composed of any combination of the standard character set (ITU-T Rec. X.4) with the exceptions noted in Table 4.5. Case insensitivity shall be used as it is widely accepted and implemented in the industry (for example e-mail addresses and URLs). However, it is recommended to use the “canonical form” of file names when files are being processed in a system. In this manner it would be expected that:

(a) File names be saved in their original form as received (with any combination of upper-lower case characters or any character set);
(b) Files would be saved with lower case characters only for internal processing, comparison, name searches, etc.;
(c) Files would be retransmitted with the original saved name to preserve character set and the upper lower case differences.

This keeps the benefits of readability of upper lower case throughout the systems, but provides case independence for processing and reference.

Table 4.5 Symbols for filenames

Symbol	Allowed	Meaning
_	yes	The underscore symbol is used has a delimiter symbol. To be used only as a delimiter of fields. The underscore is also accepted in the **freeformat** field, but not in other fields.
-	Yes	The minus symbol shall be used only as a field delimiter inside the "location indicator" and "free description" fields of the WMO Product Identifier in the **productidentifier** field. For example, in the case of location indicator: gb-metoffice-exeter. This symbol shall not appear in the "data designator" field.
+	Yes	The plus symbol shall be used to concatenate several words in a field of the WMO Product Identifier in the **productidentifier** field. For example, in the "data designator" field: TEMP+MOBIL or CLIMAT +TEMP+SHIP.
.	yes	The period symbol is used has a delimiter symbol. To be used only before the **type** and **compression** fields.
/	no	Forward stroke often has special meaning for the full path specification of a filename in some operating systems
\	no	Backward stroke often has special meaning for the full path specification of a filename in some operating systems
>	no	Greater than symbol shall not be used since it often represents special file manipulation in some operating systems
<	no	Less than symbol shall not be used since it often represents special file manipulation in some operating systems
|	no	Vertical bar (pipe) symbol shall not be used since it often represents special file manipulation in some operating systems
?	no	Question mark symbol shall not be used
'	no	Single quote shall not be used.
"	no	double quotes shall not be used
*	no	The star symbol is often used for wildcard specification in procedures that process filenames.
Space	no	The space symbol shall not be used
,	yes	The comma symbol shall be used as a field delimiter in the WMO Product Identifier of the **productidentifier** field. For example, in the static part: <location indicator>,<data designator>,<free description>. The comma symbol can be also used in the **freeformat** field.
A–Z a-z 0–9	yes	

The structure of the '.met' file, related to the WMO Metadata standard, is not defined in this guide.

Examples

- A possible imagery file (Sig Weather Chart) that would have originated from the United States:
  T_PGBE07_C_KWBC_20020610180000_D241_SIG_WEATHER_250-600_VT_06Z.tif
- A possible model output file from France:
  A_HPWZ89LFPW131200RRA_C_LFPW_20020913160300.bin

- A possible synoptic surface observations file from France:
  W_fr-meteofrance
  Toulouse,SYNOP,MAIN+HOURS,,RRA_C_LFPW_20060913030000.txt
- A possible model output file from France:
  W_fr-meteofrance-toulouse,GRIB,ARPEGE-75N10N-
  60W65E_C_LFPW_200610000000.bin
- A possible image from Australia:
  Z_IDN60000_C_AMMC_20020617000000.gif
  Note that this shows that the date and time stamp is to be interpreted to be 00 hours, 00 minutes and 00 seconds.
- A possible compressed TOVS satellite data file from the United Kingdom:
  Z_LWDA_C_EGRR_20020617000000_LWDA16_0000.BIN.Z
- A possible image (radar) from Canada:
  T_SDCN50_C_CWAO_200204201530--_WKR_ECHOTOP,2-0,100M,AGL,78,N.gif
- A possible single-record GRIB file from Canada:
  Z__C_CWAO_2002032812----
  _CMC_reg_TMP_ISBL_500_ps60km_2002032812_P036.bin
- A possible multiple record batch file from China:
  Z_SM_C_BABJ_20020520101502.TXT

File renaming

The method used by receiving centres to detect the presence of a new file may depend on the type of machine used. However most centres will do this by scanning a directory for new files.

To avoid problems with the receiving centre processing a file before it has completely arrived, all sending centres must remotely rename the files they send.

The file shall be sent with the added extent '.tmp' and then renamed to the appropriate extent defined above when the transfer is completed. e.g.

(a) put xxxxx RJTD00220401.a.tmp (xxxxx = local file name)
rename RJTD00220401.a.tmp RJTD00220401.a

(b) put xxxxx AMMC09871234.ub.tmp
rename AMMC09871234.ub.tmp AMMC09871234.ub

Use of directories

Some receiving centres may wish the files to be placed in specific sub-directories. This should be limited to require only that all files of the same type be delivered to the same directory. It is recommended that a separate directory be used for each host system which is initiating FTP sessions to avoid the possibility of filename duplication.

Account names and passwords

Using FTP the sender "logs in" to a remote machine using a specific account name and password. The receiving centre defines the account name and the password. There are potential security implications for centres so care needs to be taken.

The following general rules should however apply.

1. The receiving centre defines the user account and password for the sending centre.
2. Anonymous FTP may be used or a specific account may be created. (If anonymous FTP is used, each sending Centre must have its own sub directory on the FTP server).

FTP Sessions

To limit the load on both the sending and receiving systems, no more than one FTP session per file type should exist at the same time. If for example, Centre A wishes to send two files to Centre B of the same type (say .ua), the second file must not be sent until the first is finished. Centres should limit the number of concurrent sessions with a particular Centre to five maximum.

The idle timer for closing the FTP session should be set to a value between the cut-off time for accumulating messages (max. 60 seconds) and a maximum of 3 minutes.

To minimize overheads the sending centre should keep the FTP session connected for at least 10 minutes or until the idle timeout has been reached (subject to bilateral agreement).

Local FTP requirements

All sending centres will need to allow for additional "static" FTP commands to be included in the FTP commands that they issue. For example some MVS centres may require the inclusion of "SITE" commands to define record and block lengths. Centres should support FTP commands as specified in RFC 959 unless some are excluded by bilateral agreement. There may also need to be bilaterally agreed procedures and commands.

It is the responsibility of receiving Centres to delete files after they have been processed.

In order to meet the 2 minute maximum delivery requirement for warning messages, centres receiving files via FTP should aim to pickup and process incoming files no later than 15 seconds after they are received.

Use of file compression

If large files are to be sent then it is often desirable to compress them first.

Centres should only use compression by bilateral agreement.

Backup with an IP based GTS

A final consideration is that of MSS backup. The new GTS will use IP addresses, where an individual address is usually associated with only one system. Should a system fail and an alternative be used there are implementation issues to be considered by transmitting centres. Ideally a transmitting centre should be unaffected by a receiving Centre's backup arrangements. This is a good principle, which all Centres should seek to adhere to. However it may not always be possible to achieve complete IP transparency. If this cannot be done sending Centres must be prepared to try an alternate IP address. Once using such an alternate address it must periodically try the primary address. It is suggested that such periodicity be established by bilateral agreement between centres because it will be heavily influenced by each centres backup strategy.

TROUBLE SHOOTING AND PROBLEM RESOLUTION

IP Layer Tools

In a large IP network, every router involved in the path between two hosts must know the next hop to be used to reach the destination address. As every router and/or link might be a point of failure, it is very important to determine rapidly where the problem is, and then how to solve it.

Suggested steps in resolving problems (not necessarily in the order given) are:

(a) check the remote centre (if the security policy of the remote centre allows it).

(b) check if the link to the “outside” network is reachable

(c) check the local network by trying to reach the next/default gateway
(d) check the local IP stack and configuration

Some basic tools that can be used such as Ping, Traceroute and Netstat are described below. PING and TRACEROUTE provide information on paths between hosts. They both use ICMP (traceroute also need UDP), but it should be noted that many sites block ICMP packets as part of their security measures. To be able to locate problems in a network, it is necessary to have an exact documentation of the network.

PING

PING will check if the destination IP address can be reached. This tool is standard in almost every operating system with TCP/IP. On a Unix host the output looks like:

```
zinder# ping -s cadillac
PING cadillac : 56 data bytes
64 bytes from cadillac ( 193.168.1.17 ) : icmp_seq=0. time=3. ms
64 bytes from cadillac ( 193.168.1.17 ) : icmp_seq=1. time=2. ms
64 bytes from cadillac ( 193.168.1.17 ) : icmp_seq=2. time=3. ms
64 bytes from cadillac ( 193.168.1.17 ) : icmp_seq=3. time=3. ms
64 bytes from cadillac ( 193.168.1.17 ) : icmp_seq=4. time=5. ms
64 bytes from cadillac ( 193.168.1.17 ) : icmp_seq=5. time=3. ms
64 bytes from cadillac ( 193.168.1.17 ) : icmp_seq=6. time=3. ms
----cadillac PING statistics----
7 packets transmitted, 7 packets received, 0% packet loss
round-trip (ms) min/avg/max = 2/3/5
```

A useful test could be to ping the MSS of the neighbouring Centre. If this ping succeeds with an acceptable time delay, it would indicate that the network is operating correctly. If the ping fails, it could mean that the circuit is down or the ICMP ping packets are being blocked by the neighbouring Centre's router or security gateway. In this event, it could be useful to ping the serial interface of the neighbouring Centre's router. If this succeeds, then the communications link to the neighbouring Centre is working. Any malfunction would then be within the neighbouring Centre.

Ping can be used to check whether the network performance is reasonable. The time is the delay between sending and receiving back the packet. It is not really possible to give an average value of the delay, but it is more important to notice any variation.

Finally, it might happen that packets are lost. In this case, there are missing numbers in the icmp_seq number. Either packet loss or variation in delays will badly degrade the performance.

TRACEROUTE

This tool is used to show which routers are transited on the network between A and B. As said above, traceroute need UDP and ICMP packets to work. Firewalls or packet filter on router may block such traffic as part of local security policy. It is not available on all systems, but is rather easy to compile. It is a free tool available on the Internet.

Traceroute output looks like:

```
cadillac 22: traceroute ftp.inria.fr
traceroute to ftp.inria.fr (192.93.2.54), 30 hops max, 40 byte packets
 1 antonio.meteo.fr (137.129.1.5) 3 ms 2 ms 2 ms
 2 clara.meteo.fr (137.129.14.249) 1 ms 2 ms 2 ms
 3 andrea.meteo.fr (193.105.190.253) 4 ms 3 ms 2 ms
 4 octares1.octares.ft.net (193.48.63.5) 30 ms 35 ms 10 ms
 5 192.70.80.97 (192.70.80.97) 9 ms 15 ms 27 ms
```

```
 6 stamand1.renater.ft.net (195.220.180.21) 40 ms 96 ms 29 ms
 7 stamand3.renater.ft.net (195.220.180.41) 56 ms 100 ms 108 ms
 8 stlambert.rerif.ft.net (195.220.180.10) 63 ms 56 ms 34 ms
 9 193.55.250.34 (193.55.250.34) 46 ms 28 ms 26 ms
10 rocq-gwr.inria.fr (192.93.122.2) 21 ms 147 ms 85 ms
11 ftp.inria.fr (192.93.2.54) 86 ms 58 ms 128 ms
```

When a router does not know where to send the packet, the result may be like the following:

```
cadillac 22: traceroute 193.105.178.5
traceroute to 193.105.178.5 (193.105.178.5), 30 hops max, 40 byte packets
 1 antonio.meteo.fr (137.129.1.5) 2 ms 1 ms 1 ms
 2 clara.meteo.fr (137.129.14.249) 1 ms 4 ms 1 ms
 3 andrea.meteo.fr (193.105.190.253) 4 ms 11 ms 4 ms
 4 octares1.octares.ft.net (193.48.63.5) 42 ms 39 ms 42 ms
 5 192.70.80.97 (192.70.80.97) 8 ms 7 ms 7 ms
 6 stamand1.renater.ft.net (195.220.180.5) 48 ms 86 ms 113 ms
 7 rbs1.renater.ft.net (195.220.180.50) 63 ms 107 ms 154 ms
 8 Paris-EBS2.Ebone.net (192.121.156.105) 146 ms 167 ms 140 ms
 9 stockholm-ebs-s5-2.ebone.net (192.121.154.21) 100 ms 80 ms 92 ms
10 Amsterdam-ebs.Ebone.NET (192.121.155.13) 249 ms 227 ms 205 ms
11 amsterdam1.NL.EU.net (193.0.15.131) 257 ms 249 ms 316 ms
12 * Amsterdam5.NL.EU.net (134.222.228.81) 300 ms 297 ms
13 Amsterdam6.NL.EU.net (134.222.186.6) 359 ms 218 ms 304 ms
14 Paris1.FR.EU.net (134.222.228.50) 308 ms 311 ms 388 ms
15 * Etoile0.FR.EU.net (134.222.30.2) 177 ms *
16 Etoile0.FR.EU.net (134.222.30.2) * * *
```

In the second case, cadillac would not be able to reach 193.105.178.5 because the router Etoile0.fr.eu.net failed to send the packet. With traceroute, it is not possible to know if it is a router failure or a link failure.

NETSTAT

This is a command available on most computing platforms. It gives information about the set up of the host's IP stack.

Netstat can be used to find out if the local IP address and subnet mask are configured correctly as well as if the routing information is still correct. There are many other options but is it not the intention of this guide to describe them all.

A sample output looks like:

```
$ netstat -rn
Routing tables

Internet:
Destination      Gateway        Netmask        Flags  Refs   Use            Interface
default          141.38.48.2                   UG     12     4014211        ec0
127.0.0.1        127.0.0.1                     UH     9      2321           lo0
141.38.48        141.38.48.12   0xffffff00     U      3      68981          ec0
141.38.48.12     127.0.0.1                     UGH    10     253410         lo0
195.37.164.100   141.38.48.5                   UGH    2      345            lo0
224              141.38.48.12   0xf0000000     U      1      19848          ec0
$
```

The output shows that this particular host has the IP address 141.38.48.12 with a subnet mask of 24 bit (0Xffffff00 or 255.255.255.0). It also shows that the host 195.37.164.100 can be reached via the gateway 141.38.48.5, and the flags indicate that the route is up (U), that it is a route to a gateway (G) and that it is a host route (H). The first line indicates that all other destinations are reachable via the hosts default gateway 141.38.48.2.

In the next output:

```
$ netstat -rn
Routing tables

Internet:
Destination      Gateway       Netmask       Flags          Refs   Use        Interface
default          141.38.48.2                 UG          12      4014211        ec0
127.0.0.1        127.0.0.1                   UH    9     2321        lo0
141.38.48        141.38.48.12   0xffffff00   U     3     68981       ec0
141.38.48.12     127.0.0.1                   UGH   10    253410      lo0
195.37.164.100   141.38.48.2                 UGHM  2     345         lo0
224              141.38.48.12   0xf0000000   U     1     19848       ec0
$
```

The only difference to the first sample output is, that the host route to 195.37.164.100 is now flagged with a M, which means that this route was modified by an ICMP redirect message from the old gateway 141.38.48.5. This usually means that the router with the IP address 141.38.48.5 has lost it’s route to 195.37.164.100 and may indicate a problem with the link to the remote network.

Other monitoring tools

Verifying correct IP connectivity is a necessary first step. Other tools can be used to provide more information on what is happening. There are many options. It is possible to use protocol analysers and SNMP based software tools. For example, Sun Microsystems bundles with Solaris a tool called snoop who can replace in most cases a local area network analyser. Others tools such as TCPDUMP are available free on the Internet and can be installed on various systems. TCPDUMP is often bundled in various Linux distributions. These tools require a rather good knowledge of IP protocol. But, for example, TCPDUMP might be used to diagnose application level problems.

The following is a simple example on the host 'pontiac', of the capture of ICMP exchanges between zinder and cadillac.

```
pontiac# /usr/local/bin/tcpdump -i nf0 host cadillac and zinder and proto icmp
15:28:06.68 cadillac.meteo.fr > zinder.meteo.fr: icmp: echo request
15:28:06.68 zinder.meteo.fr > cadillac.meteo.fr: icmp: echo reply
15:28:19.45 cadillac.meteo.fr > zinder.meteo.fr: icmp: echo request
15:28:19.45 zinder.meteo.fr > cadillac.meteo.fr: icmp: echo reply
15:28:29.44 cadillac.meteo.fr > zinder.meteo.fr: icmp: echo request
15:28:29.45 zinder.meteo.fr > cadillac.meteo.fr: icmp: echo reply
```

SNMP

Simple Network Management Protocol was developed in the late 80’s in order to offer to network manager a standard tool for controlling networks. In most case SNMP could be used to replace more crude tools describe above. Unfortunately, good SNMP software is not cheap. SNMP is a client-server protocol. In order to be able to gather information with SNMP, the equipment connected on the network must have Management Information Base (MIB). These bases are catalogues of integer, counters, strings, etc…. The manager asks the agents to send it some values. These values might be for example, IP routing table. The example below is obtained by

requesting with HP Open View (a commercial package) the routeing table on the host monica.meteo.fr.

Title: : monica.meteo.fr
Name or IP Address: monica.meteo.fr

ipRouteDest	ipRouteMask	ipRouteNextHop	ipRouteProto	ipRouteMetric1
0.0.0.0	0.0.0.0	137.129.1.5	local	0
136.156.0.0	255.255.0.0	137.129.1.5	ciscoIgrp	8786
137.129.1.0	255.255.255.0	137.129.1.6	local	0
137.129.2.0	255.255.255.0	137.129.1.5	ciscoIgrp	1110
137.129.3.0	255.255.255.0	137.129.3.254	local	0
137.129.4.0	255.255.255.0	137.129.4.254	local	0
137.129.5.0	255.255.255.0	137.129.5.254	local	0
137.129.6.0	255.255.255.0	137.129.1.62	local	0
137.129.7.0	255.255.255.0	137.129.7.254	local	0
137.129.8.0	255.255.255.0	137.129.8.254	local	0
137.129.9.0	255.255.255.0	137.129.1.5	ciscoIgrp	1110

Information given above with TCPDUMP might be obtained with SNMP but to do so, probes running the Remote Monitoring MIB must be connected on the network.

On a bilateral basis, it might be useful for Centres to allow SNMP access to their router from the other NMC. However, regular polling of other Centres' routers should be avoided to avoid overloading of circuits.

MRTG

Another public domain package, called MRTG, is a very helpful tool to gather information about the local network and about connected links. The Multi Router Traffic Grapher (MRTG) is a tool to monitor the traffic load on networks and links. It generates HTML pages containing images which provide a live visual representation of this traffic. It can also be implemented to indicate failures of network links. MRTG consists of a Perl script which uses SNMP to read the traffic counters of your router(s) and a fast C program which logs the traffic data and creates graphs representing the traffic on the monitored network connection(s). Below is a sample output. It shows traffic statistics for a dedicated link and gives information about the traffic pattern on the link. This is just one of many other graphs one can create with MRTG. More information about MRTG can be found at http://oss.oetiker.ch/mrtg/

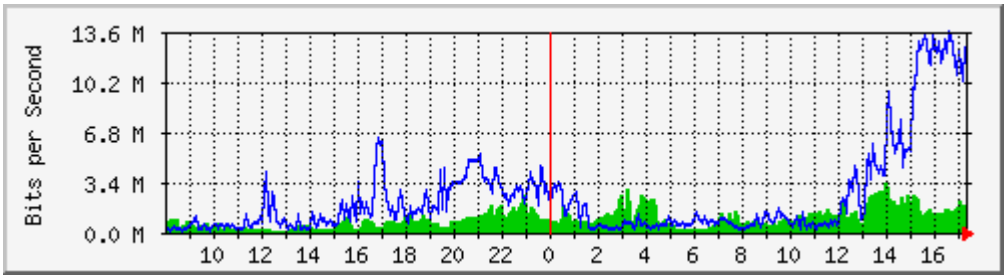

Figure 5.2.2.1 Sample MRTG Graph

SYSLOG

Many of the possible problems can be located if one not only looks at the SYSLOG files on the hosts, but uses a SYSLOG server as well and lets the router(s) send their messages to it. This file can then be checked regularly e.g. for messages that indicate high CPU load, processes that use

up much memory or CPU cycles, lines going up and down, and messages about events regarding the used routing protocol.

There are 8 different levels of messages the router will log to the syslog server. They are:

Emergencies	0	System unusable
Alerts	1	Immediate action needed
Critical	2	Critical conditions
Errors	3	Error conditions
Warnings	4	Warning conditions
Notifications	5	Normal but significant condition
Informational	6	Informational messages only
Debugging	7	Debugging messages

The default logging facility on a cisco router is set to local7, this is important to know when configuring a host to be a syslog server and will be explained there.

The configuration commands on a Cisco router to activate logging are:

```
cisco-gts-1(config)#logging trap level-of-messages-to-log
cisco-gts-1(config)#logging 141.38.48.12
```

and can be checked with the command “show logging”:

```
cisco-gts-1#sho logging
Syslog logging: enabled (0 messages dropped, 0 flushes, 0 overruns)
Console logging: level debugging, 117892 messages logged
Monitor logging: level debugging, 8317 messages logged
Trap logging: level debugging, 117150 message lines logged
Logging to 141.38.48.12, 117150 message lines logged
Buffer logging: disabled
cisco-gts-1#
```

In this example, logging is set to the level debugging (“logging trap debugging”), and all messages from level 7 up to level 0 will be sent to the syslog server with the IP address 141.38.48.12.

To activate the SYSLOG server on for instance a SGI UNIX machine, the following entries should be there:

In the file /etc/services: syslog 514/udp
In the file /etc/syslog.conf: local7.debug /usr/people/cisco/logs/cisco.log

The local7.debug relates to the default facility of logging that is defined on a cisco router as mentioned (local7). The file above will be the file to which the syslog daemon writes all incoming syslog messages for local7.

The last action on the host is to have the syslog daemon reread it’s config file (kill –1 pid-of-syslogd).

Bandwidth Management

On an IP network, all packets will be routed over the links without any prioritization mechanism. Therefore an FTP transfer can occupy all the bandwidth available starving all others applications. When traffic increases, it might therefore be needed to introduce some bandwidth management in the network configuration. Further information may be available on the online reference (http://www.wmo.~~ch~~int/).

APPENDIX 1 – HIGH LEVEL TCP/IP TOPOLOGY AND TCP/IP DATA FLOWS

The following diagrams show a high level view of the topology of a simple Centre and the main data flows regarding GTS and Internet telecommunication. More detailed X.25 over IP configurations can be found in the following appendices.

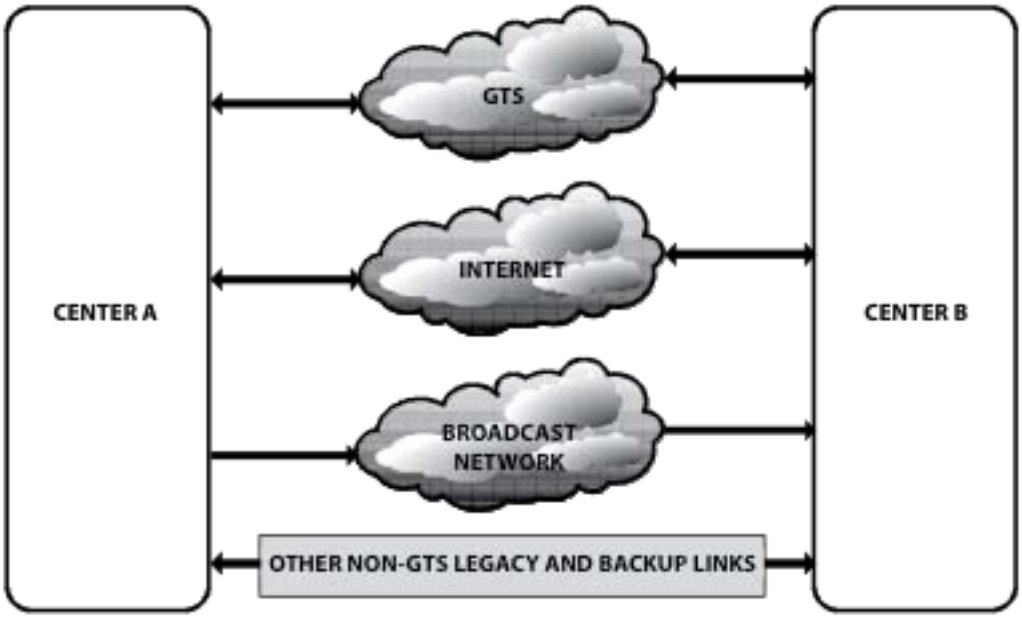

Figure A1.1 – General interconnectivity between Centres

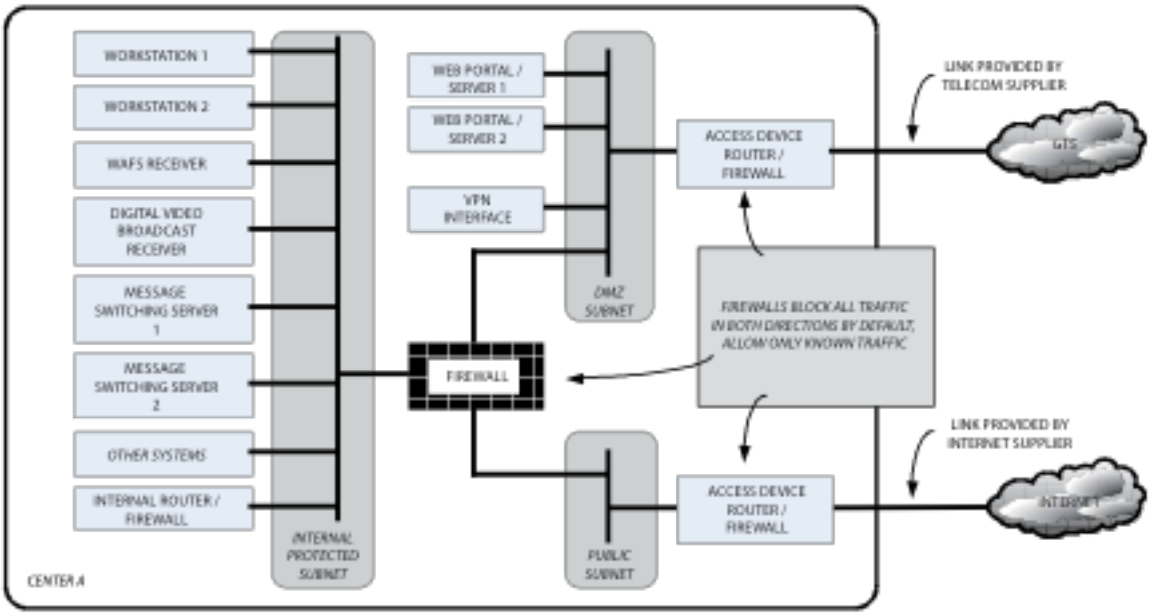

Figure A1.2 – Topology of TCP/IP network in a simple Centre

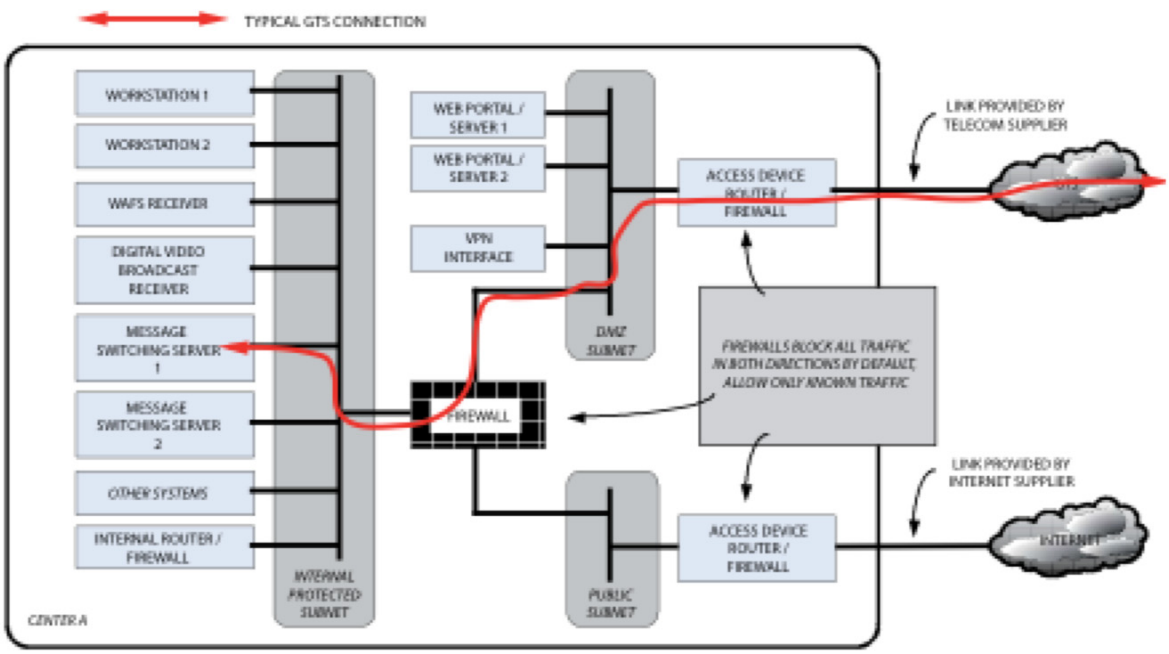

Figure A1.3 – Data flow of traffic over the GTS – IP only

~~Figure A1.4 – Data flow of traffic over the GTS – X.25 over IP~~

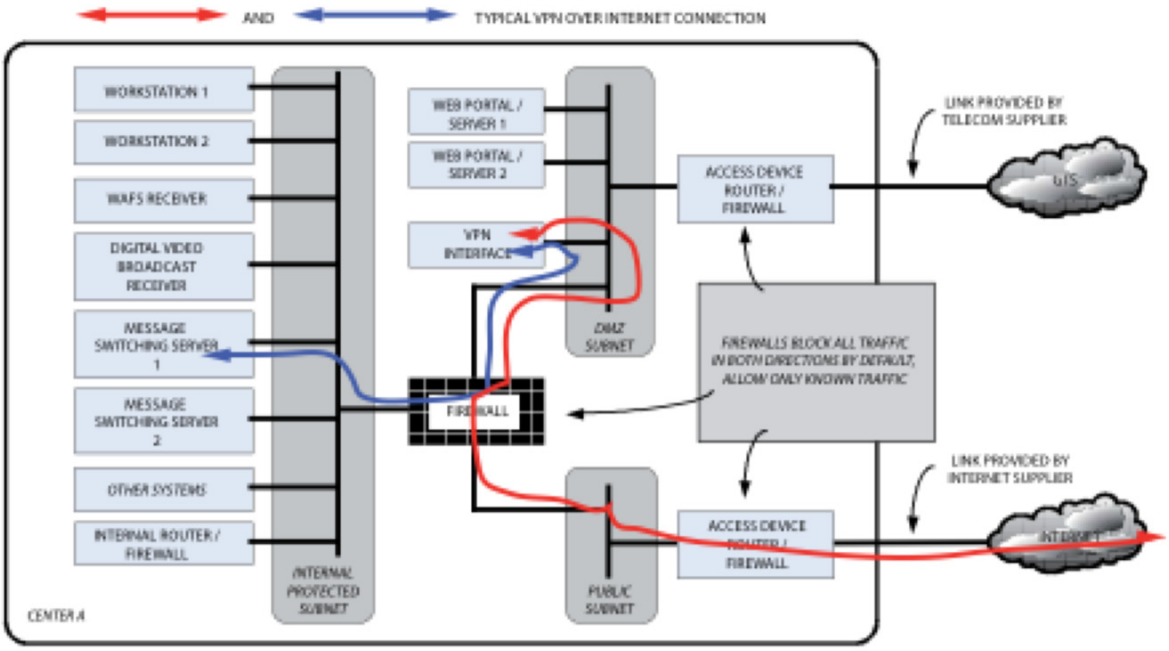

Figure A1.5 – Data flow of traffic using VPN over the Internet

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APPENDIX 2 – CISCO ROUTER CONFIGURATIONS

The router configurations provided in this appendix are examples and should not be interpreted as a suggestion that Cisco is the only supplier capable of this functionality.

This appendix is not intended to be a complete description of all available commands in a Cisco, nor a full course on this equipment, but it is useful to describe more precisely the configuration tasks in order to comply with the policy outlined in Chapter 2.

The configuration described below respects what is available in release 11.1 of Cisco IOS software. Some features are not available in previous releases, and some will be modified in the future.

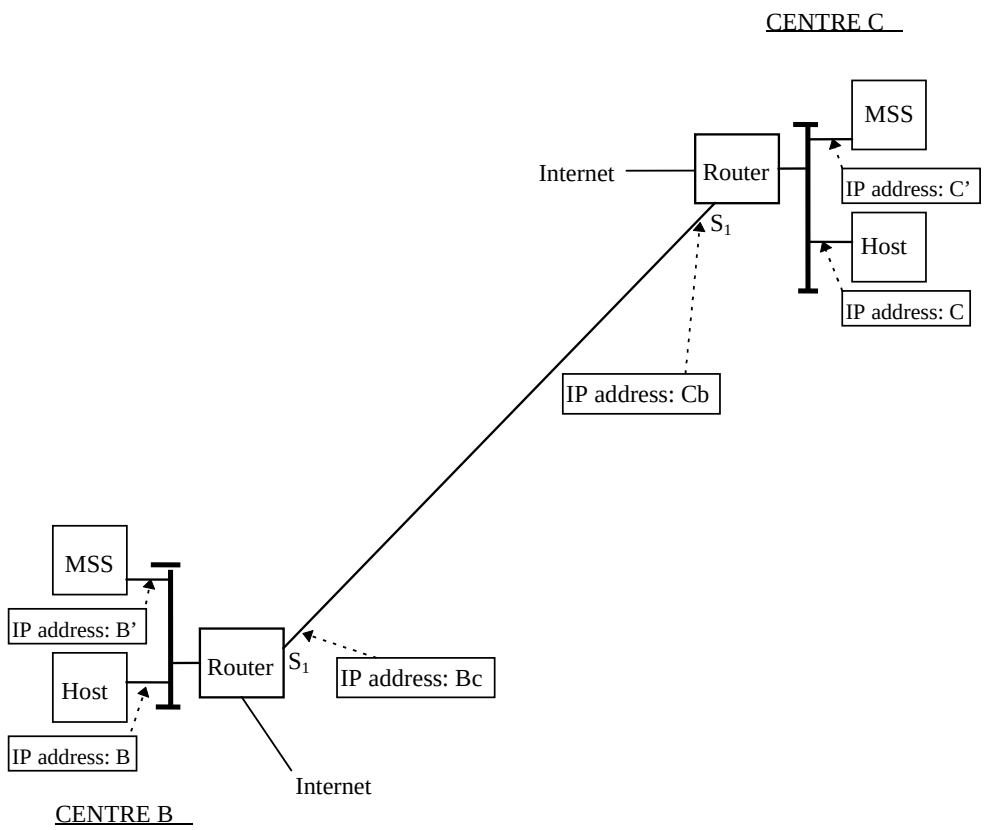
We are going to describe different steps:

1. Establishing IP connection
   - IP over PPP
   - ~~IP over X25~~
   - ~~X25 over IP (in fact it is X25 over TCP, the XOT protocol)~~

2. Routing configuration
   - leaf node with static routes (Centre A)
   - leaf node with dynamic routing (Centre C)
   - configuration in a non-leaf node (in our case two different GTS connections, Centre B)

3. Security configuration
   - filtering traffic based on declared IP addresses
   - controlling routing exchanges between GTS and the Internet

In our example, ~~A is connected to B with IP over X25 link,~~ Centre B is connected to C with IP over PPP[2]. ~~There is also the option for the MSSs at B and C to communicate using X.25 over TCP/IP. A is a leaf node, B and C are non-leaf nodes~~. B and C are also connected to the Internet. B and its Internet provider use static routes[3], C and its Internet provider use RIP[4].



[2] Note that using PPP encapsulation is not the preferred option, but since it is a non default option, it shows the usage of the "encapsulation" statement in this example

[3] B cannot use EGP and BGP on the same router; one router cannot belong to more than one AS

[4] RIP is NOT a good choice for this type of configuration. But as RIP is the most basic protocol, it is used in this case too.

The following will be used along this appendix:

	IP router address	IP hosts address for GTS	Autonomous-System
Centre B	193.105.177.2 193.105.178.5	137.129.9.0/255.255.255.0	65001
Centre C	193.105.178.6	195.1.1.0/255.255.255.0	65200

Centre B use serial interface 0 to connect to the packet switches. Centres B and C use serial interfaces 1 for the PPP link.

Step 1: Establishing connections

~~Centre A:~~
~~interface serial 0~~
~~encapsulation X25~~
~~! depending on local set-up (virtual channels,~~
~~! windows…) extra configuration might be necessary~~
~~x25 address 01016661166666~~
~~ip address 193.105.177.1 255.255.255.0~~
~~!~~
~~x25 map ip 193.105.177.2 01017771177777~~

Centre B:
~~interface serial 0~~
~~encapsulation X25~~
~~x25 address 01017771177777~~
~~! depending on local set-up (virtual channels,~~
~~! windows…) extra configuration might be necessary~~
~~ip address 193.105.177.2 255.255.255.0~~
~~!~~
~~x25 map ip 193.105.177.1 01016661166666~~
~~!~~

interface serial 1
 encapsulation PPP
 ip address 193.105.178.5 255.255.255.252
!
~~! X25 over TCP commands~~
~~x25 routing~~
~~x25 route 010177711* ip 193.105.178.5~~
~~x25 route 010188811* interface serial 0~~

Centre C:
~~interface serial 0~~
~~encapsulation X25~~
~~x25 address 01018881188888~~
~~! depending on local set-up (virtual channels,~~
~~! windows…) extra configuration might be necessary~~
interface serial 1
 encapsulation PPP
 ip address 193.105.178.6 255.255.255.252
!
~~! X25 over TCP commands~~
~~x25 routing~~
~~x25 route 010177711* ip 193.105.178.5~~
~~x25 route 010188811* interface serial 0~~

After this first step, IP configuration between the routers is complete. ~~The router in Centre A can then ping router in B. B can ping A and C, but A and C cannot communicate because there is no routing set up.~~

MSS at B and C can communicate with IP (once end-to-end routing is established) ~~or with X25 over TCP. Experience has shown that all the X25 parameters on router in centres B and C MUST be the same (packet size, window size) to avoid any strange behaviour.~~

Step 2: Routing

~~Centre A:~~
~~! Simply define a default route with a metric 10 (the price) via B~~
~~ip route 0.0.0.0 255.255.255.255 193.105.177.2 10~~

Centre B:
~~*! First define static route with A*~~
~~*ip route 194.168.1.16 255.255.255.248 193.105.177.1 10*~~
~~*ip route 0.0.0.0 ip_provider_address 10*~~
~~*! Define a default route to the internet*~~
~~ip route 0.0.0.0 0.0.0.0 *internet_provider_address* 10~~
! BGP routing
router bgp 65001
 network 137.129.9.0 mask 255.255.255.0
 neighbour 193.105.178.6 remote-as 65200
~~! Route to A is static, force sending to C~~
~~redistribute static~~

Centre C:
! BGP routing
router bgp 65200
 network 195.1.1.0
 neighbour 193.105.178.5 remote-as 65001
! 196.1.1.0 is network address for non-GTS hosts in C
router rip
version 2
network 195.1.1.0
no auto-summary

~~A defines a default route. So, when A wants to communicate with C, the router knows where to send packets. C is going to receive routing information from B, so A is also reachable from C. It is also important to note that if A tries to reach an Internet site, attempts will be made through B's Internet connection. It will fail because the Internet site A tries to reach cannot return packets to A (only B's address is reachable on the internet via B's Internet connection). The link A to B link will thus carry some inappropriate data. Also note that we use RIP version 2.~~

Step 3: Security

~~Centre A:~~
~~! Declare which hosts can use GTS~~
~~access-list 1 permit 194.168.1.16 0.0.0.7~~
~~! Declare which hosts can come from GTS~~
~~access-list 2 permit 195.1.1.0 0.0.0.255~~
~~access-list 2 permit 137.129.9.0 0.0.0.255~~
~~!~~
~~interface serial 0~~
~~ip access-group 1 out~~
~~ip access-group 2 in~~

Centre B:

```
! Declare which hosts can use GTS
access-list 1 permit 137.129.9.0 0.0.0.255
! Declare which hosts can come from GTS
access-list 2 permit 195.1.1.0 0.0.0.255

! Only accept BGP updates from AS neighbour
ip as-path access-list 3 permit ^$
ip as-path access-list 3 permit ^65200
!
interface serial 0
ip access-group 1 out
ip access-group 2 in
!
interface serial 1
 ip access-group 1 out
 ip access-group 2 in
! Restrict BGP updates
router bgp 65001
 network 137.129.9.0 mask 255.255.255.0
 neighbour 193.105.178.6 remote-as 65200
 neighbour 193.105.178.6 filter-list 3 in
 neighbour 193.105.178.6 filter-list 3 out
redistribute static
```

Centre C:

```
! Declare which hosts can use GTS
access-list 1 permit 195.1.1.0 0.0.0.255
! Declare which hosts can come from GTS
access-list 2 permit 137.129.9.0 0.0.0.255

! Only accept BGP updates from AS neighbour
ip as-path access-list 3 permit ^$
ip as-path access-list 3 permit ^65001
!
interface serial 1
 ip access-group 1 out
 ip access-group 2 in
! Restrict BGP updates
router bgp 65200
interface serial 0
ip access-group 1 out
ip access-group 2 in
! Restrict BGP updates
router bgp 65200
network 195.1.1.0 mask 255.255.255.0
 neighbour 193.105.178.5 remote-as 65001
 neighbour 193.105.178.5 filter-list 3 in
 neighbour 193.105.178.5 filter-list 3 out
```

In these configurations, there are two important features used:

(a) BGP filtering

The access-list 3 in both B and C checks the autonomous system number sent by its neighbour. By filtering in and out in the BGP process this guarantees that all known routes must be issued from one of these ASs.

(b) IP filtering

The access-list 1 list allows IP addresses issued from within each Centre. This list should be quite stable. The access-list 2 checks the incoming IP addresses. As new Centres are added to the IP network, the corresponding addresses must be added to these access-lists.

It must also be noted that despite Internet connections in B and C no extra attention is required to control routing exchange. A static default route is not sent even *if « redistribute static »* is enabled. RIP and BGP ignore routing information known via the other protocol.

APPENDIX 3 – SAMPLE SOCKET SEND AND RECEIVE ROUTINES

```
/*********************************************************************
* Sample TCP/IP Socket program that SENDS a single message
*********************************************************************/
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <signal.h>
#include <string.h>
#include <memory.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <netdb.h>

/* TCP/IP DESTINATION and SERVICE ARE DEFINED BY THE RECEIVING CENTRE */
#define DESTINATION         "localhost"
#define SERVICE      39000
#define GTS_LENFIELD 8
#define MAX_MSGSIZE        15000 /* value of the send buffer size, recommended: 4096 */

static void GetDestinationInfo();
static void SetupSocket();
static void SendData();
static void MakeConnection();

static struct sockaddr_in dest;
static int         pr_sock;

/*********************************************************************
*                              MAINLINE
* 1. Ignore SIGPIPE signals. These are generated if a connection
*  is lost. By default they cause a program to terminate.
* 2. Get information about the destination (GetDestinationInfo):
*              - IP number (and name)
*              - Service/Port number
* 3. Create a TCP/IP Socket (SetupSocket)
* 4. Connect to the destination centre (MakeConnection)
* 5. Send the message (SendData)
* 6. Close the socket (shutdown + close)
*********************************************************************/
main(int argc, char *argv[])
{

signal (SIGPIPE,SIG_IGN);
```

```
GetDestinationInfo();
SetupSocket();
MakeConnection();
SendData();
/* shutdown(pr_sock,1) */
close(pr_sock);

}

/*********************************************************************
*                              GET DESTINATION INFO
* Store the destination IP number and service number in a socket
* structure (dest).
* 1. Convert the destination name to an IP number (gethostbyname)
* 2. Store the IP number and service number in the "dest" structure.
*********************************************************************/
static void GetDestinationInfo()
{
struct hostent *hp;

hp = gethostbyname (DESTINATION);
if ( hp == NULL ) {
  printf("host error\n");
  exit(1);
  }

memset ((char *)&dest, 0, sizeof dest);
memcpy (&dest.sin_addr.s_addr, hp->h_addr, hp->h_length);
dest.sin_family = AF_INET;
dest.sin_port = SERVICE;
}

/*********************************************************************
*                              SETUP SOCKET
* Setup a TCP/IP Socket
* 1. Create the socket
* 2. Set the socket KEEPALIVE option.
*  This enables the automatic periodic transmission of "check"
*  messages to be sent on the connection. If the destination
*  does not respond then it is considered broken and this process
*  is notified (by SIGPIPE or end-of-file)
*3. Set the socket REUSEADDR option. Enable quicker restarting of
*  terminated processes.
*4. Reduce the size of the Socket send buffer to reduce the amount of data lost
*  if the connection fails.
*********************************************************************/
static void SetupSocket()
{
int          on = 1;
int          rc;
int          buffsize = MAX_MSGSIZE;

pr_sock = socket (AF_INET, SOCK_STREAM, 0);
if (pr_sock < 0) {
  printf("sock error\n");
  exit(1);
  }
```

```
 rc = setsockopt(pr_sock,SOL_SOCKET,SO_KEEPALIVE,(char *)&on,sizeof(on));
 if (rc != 0) {
  printf("keepalive error\n");
   }

 rc = setsockopt(pr_sock,SOL_SOCKET,SO_REUSEADDR,(char *)&on,sizeof(on));
 if (rc != 0) {
  printf("reuse error\n");
   }

rc = setsockopt(pr_sock,SOL_SOCKET,SO_SNDBUF,(char *)&buffsize,sizeof(buffsize));
 if (rc != 0) {
  printf("unable to set send buffer size\n");
   }

}

/*********************************************************************
*                              MAKE CONNECTION
* Attempt to make a TCP/IP Socket connection to the destination on
* the agreed service/port number.
*********************************************************************/
static void MakeConnection()
{
int             length;

length = sizeof (dest);
if ( connect (pr_sock,(struct sockaddr *)&dest,length) == -1 ) {
  printf("connection error\n");
  exit(1);
  }

printf("connected\n");
}

/*********************************************************************
*                                    SEND DATA
* Send a message on the socket (5 times actually).
*
* NOTE: A real program would check the return code from the write
* and if the write failed it would close the socket, raise an operator
* alarm, and then try to re-send from the start of the message
*********************************************************************/
static void SendData()
{
char            msg[MAX_MSGSIZE+1], buffer[MAX_MSGSIZE+GTS_LENFIELD+3];
int             buflen, i, rc = 0;

strcpy(msg,"\001\r\r\n001\r\r\nTTAA01 AMMC 000000\r\r\n");
for (i=0;i<60;i++)
  strcat(msg,"THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789\r\r\n");
strcat(msg,"\r\r\n\003");

sprintf(buffer,"%0*dAN%s",GTS_LENFIELD,strlen(msg),msg);
buflen = strlen(buffer);
```

```
for (i=0; i<5; i++) {
  rc = write(pr_sock,buffer,buflen);
  printf("write. rc = %d\n",rc);
  }

}

/*********************************************************************
* TEST TCP/IP SOCKET RECEIVING PROGRAM.
* Program is designed to give some ideas as to how to receive GTS
* style messages on a TCP/IP Socket connection.
*********************************************************************/
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <signal.h>
#include <string.h>
#include <memory.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <netdb.h>

#define SERVICE                 39000
#define MAX_MSGSIZE                     15000
#define MAX_BUFLEN                      MAX_MSGSIZE + 100
#define SOH                     '\001'
#define ETX             '\003'
#define GTS_LENFIELD                    8
#define GTS_SOCKET_HEADER       10

static void SetupService();
static void RecvData();
static void AcceptConnection();
static int ExtractMsg(char *buffer, int *buflen);
static int CheckMsgBoundaries (char *, int);
static int FindMessage (char *, int, int *);
static void ShiftBuffer (char *, int *, int);

static struct sockaddr_in dest;

static int      pr_sock, msgsock;
static char     buffer[MAX_BUFLEN+1];
static int      buflen = 0;

/*********************************************************************
*                                       MAIN
* Listen for incoming IP calls and read any incoming messages on
* the first call established.
*
* 1. Ignore SIGPIPE signals. These are generated if a connection
*  is lost. By default they cause a program to terminate.
* 2. Set-up a listening socket for incoming msgs (SetupService)
* 3. Accept the first call received (AcceptConnection)
* 4. Read any messages on this connection (RecvData)
* 5. Close the call and close the listening socket.
*********************************************************************/
main(int argc, char *argv[])
```

```
{

signal (SIGPIPE,SIG_IGN);

SetupService();
AcceptConnection();
RecvData();

close(msgsock);
/* shutdown(pr_sock,1) */
close(pr_sock);
}

/*********************************************************************
*                              SETUP SERVICE
* Listen for calls on a given Service/Port.
* 1. Create a socket
* 2. Set the socket KEEPALIVE option.
*  This enables the automatic periodic transmission of "check"
*  messages to be sent on the connection. If the destination
*  does not respond then it is considered broken and this process
*  is notified (by SIGPIPE or end-of-file)
* 3. Set the socket REUSEADDR option. Enable quicker restarting of
*  terminated processes.
* 4. Bind the socket to the required Service/Port
* 5. Start listening for calls.
*********************************************************************/
static void SetupService()
{
int             on = 1;
int             rc;
/* adjust the TCP receive buffer size
int             buffsize = MAX_MSGSIZE; */

memset ((char *)&dest, 0, sizeof dest);
dest.sin_addr.s_addr = INADDR_ANY;
dest.sin_family = AF_INET;
dest.sin_port = SERVICE;

pr_sock = socket (AF_INET, SOCK_STREAM, 0);
if (pr_sock < 0) {
  printf("sock error\n");
  exit(1);
  }

 rc = setsockopt(pr_sock,SOL_SOCKET,SO_KEEPALIVE,(char *)&on,sizeof(on));
 if (rc != 0) {
  printf("keepalive error\n");
  exit(1);
  }
 rc = setsockopt(pr_sock,SOL_SOCKET,SO_REUSEADDR,(char *)&on,sizeof(on));
 if (rc != 0) {
  printf("reuse error\n");
  exit(1);
  }
/* adjust the TCP receive buffer size
rc = setsockopt(pr_sock,SOL_SOCKET,SO_RCVBUF,(char *)&buffsize,sizeof(buffsize));
```

```
 if (rc != 0) {
  printf("unable to set send receive size\n");
  }
*/
rc = bind(pr_sock,(struct sockaddr *)&dest,sizeof dest);
if ( rc < 0) {
  printf("bind error\n");
  exit(1);
  }


rc = listen(pr_sock,1);
if ( rc < 0) {
  printf("listen error\n");
  exit(1);
  }

printf("listening\n");
}

/*********************************************************************
*                              ACCEPT CONNECTION
* Wait for an incoming call (accept).
* Return the socket of the call established.
*********************************************************************/
static void AcceptConnection()
{
int             addrlen;

printf("waiting connection\n");

addrlen = sizeof(sockaddr_in);
msgsock = accept (pr_sock,&dest,&addrlen);
if ( msgsock < 0) {
  printf("accept error\n");
  exit(1);
  }
printf("connected\n");
}

/*********************************************************************
*                              RECV DATA
* Read data from the message/call socket.
* Extract GTS messages from this data.
* Keep reading until the sender drops the call or there is an error.
*********************************************************************/
static void RecvData()
{
int             numr = 1;
int             rc = 0;

while (numr > 0 && rc >= 0) {
  numr = read(msgsock,buffer+buflen, MAX_BUFLEN-buflen);
  if (numr > 0) {
    buflen += numr;
    buffer[buflen] = '\0';
    printf("buffer = %s\n",buffer);
```

```
    rc = ExtractMsg(buffer,&buflen);
    }
  }
}


/*********************************************************************
*                          EXTRACT MSG
*  DESCRIPTION
*  This function accepts a buffer of data on input, along with the
*  amount of data in the buffer, and extracts GTS messages from this
*  buffer.
*
*  Messages that are in the buffer are identified as follows…
*
*  – The first 8 bytes of the message buffer HAVE to be a message
*   length in character format.
*   If the length exceeds the GTS defined maximum message size, or
*   does not consist of numeric characters, then an error is returned
*   (lost synchronization).
*
*  – Immediately following the message length is a 2 character
*              Message Type: "AN" = Alphanumeric, "BI" = binary, “FX” = Fax
*
*  – The GTS message begins with a SOH character, and is terminated
*   with a ETX character, if this does not occur, then an error is
*   returned (lost synchronization).
*
*  – If a GTS message is identified, then it is extracted and the
*   message is shifted out of the buffer.
*
*  – As there may be more than 1 message in the buffer, this function
*   will loop (extracting messages) until either and
*   error or incomplete message is detected.
*
*
*  RETURNS   = 0 - Not a complete message in the buffer.
*                < 0 - Fatal error in the format of the buffer.
*                > 0 - Success, the message(s) have been extracted
*********************************************************************/
static int ExtractMsg(char *buffer, int *buflen)
{
int          rc, msglen;
char         msg[MAX_MSGSIZE+1];

/* FIND THE FIRST MESSAGE IN THE BUFFER */
rc = FindMessage (buffer, *buflen, &msglen);

/* WHILE A VALID MESSAGE LENGTH IS FOUND IN THE MESSAGE BUFFER… */
while ( rc > 0 ) {

 /* ENSURE THAT THE FIRST CHARACTER AFTER THE MESSAGE LENGTH IS
   A 'SOH' CHARACTER, AND THE LAST CHARACTER AS INDICATED BY
   THE MESSAGE LENGTH IS AN 'ETX' CHARACTER. */
 if ( (rc = CheckMsgBoundaries (buffer, msglen)) < 0 )
   continue;
```

```
 /* PRINT THE EXTRACTED MESSAGE */
 memcpy(msg,buffer+GTS_SOCKET_HEADER,msglen);
 msg[msglen] = '\0';
 printf("GTS MSG = \n%s\n",msg);

 /* SHIFT THE JUST INJECTED MESSAGE OUT OF THE MESSAGE BUFFER,
   AND LOOP BACK TO LOOK FOR A NEW MESSAGE. */

 ShiftBuffer (buffer, buflen, msglen);

 /* FIND THE FIRST MESSAGE IN THE SHIFTED BUFFER */
 rc = FindMessage (buffer, *buflen, &msglen);

 }

return (rc);
}

/*********************************************************************
*                              FIND MESSAGE
* Check that the complete message is at the start of the buffer.
* 1. Check the first 8 characters which are the message length
* 2. Check the next 2 characters - Message Type
* 3. Check that the complete message, as defined by the "message length"
*  field, is in the buffer.
* Return codes:
*   0 = message incomplete
*   1 = message complete
*  -1 = error
*********************************************************************/
static int FindMessage (char *buffer, int buflen, int *mlen)
{
  char charlen[GTS_LENFIELD+1];
  int  intlen;

  *mlen = 0;

  /* IF THE LENGTH OF THE PASSED MESSAGE BUFFER IS NOT GREATER THAN
   10 CHARACTERS THEN RETURN 'INCOMPLETE'.  */
  if ( buflen < GTS_SOCKET_HEADER ) {
   return (0);
   }

  /* CHECK THAT THE MESSAGE TYPE IS VALID */
  if   (strncmp(buffer+GTS_LENFIELD,"AN",2)   &&   strncmp(buffer+GTS_LENFIELD,"BI",2)   &&
strncmp(buffer+GTS_LENFIELD,"FX",2)) {
   printf("ERROR: Message Type field invalid");
   return (-1);
   }

  /* EXTRACT THE MESSAGE LENGTH */
  strncpy (charlen, buffer, GTS_LENFIELD);
  charlen[GTS_LENFIELD] = '\0';

  /* CHECK THAT THE MESSAGE LENGTH CHARACTER STRING COMPRISES
   ENTIRELY OF DIGITS. RETURN AN ERROR IF THIS IS NOT THE CASE. */
  if ( strspn (charlen, "0123456789") != strlen (charlen) ) {
```

```
   printf("ERROR: length not numeric");
   return (-1);
   }

  /* CONVERT THE MESSAGE LENGTH CHARACTER STRING TO AN INTEGER. */
  intlen = atoi (charlen);

  /* CHECK THAT THE LENGTH EXTRACTED FROM THE BUFFER IS NOT GREATER
   THAN THE GTS DEFINED MAXIMUM MESSAGE SIZE - RETURN AN ERROR IF
   THIS IS THE CASE. */
  if ( intlen > MAX_MSGSIZE ) {
   printf("ERROR: message overlength");
   return (-1);
   }

  /* CHECK IF THE ENTIRE MESSAGE HAS BEEN RECEIVED. RETURN IF NOT */
  if ( buflen < intlen + GTS_SOCKET_HEADER ) {
   return (0);
   }

  *mlen = intlen;
  return (1);
}

/*********************************************************************
*                              CHECK MSG BOUNDARIES
* Confirm the first character after the Socket Header is
* a SOH, and the last character in the message (given by the message
* length) is an ETX.
*********************************************************************/
static int CheckMsgBoundaries (char *buffer, int msglen)
{

  /* CHECK THAT THE FIRST CHARACTER (AFTER THE MESSAGE LENGTH
    FIELD) IS AN SOH CHARACTER - RETURN AN ERROR IF IT ISN'T. */
  if ( buffer[GTS_SOCKET_HEADER] != SOH ) {
   printf("ERROR: SOH not found\n");
   return (-1);
   }

  /* CHECK THAT THE LAST CHARACTER (ACCORDING TO THE MESSAGE LENGTH
    FIELD) IS AN ETX CHARACTER - RETURN AN ERROR IF IT ISN'T. */
  if ( buffer[msglen+GTS_SOCKET_HEADER-1] != ETX ) {
   printf("ERROR: ETX not found\n");
   return (-1);
   }

  return (1);
}

/*********************************************************************
*                              SHIFT BUFFER
* Shift the leading message in the buffer out of the buffer. This may
* either empty the buffer, or move all or part of a new message to the
* start of the buffer.
*********************************************************************/
static void ShiftBuffer (char *buffer, int *buflen, int msglen)
```

```
{
  int shiftlen;

  /* CALCULATE THE AMOUNT OF DATA TO BE SHIFTED OUT OF THE BUFFER. */
  shiftlen = msglen + GTS_SOCKET_HEADER;

  /* SHIFT THE 'PROCESSED' DATA OUT OF THE BUFFER BY MOVING THE
   UNPROCESSED DATA OVER THE TOP OF IT.
   CALCULATE THE NEW AMOUNT OF DATA IN THE BUFFER. */
  *buflen = *buflen - shiftlen;
  memcpy (buffer, buffer + shiftlen, *buflen);
}
```

APPENDIX 4 – SOME SECURITY ARRANGEMENTS FOR SMALL GTS CENTRES (OBSOLETE)

Appendix 4 has been removed from this Attachment. All IT Security material can now be found in the "Guide on Information Technology Security" which is at

http://www.wmo.int/pages/prog/www/documents.html

~~This Appendix provides information on low-cost measures to secure GTS centres, when they are connected to the Internet. The traditional GTS with Message Switching Systems passing bulletins over point-to-point circuits is inherently secure, while the Internet is inherently insecure. So, it is important to prevent Internet users from being able to traverse GTS links, where they may be able to cause damage to neighbouring centres.~~

~~Security policy~~

~~In a mixed Internet/GTS environment, a security hole at a GTS centre may compromise other GTS segments. It is very likely that sooner or later, most of the GTS centres will be connected to the Internet, so a solution for the security aspects must be found, which are practical for all Centres and especially, small centres. Different levels of network security can be achieved with the tools available today at costs that vary from a few dollars (freeware) to expensive proprietary solutions.~~

~~There are, however, other important aspects besides costs. Technical expertise and strong management support are indispensable elements to implement and enforce an effective security policy. Without them, no protection will be achieved, even with the best and most expensive firewall systems.~~

~~Coexistence of Internet and dedicated GTS links~~

~~There are many options for the general configuration of systems in small Centres. Figure A4.1 shows an arrangement where separate routers are used to provide access to Internet and GTS.~~

~~Figure A4.1 — Coexistence of GTS and Internet – separate access routers~~

~~To achieve cost reduction, GTS centres, may wish to consolidate the GTS and Internet networks, whilst still providing a level of security for their GTS systems. Figure A4.2 depicts a low cost configuration that may meet this objective.~~

~~Figure A4.2 — Coexistence of GTS and Internet – common access router~~

~~Protecting the GTS links from the Internet~~

~~It is important that the exterior router(s), connected to both GTS and Internet links be securely passworded, and protected so that it may not be configured via the Internet. Additionally, no Internet traffic should be allowed to propagate down GTS links, nor GTS traffic be sent to the Internet unless specifically intended to do so. This can be achieved by carefully filtering routing updates.~~

~~There should be a definite separation between general Internet services (www/http, e-mail access) and the GTS system (e.g. Message Switch). They should be in separate machines. Additionally, use of firewalling technology should be undertaken to limit general Internet access to the GTS~~

~~Centre internal network, possibly restricting incoming connections to SMTP on the mail server, HTTP on the web server and DNS on the Domain Name servers.~~
~~In between the exterior router and critical systems, a firewall should be deployed. This firewall must have the capacity to limit, proxy or redirect access to internal hosts in order to protect them. Several brands of firewall are on the market, with ranges of capabilities. In most cases because of the simple nature of the network in small centres, a simple firewall may be deployed.~~
~~When connecting to the Internet, deploying some sort of firewall is virtually mandatory. The risks for internal data and systems would justify this. In order to allow the access control some low-cost options are available.~~

~~Linux computers~~
~~Linux Operating system is free, and runs on a variety of hardware platforms, notably on PCs. The newest versions of Linux (Kernel version 2.2) come with firewalling software called ipchains. Additionally, they support routing protocols through a routing program called gated. Centres with some experience with UNIX will be able to get a working firewall setting up linux from scratch.~~

~~Windows NT~~
~~A variety of commercial packages exist. The familiarity with the Windows and relatively low cost of PC hardware is seen as main advantage.~~

~~Free Toolkits~~
~~A company called TIS (Trusted Information Systems) has released a set of source code, mainly for UNIX/LINUX hosts, which is freely available. This requires access to UNIX/LINUX machines, compilers, and requires good knowledge of Internet security issues.~~

~~Routers~~
~~Many routers have packet filtering capabilities. It is possible to deploy one of these as firewall, although they aren't very flexible. Smaller centres may want to consider this.~~
~~Desirable solution~~
~~Some firewall vendors have been providing firewall solutions, based on their hardware. Cisco's IOS firewall is a notable example. This type of solution is depicted in Figure A4.3.~~

~~Figure A4.3 — Coexistence of GTS and Internet – separate access routers plus firewall GTS using the Internet~~

~~There will be situations where GTS centres will use Internet to transport data and products. Security concerns are also applicable here. The arrangement shown below in Figure A4.4 represents a simple and safe way to use the Internet to connect neighbouring GTS centres that may become popular in small centres in future. Firewalling is done using access lists.~~
~~Figure A4.4 — The use of Internet between neighbouring GTS Centres~~

~~Virtual private network – secure GTS connections over the Internet~~
~~A virtual private network (VPN) is a private network implementation among organizations to communicate over a publicly accessible network. VPN message traffic can be carried over the Internet on top of the standard TCP/IP protocols. Secure VPNs use cryptographic tunneling protocols to provide the sender authentication, message integrity and confidentiality to achieve privacy. This is considered suitable for use for the transmission and exchange of meteorological data among centres.~~

~~The most common Secure VPN protocol is IPSec. IPSec is designed to provide interoperable high quality, cryptographically based security for IP. The set of security services offered includes access control, connectionless integrity, data origin authentication, protection against replays, as well as confidentiality. IPSec is an end-to-end security protocol: all the functionality and intelligence of the VPN connection reside at the end points, either in a gateway or in the end-host. Through IPSec, it is possible to establish a tunnel between two gateways. An IPSec gateway would typically consist of an access router, a firewall or a VPN gateway on which the IPSec protocol is implemented. The IPSec gateway locates between the user's private network and the carrier's shared network.~~

~~IPSec tunnels are established dynamically and released automatically when they are not in use. To establish an IPSec tunnel, two gateways must authenticate themselves and defi ne which security algorithms and keys they will use for the tunnel. The entire original IP packet is encrypted and wrapped inside IPSec authentication and encryption headers. Figure A4.5 shows an implementation of a VPN connection using IPSec between two GTS centres.~~

~~Figure A4.5 — The use of VPN over the Internet to connect two GTS Centres~~

~~The VPN gateway is connected to a firewall and a router. The VPN gateway can establish a VPN tunnel with other VPN gateways through the interface of the router. The flow of traffic into the internal network will be through the firewall and will be controlled by an access list defined by the user.~~

~~IPSec makes use of the Authentication Header (AH) and the Encapsulation Security Payload (ESP) to achieve data integrity and confidentiality.~~

~~The most common encryption algorithm used in ESP is Triple Data Encryption Standard (3DES) and Advanced Encryption Standard (AES). They have encryption key sizes from 128 bits to 256 bits, providing suffi cient protection for data traffi c along the trunk.~~

~~Further details on VPN implementation can be found in the Guide on Virtual Private Network (VPN) via the Internet between GTS centres. This Guide is available on the WMO web page at http://www.wmo.int/web/pages/prog/manuals.html.~~

APPENDIX 5 – REFERENCE MATERIAL

General references on TCP/IP

1. Internetworking TCP/IP Vol. 1 (2/E) – Douglas Comer – Prentice Hall
2. TCP/IP Illustrated Vol. 1. – Stevens – Addison-Wesley
3. TCP/IP Architecture, Protocols and Implementation – Feit – McGraw Hill
4. TCP/IP and Related Protocols – Black – McGraw Hill
5. TCP/IP Running a Successful Network – Washburn and Evans – Addison-Wesley
6. TCP/IP and ONC/NFS (2/E) – Santifaller – Addison-Wesley
7. Inside TCP/IP – Arnett et. al. – New Riders Publishing
8. Teach Yourself TCP/IP in 14 days – Parker – SAMS
9. Introduction to TCP/IP – Davidson – Springer

References on Security

1. Firewalls and Internet Security- Cheswick & Bellovin – Addison-Wesley
2. Building Internet Firewall – Chapman – O'Reilly
3. Practical Unix Security – Garfinkel & Spafford – O'Reilly
4. Internet RFC 2196 (Site security Handbook)
5. http://www.computersecuritynow.com: a website with a lot of reference documents on 6. implementing security

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APPENDIX 6 – SUGGESTED PASSWORD MANAGEMENT PRACTICES (OBSOLETE)

Password management is a topic included in the IT Security discussion. All IT Security material can now be found in the "Guide on Information Technology Security" which is at

http://www.wmo.int/pages/prog/www/documents.html

~~Passwords are the system's fi rst line of defence against unauthorized intrusion. While it is possible to violate system security without logging in, a poorly protected or chosen password can make a hacker's task a lot easier.~~

~~GOOD PASSWORDS:~~

1. ~~Have both upper-case and lower case letters, and/or~~
2. ~~Have digits and/or non-alphanumeric characters.~~
3. ~~Are 6 to 8 characters long.~~
4. ~~Should consist of at least 2 words or groups of characters.~~
5. ~~Should not be shared or used by more than one user.~~
6. ~~Should not be used on more than one computer.~~
7. ~~Should be changed regularly, e.g. monthly.~~
8. ~~Can be typed quickly and easily, so that an observer cannot follow the keystrokes.~~
9. ~~Are easy to remember so that they should not have to be written down. (e.g. use first letter of words in a well known phrase).~~

~~BAD PASSWORDS:~~

1. ~~The name of: yourself, your spouse, your children, your parents, your pet, your friends, your favourite film stars/characters, anyone associated with you, your workstation or its host.~~
2. ~~The number of: your telephone, your car's license plate, your user ID, any part of your credit cards' numbers, or any number associated with you.~~
3. ~~The birthday of yourself or anyone associated with you.~~
4. ~~Any word from any dictionary, any place name, any proper noun.~~
5. ~~The name of a well known public identity such as a sporting hero, entertainer or well known fictional character.~~
6. ~~Simple patterns: aaaaaaa, qwerty.~~
7. ~~Any of 1 - 6 spelled backwards.~~
8. ~~Any of 1 - 6 preceded or followed by a digit.~~
9. ~~Any password that has been written down and left in an unlocked drawer or unsecured computer file.~~
10. ~~Any password that has been on a machine that may have been successfully hacked (except as part of authorised exercises).~~
11. ~~Any password on a machine that has been left unattended when any user is logged on.~~

APPENDIX 7 – IP ADDRESSES FOR USE ON THE GTS

INTRODUCTION

The current "Recommended practices and procedures for the implementation, use and application of the Transmission Control Protocol/Internet Protocol (TCP/IP) on the GTS" as given in the Manual on GTS, Attachment II-15 (also known as "Guide on the Use of TCP/IP on the GTS") describe guidelines and a procedure for assigning IP addresses to GTS links which are no longer adequate. In particular, it states that a number of official class C IP addresses were available through the WMO Secretariat to be assigned for GTS links. These sets of IP addresses are no longer officially available, as a consequence of a strict application of Internet standards (RFCs) by Internet Authorities and Services Providers, and unfortunately cannot be used on the GTS, as they may now be assigned to other organizations on the Internet. The WMO Secretariat has therefore been instructed to discontinue the assignment of such IP addresses.

The Expert Team on Communication Techniques and Structure (ET-CTS) has been tasked to provide alternate solutions to solve this issue.

This document is a provisional description of the available options and related guidance to mitigate this problem and assist Members in their implementation. The included guidelines only concern the IP addressing. They do not change the existing recommendations on how IP relates to X.25 or other IP functionality.

The ET-CTS will proceed with developing the proposed amendments to this Attachment to reflect the new recommended practices for allocating IP addresses.

WHO CAN PROVIDE OFFICIAL IP ADDRESSES?

In order to build a network that interconnects many organizations from various countries in the world, it is essential to maintain a standard in the addressing scheme, and to maintain uniqueness in the allocation of addresses to the various organizations. The Internet community has identified this basic principle and created some official bodies to coordinate the distribution of official IP addresses. Today, this responsibility belongs to the Internet Assigned Numbers Authority (IANA), and its regional delegates, the relevant Regional Internet Registries:

AfriNIC (African Network Information Centre) – Africa region
APNIC (Asia Pacific Network Information Centre) – Asia Pacific region
ARIN (American Registry for Internet Numbers) – Americas and Southern Africa
LACNIC (Regional Latin-American and Caribbean IP Address Registry) – Latin America and some Caribbean islands
RIPE NCC (Réseaux IP Européens Network Coordination Centre) – Europe and surrounding areas

These organizations further delegate the allocation of addresses to their regional Internet and telecommunications suppliers through national Internet registries.

In this scheme, it is not the WMO's responsibility to allocate IP addresses. Since the GTS is not built as a unique network under the complete authority of a single organization, the allocation of addresses must therefore go through the respective national Internet registry or the appropriate Regional Internet Registry.

However, several countries now face the issue of the restriction of allocation of IP version 4 (IPv4) addresses and may have difficulty obtaining official addresses. This problem is not an easy one to solve in the short term and provisional measures may have to be taken to allow the further development of the GTS. The following guidelines explain how to interconnect networks with and without the use of official IP addresses.

CONNECTING NETWORKS WITH OFFICIAL IP ADDRESSES

Using official IP addresses assigned directly to an organization (e.g. the NMS)

This remains the preferred option if it is feasible. It is basically the main procedure described in the existing "Guide on Use of TCP/IP on the GTS". It follows all the Internet rules and allows an organization to build a coherent network with interconnections to the Internet, GTS and possibly other partner organizations. It is also the easiest configuration to maintain.

In interconnecting two countries to form a GTS link, the two National Meteorological Services should decide which one actually provides the address to the interconnecting link. The decision remains one of practicality for the countries. There are no general rules that would favour one set of addresses over another one.

Using official IP addresses provided by a telecommunications supplier

This option is very similar to the previous one. The addresses supplied would be official and all the rules would of course be followed.

It may require that a common telecommunications supplier be used between the two interconnecting organizations.

This option however has the drawback that a change in telecommunication suppliers may require a change in IP addressing as original incumbent reclaims "his" addresses. Each organization should

plan for this possibility ahead of time and evaluate its impact on future operations. If these addresses are only used for link purposes and not for an organization's internal purposes, then this drawback may be of minimal impact.

Using IP version 6 (IPv6) addresses

The new IP version 6 (IPv6) protocol standard was designed in great part to address the shortage of IPv4 addresses. Although the IPv6 protocol is available and supported in many telecommunication equipments available today, its implementation requires much planning. In particular, IPv4 and IPv6 are not compatible without the use of gateways and there are several operational tools still missing to make IPv6 usable for the GTS at this time. Converting to IPv6 would be a major task that can not be imposed on our members until the industry is ready to take this step as a whole.

This option is therefore not available today. It is only mentioned here for completeness and will be further studied over the next years.

CONNECTING NETWORKS WITHOUT OFFICIAL IP ADDRESSES

Using the "ip unnumbered" feature

Several network equipment suppliers (Cisco, 3Com, Juniper) have now introduced a feature in their configurations which allows the implementation of links without the need for allocation of IP addresses. This feature is usually called the "ip unnumbered" feature. For example, Cisco provides a document on "Understanding and Configuring the ip unnumbered Command" (see
http://www.cisco. com/warp/public/701/20.html
for details).

This feature is not a standard IP protocol feature, so it requires compatible equipment at both ends of the link to work (most frequent situation anyhow).

Routing between the two networks can be accomplished by binding the unnumbered interface to another existing interface in the router (either a real LAN or virtual loopback interface). The use of this feature may introduce limitations in routing flexibility.

Using RFC1918 – Addresses for private internets

The Internet Engineering Task Force (IETF) document "RFC1918 – Addresses for private internets" describes a set of addresses reserved for use by organizations *for sole intra-enterprise communications, without any intention to ever directly connect to other enterprises or the Internet itself*. Private internet addresses are sometimes referred to as "non-official IP addresses" or "non-registered IP addresses". Addresses for private internets are in fact official, but they are not unique.

Therefore the use of these addresses does not require official registration. The main purpose of this scheme is to allow a big organization to make use of a larger address space for its internal operations. As soon as the organization needs to exchange with others, a gateway must be traversed to enter an area of officially assigned addresses to maintain overall network coherence. This gateway must translate the internal RFC1918 addresses into official external IP addresses, which must be obtained via the official bodies. The function (usually performed by a router or firewall) that does this translation is called Network Address Translation (NAT). This address translation will also have the effect of concentrating several RFC1918 internal addresses into a very small number of official addresses, thus preserving official address space.

Although this scheme might seem attractive at first for our issue, the GTS is not the network of a single enterprise. At this time, any number of the WMO Member NMHSs and related organizations

may already make use of the RFC1918 in their own networks, which may result in conflicting address allocations if the networks interconnect. A recommendation from WMO for the use of RFC1918 is almost an impossible task, as the NMHSs may already be under guidelines of their own government, which might conflict with a directive of WMO. However, interconnecting countries may find adequate address space within RFC1918 in a bilateral agreement.

This option is therefore feasible as long as the following points are carefully considered, planned, maintained and monitored:

1. Great care should be taken in selecting a proper RFC1918 set of addresses for links between organizations. It is important that the selected addresses are not already in use by any of the involved organizations.

2. Great care should be taken to ensure that routing configurations do not allow the leaking of RFC1918 addresses into other organization's network or worse, into the Internet.

3. Although this solution will work quite satisfactorily between a few countries, it cannot be expanded to many directly interconnected countries, as the choice of RFC1918 addresses will get more and more complicated.

4. The IANA has reserved the following blocks in RFC1918.
   10.0.0.0 - 10.255.255.255 (10/8 prefix)
   172.16.0.0 - 172.31.255.255 (172.16/12 prefix)
   192.168.0.0 - 192.168.255.255 (192.168/16 prefix)
   Since many organizations already use the 10.0.0.0/8 block internally and since the 192.168.0.0/16 block is often used as default addresses by several equipment manufacturers, it is recommended that GTS links be used out of the 172.16.0.0/12 block only if possible.

6. Furthermore, it is also recommended that the 172.16.0.0/12 be subnetted in a way to maximize the usage of the address space. To that effect, GTS links can be subnetted to /30 bits. This allows 4 hosts per link (leaving the hosts addresses 1 and 2 available to designate the 2 ends of a given link).

7. NMHS that consider using the RFC1918 addresses should consult with all potential NMHS with whom they might establish a link in order to coordinate and plan the use of these subnets ahead of time. In the case of address conflicts, other address schemes within RFC1918 might be used by bilateral agreement. The ET-CTS would like to be informed of such issues if they arise to further develop this recommendation.

The use of RFC1918 addresses should not introduce security problems as long as the above points are well managed.

RECOMMENDATION

All the options described above can be used in the GTS. The order of preference is as follows:

1. Using official IP addresses assigned directly to an organization, e.g. the NMHS (preferred).
2. Using official IP addresses provided by a telecommunications supplier.
3. Using the "ip unnumbered" feature.
4. Using RFC1918 – Addresses for private internets.

The use of IPv6 on the GTS is not recommended at this time.

It should be understood that all options that do not require official IP addresses are workarounds to mitigate the shortage of addresses and must be used with care.

It should be understood that all options that do not require official IP addresses are workarounds to mitigate the shortage of addresses and must be used with care.

CONFIGURATION EXAMPLES

Option 1 – Using existing organization (NMHS) official IP addresses or Option 2 – Using Telecommunication Supplier official IP addresses

This is the standard way to configure an interface between two networks.

```
Router A:
!
interface Ethernet0
ip address 131.238.17.11 255.255.255.0
!
interface Serial0
description 64Kbps leased line to router B
ip address 131.238.18.01 255.255.255.252
encapsulation ppp
bandwidth 64
!
ip route 142.47.43.0 255.255.255.0 131.238.18.2
!
Router B:
!
interface Ethernet0
ip address 142.47.43.201 255.255.255.0
!
interface Serial0
description 64Kbps leased line to router A
ip address 131.238.18.02 255.255.255.252
encapsulation ppp
bandwidth 64
!
ip route 131.238.17.0 255.255.255.0 131.238.18.1
```

Recommendation 4 (CBS-Ext.(10))

DESIGNATION OF CENTRES OF THE WMO INFORMATION SYSTEM

THE COMMISSION FOR BASIC SYSTEMS,

Noting:

(1) The designation procedure for Global Information System Centres (GISCs) and Data Collection or Production Centres (DCPCs) as endorsed in the *Abridged Final Report with Resolutions of the Fifteenth World Meteorological Congress* (WMO-No. 1026), general summary, paragraph 3.1.2.13,

(2) The recommended designation procedures for GISCs and DCPCs, as in the Annex III of the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session of the Commission for Basic Systems* (2006) (WMO No. 1017),

(3) The amendments to the *Technical Regulations* (WMO-No. 49), Volume I, Section A.3 as proposed in Recommendation 5 (CBS-Ext.(10)) – Amendments to the *Technical Regulations* (WMO-No. 49), Volume I, Section A.3,

(4) The recommendation for the *Manual on the WMO Information System* (WMO-No.1060) as proposed in Recommendation 6 (CBS-Ext.(10)) – The *Manual on the WMO Information System* (WMO-No. 1060),

Recommends that Congress:

(1) Designate as GISCs of WIS those centres listed in Table 1 of the annex to the present recommendation;

(2) Designate as DCPCs of WIS those centres listed in Table 2 of the annex to the present recommendation;

(3) Designate those centres listed in Table 3 of the annex to the present recommendation for the roles defined in Table 3;

(4) Conditionally designate as a GISC or DCPC those centres shown in Table 4 of the annex to the present recommendation, subject to demonstration of meeting the pre-operational compliance requirements to the Management Group of the Commission, and that any centre in Table 4 that has not demonstrated pre-operational compliance by the time the Executive Council holds its sixty-fourth session will have its conditional designation removed;

(5) Confirm that any centres which have not been designated as a DCPC or GISC by the time the Executive Council holds its sixty-fourth session that wish to be recognized as a centre must demonstrate that they meet the pre-operational compliance requirements and be endorsed by the Management Group of the Commission before Executive Council decides whether or not to designate that centre in the requested role;

Requests the Secretary-General to take appropriate actions to propose the present recommendation, as updated by the president of the Commission after consultation with the Management Group of the Commission, to the Sixteenth World Meteorological Congress.

Annex to Recommendation 4 (CBS-Ext.(10))

DESIGNATION OF CENTRES OF THE WMO INFORMATION SYSTEM

This annex lists those centres that the Commission recommends should receive designation as a WMO Information System Centre

Table 1: Centres that have been endorsed by CBS-Ext.(10) for the role of Global Information System Centre of the WIS (GISC) as satisfying the pre-operational compliance requirements

Centre	Proposed role
Beijing, China	GISC
Offenbach, Germany	GISC
Tokyo, Japan	GISC

Table 2: Centres that have been endorsed by CBS-Ext.(10) for the role of Data Collection and Production Centre of the WIS (DCPC) as satisfying the pre-operational compliance requirements

Centre	**Proposed role**
Beijing, China	DCPCs
Offenbach, Germany	DCPCs
Tokyo, Japan	DCPCs
ECMWF	DCPC
EUMETSAT	DCPC

Table 3: Centres that have been endorsed by Management Group of the Commission after CBS-Ext.(10) as satisfying the pre-operational compliance requirements

Centre	**Proposed role**

Note: to be updated by the president of the Commission prior to Sixteenth Congress

Table 4: Centres that have registered to be considered for the role of GISC and/or DCPC of the WIS, but for which the demonstration of pre-operational compliance requirements had not been completed at the time of submitting papers to Sixteenth Congress.

Centre	**Proposed role**
Ashville, United States of America	DCPC
Boulder, United States	DCPC
Brasilia, Brazil	GISC
Delhi, India	GISC, DCPC
Exeter, UK	GISC, DCPCs
Hong Kong, China (World Weather Information Service)	DCPC
Jeddah, Saudi Arabia	GISC
Khabarovsk, Russian Federation	DCPC
Marrakesh, Morocco	GISC
Melbourne, Australia	GISC, DCPCs
Montreal, Canada	DCPC
Moscow, Russian Federation	GISC, DCPCs
Obninsk, Russian Federation	DCPCs
Oslo, Norway	DCPCs
Pretoria, South Africa	GISC
Rome, Italy	DCPCs
St Petersburg, Russian Federation	DCPCs
Seoul, Republic of Korea	GISC, DCPCs

Centre	Proposed role
Sodankylä, Finland	DCPC
Stockholm, Sweden	DCPCs
Tehran, Islamic Republic of Iran	GISC
Toulouse, France	GISC, DCPCs
Novosibirsk, Russian Federation	DCPC
Washington, United States	GISC, DCPCs

Recommendation 5 (CBS-Ext.(10))

AMENDMENTS TO THE *TECHNICAL REGULATIONS* (WMO-No. 49), VOLUME I, SECTION A.3

THE COMMISSION FOR BASIC SYSTEMS,

Noting:

(1) Resolution 1 (Cg-XV) – Technical Regulations of the World Meteorological Organization,

(2) Resolution 2 (Cg-XV) – World Weather Watch Programme for 2008–2011,

(3) The *Technical Regulations* (WMO-No. 49), Volume I – General Meteorological Standards and Recommended Practices, Section A.3,

(4) The decision of the Fourteenth Congress to establish an overarching WMO Information System (WIS) that would be used for the collection and sharing of information for all WMO and related international programmes,

Considering:

(1) That the Fifteenth Congress emphasized the need for appropriate WIS regulatory documentation and tasked the Commission for Basic Systems to develop regulatory documentation,

(2) That the Executive Council, at its sixty-second session, emphasized the importance of appropriate regulatory and guidance documentation on WIS and requested the Intercommission Coordination Group on the WMO Information System (ICG-WIS) and the Commission for Basic Systems to prepare amendments to the relevant section of the *Technical Regulations* (WMO-No. 49), for consideration by the Sixteenth Congress,

Recommends to Congress that the *Technical Regulations*, Volume I – General Meteorological Standards and Recommended Practices, Section A.3, be amended as given in the annex to the present recommendation, with effect from 1 January 2012.

Annex to Recommendation 5 (CBS-Ext.(10))

AMENDMENTS TO THE *TECHNICAL REGULATIONS* (WMO-No. 49), VOLUME I, SECTION A.3

Volume I – General Meteorological Standards and Recommended Practices, Section A.3

Replace the whole Section A.3, including its title, by the following, and amend the Contents of Volume I accordingly:

CONTENTS
A. World Weather Watch
A.3. WMO Information System (WIS)

CHAPTER A.3.1	**PURPOSE**	*{Insert Page Ref}*
CHAPTER A.3.2	**PRINCIPLES**	*{Insert Page Ref}*
CHAPTER A.3.3	**ORGANIZATION**	*{Insert Page Ref}*
CHAPTER A.3.4	**RESPONSIBILITIES**	*{Insert Page Ref}*
CHAPTER A.3.5	**PRACTICES, PROCEDURES AND SPECIFICATIONS**	*{Insert Page Ref}*

CHAPTER A.3.1 PURPOSE

WMO recognizes that its mission in weather, climate, water, and related environmental issues depends upon the collection, distribution and open sharing of information, often using rapid and highly reliable methods. The WMO Information System (WIS) is a key strategy to optimize the efficiency and effectiveness of WMO.

CHAPTER A.3.2 PRINCIPLES

A.3.2.1 WIS shall be used for the collection and sharing of information for all WMO and related international programmes.

A.3.2.2 WIS shall provide a flexible and extensible data management and data communication structure that allows the participating centres to enhance their capabilities as their national and international responsibilities grow.

A.3.2.3 WIS shall make use of international standards for relevant practices, procedures and specifications.

A.3.2.4 The basic engineering principles adopted for the WIS data communication networks shall provide for the integration of global, regional and national data communication systems to ensure transmission of the required information within the specified acceptable time delays.

CHAPTER A.3.3 ORGANIZATION

A.3.3.1 WIS shall be organized primarily by data management functions and also incorporate the required information exchange functions. The WMO Global Telecommunication System (GTS) shall be incorporated into WIS.

A.3.3.2 Centres participating in WIS shall be categorized by three types:
– Global Information System Centres (GISCs),
– Data Collection or Production Centres (DCPCs),
– National Centres (NCs).

A.3.3.3 Congress and Executive Council shall consider the designation of GISCs and DCPCs on recommendations of the Commission for Basic Systems (CBS). Congress and the Executive Council shall regularly review previously designated GISCs and DCPCs, and may reconsider

their designation based on recommendations from CBS. CBS recommendations shall include consultation with relevant technical commissions and regional associations, as appropriate. Members shall designate NCs.

A.3.3.4 WIS functions and operation shall be based on catalogues that contain metadata describing data and products available across WMO, plus metadata describing dissemination and access options. These catalogues shall be maintained by WIS Centres.

A.3.3.5 Through collaboration across all GISCs, each GISC shall provide comprehensive search across catalogues. Each GISC shall provide access to and disseminate WMO data and products intended for global exchange. Each GISC shall be associated with DCPCs and NCs within its area of responsibility.

A.3.3.6 DCPCs shall use WIS to collect, disseminate, provide access to, and store relevant regional or programme-specific data and products. DCPCs shall maintain catalogues of their holdings and services, and provide appropriate parts of these catalogues to the GISCs to ensure a comprehensive catalogue of WIS holdings.

A.3.3.7 NCs shall use WIS to provide data and products in accord with their programme responsibilities. NCs shall provide associated metadata to other WIS Centres to become part of the comprehensive catalogue of WIS holdings.

A.3.3.8 Each GISC, DCPC and NC shall participate in the relevant monitoring of the performance of WIS.

A.3.3.9 WIS shall incorporate data communication network management that includes dedicated data network services, especially for mission-critical information exchange, and public data network services such as the Internet, to ensure the efficiency and effectiveness of the required information exchange.

CHAPTER A.3.4 RESPONSIBILITIES

A.3.4.1 Members operating GISCs, DCPCs, and NCs shall ensure that all appropriate measures are taken for the installation and good functioning of their centres, and of the required data communication systems and services, in relation to their needs and the roles which they have accepted.

A.3.4.2 Members shall ensure that their national collecting systems for information allow not only national but also international needs to be met.

CHAPTER A.3.5 PRACTICES, PROCEDURES AND SPECIFICATIONS

A.3.5.1 The WIS data management and information exchange functions shall be established and operated in accordance with practices, procedures and specifications set out in Annex VII (*Manual on the WMO Information System* (WMO-No. 1060)).

A.3.5.2 The GTS, as a part of WIS, shall be operated in accordance with practices, procedures and specifications set out in Annex III (*Manual on the Global Telecommunication System* (WMO-No. 386), Volume 1).

Note: The Manual on WIS complements the Manual on GTS (WMO-No. 386). Eventually, the Manual on WIS will replace the Manual on GTS while incorporating relevant content.

Recommendation 6 (CBS-Ext.(10))

THE *MANUAL ON THE WMO INFORMATION SYSTEM* (WMO-No. 1060)

THE COMMISSION FOR BASIC SYSTEMS,

Noting:

(1) Resolution 1 (Cg-XV) – Technical Regulations of the World Meteorological Organization,

(2) Resolution 2 (Cg-XV) – World Weather Watch Programme for 2008–2011,

(3) The *Technical Regulations* (WMO-No. 49),

(4) The *Manual on the Global Telecommunication System* (WMO-No. 386), Volume I – Global Aspects,

Considering:

(1) That the Fifteenth Congress emphasized the need for appropriate WMO Information System (WIS) regulatory documentation and tasked the Commission for Basic Systems to develop regulatory documentation in phases based on the validation of preliminary organizational, functional and operational design,

(2) That the Executive Council, at its sixty-second session,

(a) Emphasized the high priority need for the development of the *Manual on the WMO Information System*, based on the experience gained through early WIS implementation;

(b) Noted and supported the important building blocks that were developed towards the future *Manual on the WMO Information System*, including the WIS Compliance Specifications and the WIS Functional Architecture,

Recommends that the *Manual on the WMO Information System* be adopted as Annex VII to the *Technical Regulations* (WMO-No. 49), as given in the annex to the present recommendation, with effect from 1 January 2012;

Requests the Secretary-General to publish the *Manual on the WMO Information System*, as given in the annex to the present recommendation, in all the WMO official languages;

Authorizes the Secretary-General to make any consequent purely editorial amendments to the *Manual on the WMO Information System*.

Annex to Recommendation 6 (CBS-Ext.(10))

THE *MANUAL ON THE WMO INFORMATION SYSTEM* (WMO-No. 1060)

WORLD METEOROLOGICAL ORGANIZATION

MANUAL ON THE WMO INFORMATION SYSTEM (WIS)

(Annex VII to the WMO Technical Regulations)

2012 edition

Basic Documents No. 2

WMO-No. 1060

Secretariat of the World Meteorological Organization–Geneva–Switzerland

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1. INTRODUCTION

1.1 Purpose of this Manual

1.1.1 The Manual on WIS is designed to ensure adequate uniformity and standardization in the data, information, and communications practices, procedures and specifications employed among WMO Members in the operation of WIS as it supports the mission of WMO. The Manual on WIS sets out standard practices, procedures and specifications (distinguished by the term "shall") having the status of requirements in a technical resolution, which it is necessary that WMO Members follow or implement. The Manual on WIS also sets out recommended practices, procedures and specifications (distinguished by the term "should") which Members are urged to comply with.

1.1.2 The Manual on WIS is Annex VII to the Technical Regulations (WMO-No. 49), Volume I (General meteorological standards and recommended practices), where it is stated that WIS is established and operated in accordance with practices, procedures and specifications in the Manual on WIS.

1.1.3 Because WIS cross cuts all WMO related discipline areas, many other WMO practices, procedures and specifications intersect WIS. Such practices, procedures and specifications are primarily defined in their specific publications, for example, the Manual on Global Data Processing and Forecast System (WMO-No. 485), and the Manual on Global Observing Systems (WMO-No. 488), among others.

2. ORGANIZATION AND RESPONSIBILITIES

2.1 Organization of WIS

2.1.1 In keeping with WMO-No. 49, Vol I, A.3, Centres operated by WMO Members and their collaborating organizations shall be categorized as one of the three types of WIS Centres forming the core infrastructure of WIS:

- Global Information System Centres (GISCs),
- Data Collection or Production Centres (DCPCs),
- National Centres (NCs).

Refer to 4, Functions of WIS, for the distinct functions of the three types of WIS Centre (GISC, DCPC, NC).

2.1.2 Each Permanent Representative with WMO shall have the responsibility to authorize users of WIS. Authority to manage the process may be delegated.

2.2 Compliance with Required WIS Functions

WIS Centres shall maintain compliance with required WIS functions. The Manual on WIS serves as instruction on practices, procedures and specifications for WIS functions, supplemented by additional information concerning practices, procedures and specifications for WIS functions set out in the Guide to WIS (WMO-No. 1061).

2.3 Interaction among WIS Centres

GISCs shall connect to other GISCs by the WIS Core Network, based on the Main Telecommunication Network (MTN). Data, products and metadata shall flow to a GISC from DCPCs and from NCs within its area of responsibility. An Area Meteorological Data Communication Network (AMDCN) shall connect each GISC to DCPCs and NCs in its area of responsibility. An AMDCN may span multiple Regional Meteorological Telecommunication Networks (RMTNs) and parts of RMTNs.

2.4 Implementation of WIS

WIS shall be implemented in two parallel parts. One part of WIS is the continued evolution of the WMO Global Telecommunication System (GTS). This focuses on further improving the delivery of time-critical and mission-critical data, products, and services including warnings. The other part of WIS extends WMO services through Discovery, Access and Retrieval (DAR) facilities, as well as flexible timely delivery.

2.5 Discovery, Access and Retrieval Function

As required per WMO-No. 49, Vol. I, A.3, WIS shall be based on catalogues that contain metadata

describing data and products available across WMO, plus metadata describing dissemination and access options. The Discovery, Access and Retrieval (DAR) function of WIS shall be the primary realization of the WIS comprehensive catalogue, maintained collaboratively by all WIS Centres.

2.6 Robustness and Reliability of Components

High robustness and reliability of WIS components are essential to the operation of WIS. Indicators of performance shall be evaluated in the designation procedure for WIS Centres. That evaluation shall include assurance that data content flowing via WIS network technologies fully satisfies requirements for security, authenticity, and reliability. Some aspects of service levels are identified within this Manual on WIS.

2.7 Collection and Dissemination Services

2.7.1 WIS shall provide three types of collection and dissemination services:

- Routine collection and dissemination service for time-critical and operation-critical data and products: This service is based on real-time "push" mechanism including multicast and broadcast; it should be implemented through dedicated telecommunication means providing a guaranteed quality of service.
- Discovery, Access and Retrieval (DAR) service: This service is based on request/reply "pull" mechanism with relevant data management functions; it is implemented through the Internet.
- Timely delivery service for data and products: This service is based on delayed mode "push" mechanism; it is implemented through a combination of dedicated telecommunication means and of public data telecommunication networks, especially the Internet.

2.7.2 WIS shall support the WMO virtual all-hazards network ensuring fast, secure and reliable exchange of alert and warning information, including ITU (International Telecommunication Union) Recommendation X.1303 (Common Alerting Protocol).

Note: The virtual all-hazards network encompasses all of the technical and operational arrangements necessary for the timely handling and delivery of alert and warning information involving WMO.

2.7.3 The goal of the WMO Integrated Global Data Dissemination Service (IGDDS) is to ensure the definition and operational implementation of an efficient circulation scheme of space-based observation data and products meeting the needs of WMO programmes, in the context of WIS. IGDDS shall remain an important component of WIS, mainly for the exchange and dissemination of data and products generated by space-based observing systems.

3. DESIGNATION PROCEDURES FOR WIS CENTRES

3.1 General

3.1.1 The establishment and operation of WIS depends on WMO Member and related organizations taking on the functional roles of GISCs, DCPCs and NCs. Procedures for designation as a WIS Centre rely on the agreed WIS Functional Architecture and the WIS Compliance Specifications.

3.1.2 As required per WMO-No. 49, Vol. I, A.3, Congress and Executive Council shall consider the designation of GISCs and DCPCs on recommendations of the Commission for Basic Systems (CBS). The development of the CBS recommendations includes consultation and coordination with the relevant technical commissions responsible for the WMO and related international programmes concerned and with regional associations as appropriate. Note: The relevant groups established by Executive Council have a role in the GISC and DCPCs designation process, in accordance with their mandate.

3.2 Procedure for a Global Information System Centre (GISC)

The procedure for the designation of a GISC shall consist of four steps:

(1) Statement of WIS Requirements,
(2) Service Offer by a Member for a Potential GISC,
(3) Demonstration of GISC Capabilities,

(4) Designation of a GISC.

3.2.1 Statement of WIS Requirements

The WMO technical commissions and other bodies representing the participating programmes, including regional bodies, shall state their requirements for WIS services and review them periodically. The list of all relevant requirements shall be compiled and regularly reviewed by the Commission for Basic Systems (CBS), and reported to Executive Council.

3.2.2 Service Offer by a Member for a Potential GISC

3.2.2.1 A WMO Member can apply for designation of a centre as one of the GISCs forming the core infrastructure of WIS. The service offer shall include:

- A statement of compliance with the required WIS functions,
- A proposal for the area of responsibility for WIS services, and
- A formal commitment by the PR of the Member that such services shall be provided on a routine basis and sustained over time.

3.2.2.2 The service offer shall be addressed to WMO. CBS, in consultation with the Regional Association(s) concerned; shall analyse the proposed service offer with regard to WIS requirements and compliance with GISC functions and specifications, and shall formulate a recommendation.

Demonstration of GISC Capabilities

3.2.3.1 The Member offering a GISC shall demonstrate to CBS the capabilities of the proposed centre to provide WIS services to the accredited users with the required reliability and quality. Compliance shall be demonstrated for: real-time functions of data and product collection and dissemination: non real-time services for requests: storage functions for the required set of data and products and relevant up-to-date metadata catalogues: coordination functions with other GISCs and the planning of mutual back-up services: adherence to WIS standards and relevant data exchange policies and access rights.

3.2.3.2 A formal commitment and time schedule to implement the GISC and to provide GISC services in accordance with the offer shall be given by the PR of the Member operating the candidate GISC.

3.2.3.3 Upon the demonstration of capabilities of the candidate GISC, CBS shall submit its recommendation on the GISC designation to the Congress or Executive Council.

3.2.4 Designation of a GISC

The list of GISCs as approved by Congress or Executive Council is included in Appendix C of this Manual on WIS.

3.3 Procedure for a Data Collection or Production Centre (DCPC)

3.3.1 WMO has determined that all WMO and related international programmes shall be served by WIS and therefore each established centre shall implement required WIS functions. CBS shall recommend how these centres are categorized as DCPCs within WIS.

3.3.2 The procedure for the designation of a DCPC shall consist of three steps:

(1) Service Offer by a Potential DCPC,
(2) Demonstration of DCPC Capabilities,
(3) Designation of a DCPC.

3.3.3 Service Offer by a Potential DCPC

3.3.3.1 Required DCPC functions should be undertaken by a centre that has been established under a WMO or related international programme, and/or a Regional Association. Accordingly, the relevant Technical Commission and/or Regional Association shall consider the service offers by Members for potential DCPCs, and shall endorse candidate DCPCs.

3.3.3.2 The service offer of a candidate DCPCs shall then be submitted to CBS. CBS shall analyse the

compliance to the required DCPC functions and specifications, and formulate a recommendation.

3.3.4 Demonstration of DCPC Capabilities

3.3.4.1 The Member offering a DCPC will be invited to demonstrate to CBS the capabilities of the proposed centre to provide WIS services in compliance with the DCPCs functions and responsibilities, including proper synchronization and communications with its associated GISC. Compliance shall be demonstrated, where applicable, for: real-time functions of data and product dissemination; non real-time services for requests: provision of relevant up-to-date metadata catalogues; coordination and synchronization functions with the associated GISC; adherence to WIS standards and relevant data exchange policies and access rights.

3.3.4.2 Upon acceptance of the demonstration of capabilities of the candidate DCPC, CBS shall submit its recommendation for the DCPC designation to the Congress or Executive Council.

3.3.5 Designation of a DCPC

The list of DCPCs as approved by Congress or Executive Council is included in Appendix C of this Manual on WIS. Each DCPC entry includes the name of the associated GISC.

3.4 Procedure for a National Centre (NC)

3.4.1 As required per WMO No. 49, Vol. I, A.3, each NC shall use WIS to provide data and products, in accord with its programme responsibilities. These shall be provided with associated metadata, in accordance with WIS practices, procedures and specifications. Each NC shall participate as appropriate in the relevant monitoring of the performance of WIS.

3.4.2 Each WMO Member shall notify WMO of the current name and location of each of its centres to be designated as an NC. CBS, with involvement of relevant regional associations and with the assistance of the WMO Secretariat, shall review the Member designations, to ensure support of each NC by a GISC, DCPC, or other NC. The NCs designated by Members shall be included in the list of WIS Centres in Appendix C of this Manual on WIS. Each NC entry includes the name of the associated GISC.

4. FUNCTIONS OF WIS

4.1 Roles in and Review of WIS Functions

An ongoing process for understanding user requirements, including quality of service, shall determine the functional scope and physical sizing of WIS, thereby to ensure that WIS continues to be responsive to the current and future needs of the supported programmes. All supported programmes and technical commissions shall participate in this process, which shall be part of general WMO requirements reviews.

4.2 List of WIS Functions

4.2.1 WIS Centres collectively support the major WIS functions listed here:

1 Collect Observations, Generate Products, Create Metadata and Archive Information
2 Assign User Role
3 Maintain and Expose Catalogue of Services and Information
4 Authorise Access to Information by Users
5 Deliver Information to Users (Internal and External)
6 Manage System Performance

Note: WIS is concerned with data management and telecommunications aspects but the actual content of data and products is out of scope for WIS itself. Such content is a matter for the specific programme supported.

4.2.2 The required standard interfaces to these functions are described in the WIS Technical Specifications (section 5 in this Manual on WIS).

4.3 Functional Architecture of WIS

Note: Guide to WIS 4.3 references the Functional Architecture of WIS, provided as supplementary guidance for WIS Centres in a technical document.

4.4 Data Flow among WIS Functions

Note: Guide to WIS 4.4 provides, as supplementary guidance for WIS Centres, a data flow model of the WIS functional architecture for the required WIS functions, illustrating a possible implementation of major WIS functions.

4.5 Functional Requirements of a GISC

4.5.1 General

Note: The phrase "information intended for global exchange" encompasses time-critical and operation-critical information (data and products). This includes "essential data" and part of the "additional data", as specified in WMO Resolution 25 (Cg-XIII) and Resolution 40 (Cg-XII).

4.5.2 Receive Information from GISC Area

4.5.2.1 Each GISC shall receive information intended for global exchange from NCs and DCPCs within its area of responsibility. This requirement also intersects the WIS Discovery Access and Retrieval (DAR) requirement, noted here following.

4.5.2.2 See also sections 5.2, WIS-TechSpec-1 (Uploading of Metadata for Data and Products), and 5.3, WIS-TechSpec-2 (Uploading of Data and Products).

4.5.3 Exchange Information with Other GISCs

4.5.3.1 Each GISC shall exchange information intended for global exchange with other GISCs. Each GISC shall collect such information from its area and exchange with other GISCs so that each GISC has such information from all GISCs.

4.5.3.2 GISCs should employ the MTN and associated collaborative mechanisms to achieve the exchange efficiently, and without detriment to the performance of any GISC.

4.5.3.3 See also section 5.4, WIS-TechSpec-3 (Centralization of Globally Distributed Data).

4.5.4 Disseminate Information to GISC Area

4.5.4.1 Each GISC shall disseminate information to NCs and DCPCs within its area of responsibility, including but not limited to the information intended for global exchange.

4.5.4.2 See also sections: 5.11, WIS-TechSpec-10 (Downloading Files via Dedicated Networks); 5.12, WIS-TechSpec-11 (Downloading Files via Non-dedicated Networks); 5.13, WIS-TechSpec-11 (Downloading Files via Other Methods).

4.5.5 Maintain 24 hour Cache

4.5.5.1 Each GISC shall hold the information intended for global exchange for at least 24 hours and make it available via WMO request/reply ("Pull") mechanisms. This requirement intersects the WIS Discovery Access and Retrieval (DAR) requirement, noted here following.

4.5.5.2 See also sections: 5.4, WIS-TechSpec-3 (Centralization of Globally Distributed Data); 5.5, WIS-TechSpec-4 (Maintenance of User Identification and Role Information); 5.6, WIS-TechSpec-5 (Consolidated View of Distributed Identification and Role Information).

4.5.6 Discovery Access and Retrieval

4.5.6.1 In support of the Discovery, Access and Retrieval (DAR) function, each GISC shall maintain and provide access to a comprehensive catalogue of information across all WMO programmes encompassed by WIS. This includes, but is not limited to, information intended for global exchange. To satisfy the DAR functional requirement, GISCs are required to support, in interactive and batch modes: upload, change and delete of metadata; user discovery of metadata; user access to metadata; and synchronization of the WIS comprehensive metadata catalogue with other GISCs.

4.5.6.2 See also sections 5.9, WIS-TechSpec-8 (DAR Catalogue Search and Retrieval), and 5.10, WIS-TechSpec-9 (Consolidated View of Distributed DAR Metadata Catalogues).

4.5.7 Data Network Connectivity of GISC

Each GISC shall provide around-the-clock connectivity to the public and dedicated communication networks at a capacity that is sufficient to meet its global and regional responsibilities. Each GISC should assure the appropriate level of availability and capacity for every telecommunications facility employed in support of WIS, to include as necessary routing and backup arrangements. Each GISC should maintain service level agreements with suppliers of its communication links and associated hardware.

4.5.8 Coordinate Telecommunications in GISC Area

Each GISC shall coordinate with the Centres within its area of responsibility a WIS telecommunications infrastructure that can meet the WIS requirements for information exchange within the area. In the case of particular global and/or regional agreements, a GISC could also support the exchange of agreed WIS time critical and operational critical information with other areas. The telecommunications infrastructure is implemented through various technologies and services (for example, Internet, satellite-based data distribution, dedicated data network) in accordance with capacity and reliability requirements.

4.5.9 Recovery Arrangements of a GISC

Each GISC shall implement and operate proper procedures and arrangements to provide swift recovery or backup of its essential services in the event of an outage. Each GISC shall maintain arrangements for its essential services to be taken up by another GISC in case of an incapacitating system failure. Each GISC should maintain arrangements for system back up in case of total site failure (for example, an offsite Disaster Recovery Centre) and for partial back up in cases otherwise affecting WIS functions within the GISC.

4.5.10 Performance Monitoring of a GISC

4.5.10.1 Each GISC shall participate in monitoring the performance of WIS, including monitoring the collection and distribution of data and products intended for global exchanges. Each GISC shall report routinely to other GISCs and to WMO Secretariat information concerning the status and performance of connectivity to WIS Centres in its area, including capacity as well as technology used (for example, Internet, satellite-based data distribution, dedicated data network). CBS shall review and report on the status and performance of GISCs with the assistance of the WMO Secretariat.

4.5.10.2 Monitoring of the collection and dissemination of WIS information (data and products) should include, as appropriate, Integrated World Weather Watch Monitoring and other programme-related monitoring.

4.5.10.3 See also sections 5.16, WIS-TechSpec-15 (Reporting of Quality of Service).

4.6 Functional Requirements of a DCPC

4.6.1 GENERAL

Note: The term information is used in a general sense and includes data and products.

The specific performance and functional requirements of a particular DCPC shall be determined by the programme it supports. DCPCs that support programmes with mission-critical responsibilities, and especially programmes with safety-of-life missions, shall maintain a high level of operational reliability, including required telecommunications. Each DCPC shall provide metadata describing the information it makes available through the WIS comprehensive catalogue, shall provide access to that information, and shall participate in monitoring the overall performance of WIS.

4.6.2 Collect Information from DCPC Area

4.6.2.1 As appropriate to its programme role, a DCPC shall collect information intended for dissemination to NCs within its area of responsibility (that is, regional collections).

4.6.2.2 See also sections 5.2, WIS-TechSpec-1 (Uploading of Metadata for Data and Products), and 5.3, WIS-TechSpec-2 (Uploading of Data and Products).

5.6.3 Collect Programme-Related Information

4.6.3.1 As appropriate to its programme role, a DCPC shall collect the specific programme-related data and products.

4.6.3.2 See also sections 5.2, WIS-TechSpec-1 (Uploading of Metadata for Data and Products), and 5.3, WIS-TechSpec-2 (Uploading of Data and Products).

4.6.4 Production Support of Programme-Related Information

4.6.4.1 As appropriate to its programme role, a DCPC shall provide data management and data communications adequate to support the production of regional or specialized data and products.

4.6.4.2 See also sections 5.2, WIS-TechSpec-1 (Uploading of Metadata for Data and Products), and 5.3, WIS-TechSpec-2 (Uploading of Data and Products).

4.6.5 Provide Information Intended for Global Exchange

4.6.5.1 As appropriate to its programme role, each DCPC shall provide information intended for global exchange to its responsible GISC.

4.6.5.2 See also sections 5.2, WIS-TechSpec-1 (Uploading of Metadata for Data and Products), and 5.3, WIS-TechSpec-2 (Uploading of Data and Products).

4.6.6 Disseminate Information

4.6.6.1 As appropriate to its programme role, each DCPC shall disseminate information other than information intended for global exchange.

4.6.6.2 See also sections: 5.11, WIS-TechSpec-10 (Downloading Files via Dedicated Networks); 5.12, WIS-TechSpec-11 (Downloading Files via Non-dedicated Networks); 5.13, WIS-TechSpec-11 (Downloading Files via Other Methods).

4.6.7 Provide Access to Information

4.6.7.1 Each DCPC shall support access to its products via WMO request/reply ("Pull") mechanisms in an appropriate manner.

4.6.7.2 See also sections: 5.5, WIS-TechSpec-4 (Maintenance of User Identification and Role Information); 5.7, WIS-TechSpec-6 (Authentication of a User); 5.8, WIS-TechSpec-7 (Authorization of a User Role).

4.6.8 Describe Information with Metadata

4.6.8.1 Each DCPC shall describe its data and products according to an agreed WMO metadata standard, provide access to this catalogue of data and products, and provide this metadata as appropriate to other centres, in particular a GISC.

4.6.8.2 See also sections: 5.9, WIS-TechSpec-8 (DAR Catalogue Search and Retrieval); 5.10, WIS-TechSpec-9 (Consolidated View of Distributed DAR Metadata Catalogues).

4.6.9 Recovery Arrangements of a DCPC

As appropriate to its programme role, each DCPC shall implement and operate proper procedures and arrangements to provide swift recovery or backup of their essential services in the event of an outage.

4.6.10 Performance Monitoring of a DCPC

4.6.10.1 Each DCPC shall participate in monitoring the performance of WIS.

4.6.10.2 See also sections 5.16, WIS-TechSpec-15 (Reporting of Quality of Service).

4.7 Functional Requirements of an NC

4.7.1 Provide Data, Products and Metadata

4.7.1.1 As required per WMO-No. 49, Vol. I, A.3, each NC shall use WIS to provide data and products, in accord with its programme responsibilities. These shall be provided with associated metadata, in accordance with WIS practices, procedures and specifications.

4.7.1.2 See also sections 5.2, WIS-TechSpec-1 (Uploading of Metadata for Data and Products), and 5.3, WIS-TechSpec-2 (Uploading of Data and Products).

4.7.2 Collect Programme-Related Information

4.7.2.1 As appropriate to its programme role, each NC shall collect programme-related data and products.

4.7.2.2 See also sections 5.2, WIS-TechSpec-1 (Uploading of Metadata for Data and Products), and 5.3, WIS-TechSpec-2 (Uploading of Data and Products).

4.7.3 Production Support of Programme-Related Information

4.7.3.1 As appropriate to its programme role, each NC shall provide data management and data communications adequate to support the production of data and products.

4.7.3.2 See also sections 5.2, WIS-TechSpec-1 (Uploading of Metadata for Data and Products), and 5.3, WIS-TechSpec-2 (Uploading of Data and Products).

4.7.4 Describe Information with Metadata

4.7.4.1 Each NC shall describe its data and products according to an agreed WMO standard and provide this information as appropriate to other centres.

4.7.4.2 See also sections: 5.9, WIS-TechSpec-8 (DAR Catalogue Search and Retrieval).

4.7.5 Performance Monitoring of an NC

4.7.5.1 As required per WMO No. 49, Vol. I, A.3, each NC shall participate in monitoring the performance of WIS.

4.7.5.2 See also sections 5.16, WIS-TechSpec-15 (Reporting of Quality of Service).

5. TECHNICAL SPECIFICATIONS OF WIS

5.1 General

5.1.1 Fifteen Technical Specifications (WIS-TechSpecs) define the interfaces to the major WIS functions. The specifications for these interfaces are named and numbered as follows:

1. Uploading of Metadata for Data and Products
2. Uploading of Data and Products
3. Centralization of Globally Distributed Data
4. Maintenance of User Identification and Role Information
5. Consolidated View of Distributed Identification and Role Information
6. Authentication of a User
7. Authorization of a User Role
8. DAR Catalogue Search and Retrieval
9. Consolidated View of Distributed DAR Metadata Catalogues
10. Downloading Files via Dedicated Networks
11. Downloading Files via Non-dedicated Networks
12. Downloading Files via Other Methods
13. Maintenance of Dissemination Metadata
14. Consolidated View of Distributed Dissemination Metadata Catalogues
15. Reporting of Quality of Service

5.1.2 NCs shall support seven of the 15 Technical Specifications, specifically: WIS-TechSpec-1, -2, -4, -10, -11, -12, and -15. An NC can arrange through bilateral agreements for another NC, a DCPC or a GISC to perform functions on its behalf.

5.1.3 According to the particular requirements of a DCPC in its programme role, DCPCs shall support up to 13 of the 15 Technical Specifications. DCPCs are not required to support WIS-TechSpec-3 and WIS-TechSpec-9.

5.1.4 WIS GISCs shall support all 15 Technical Specifications.

5.1.5 Any DCPC or NC is welcome to implement interfaces beyond the minimum required. Accordingly, the Technical Specification is mandatory wherever the interface is required to be applied.

5.1.6 The GTS file naming convention shall be used for files and the associated metadata record whenever it is necessary. The GTS file naming convention is documented in the Manual on GTS (WMO-No. 386), Vol. 1, Part II, Attachment II-15.

Note: Guide to WIS 5.1 references "WIS Compliance Specifications for GISCs, DCPCs, and NCs", provided as supplementary guidance for WIS Centres.

5.2 WIS-TechSpec-1: Uploading of Metadata for Data and Products

5.2.1 This specification requires that each metadata record uploaded shall be represented in compliance with the WMO Core Metadata Profile of ISO 19115 version 1.2, with a unique identifier. Note: Guide to WIS 5.2 references "Metadata Representation", which defines the WMO Core Metadata Profile.

5.2.2 Uploading shall use methods prescribed by the receiver, which is typically the host of a WIS DAR Metadata Catalogue.

5.2.3 DAR Metadata should be provided prior to the files or messages associated with the metadata.

5.2.4 For updating the DAR Metadata Catalogue, GISCs should support two kinds of maintenance facilities: a file upload facility for batch updating (add, replace, or delete metadata records treated as separate files); and an online form for changing metadata entries in the DAR Metadata Catalogue (add, change, or delete of elements in a record as well as whole records).

5.2.5 GISCs shall maintain the updated DAR Metadata Catalogue as a searchable resource (see WIS-TechSpec-8).

5.2.6 See also sections: 4.5.2 (Receive Information from GISC Area); 4.6.2 (Collect Information from DCPC Area); 4.6.3 (Collect Programme-Related Information); 4.6.4 (Produce Programme-Related Information).

5.3 WIS-TechSpec-2: Uploading of Data and Products

5.3.1 This specification requires that data or products uploaded shall be represented in the manner prescribed by the relevant programme, including where appropriate the Manual on GTS (WMO No. 386), Vol. 1, Part II, Attachment II-2, the Manual on Codes, and other WMO manual(s) and the GTS file naming convention as noted in 5.1.6.

5.3.2 Data and products should be handled as specified in the Manual on GTS, Vol. I, Part I, 1.3 Design principles of the GTS, and other WMO manual(s), specific to the relevant programme.

5.3.3 See also sections: 4.5.2 (Receive Information from GISC Area); 4.6.2 (Collect Information from DCPC Area); 4.6.3 (Collect Programme-Related Information); 4.6.4 (Produce Programme-Related Information).

5.4 WIS-TechSpec-3: Centralization of Globally Distributed Data

5.4.1 This specification requires that the Manual on GTS (WMO No. 386), Vol. 1, Part I, Attachment I-3 is applied as appropriate to the centralized copies of information intended for global exchange (described at 4.5.1).

5.4.2 Warnings shall be transmitted end-to-end within WIS within two minutes.

5.4.3 See also sections 4.5.3 (Exchange Information with Other GISCs), and 4.5.5 (Maintain 24 hour Cache).

5.5 WIS-TechSpec-4: Maintenance of User Identification and Role Information

5.5.1 User identification and role information shall be represented and communicated using methods prescribed by the receiver, which is typically the host of an identification and role information database.

Note: The term "user identification" in this context does not imply that a user is personally identifiable. Administrators of authentication and authorization at WIS Centres need to share updated identification and role information as a resource available across WIS Centres. Yet, it is necessary to prevent the inappropriate disclosure of any personally identifiable information.

5.5.2 User identification and role information maintenance should satisfy timeliness requirements of the application and host centre.

5.5.3 See also sections: 4.5.5 (Maintain 24 hour Cache), and 4.6.7 (Provide Access to Information).

5.6 WIS-TechSpec-5: Consolidated View of Distributed Identification and Role Information

5.6.1 This interface for a consolidated view of distributed identification and role information is not yet required. (see also Note at 5.5.1)

5.6.2 WIS Centres that do exchange identification and role information should do so using data encryption technologies.

5.6.3 See also sections: 4.5.5 (Maintain 24 hour Cache), and 4.6.7 (Provide Access to Information).

5.7 WIS-TechSpec-6: Authentication of a User

5.7.1 WIS Centres should employ authentication standards, which may include public key infrastructure techniques.
Note: Commercial, off-the-shelf authentication software based on industry and/or international standards should be preferred.

5.7.2 User authentication should satisfy application-specific and host centre processing constraints, and shall provide a quality of service that meets user requirements.

5.7.3 See also sections: 4.5.5 (Maintain 24 hour Cache), and 4.6.7 (Provide Access to Information).

5.8 WIS-TechSpec-7: Authorization of a User Role

5.8.1 WIS Centres should employ government-endorsed standards for user authorization software, techniques and procedures.

5.8.2 User authorization should satisfy application-specific and host centre processing constraints and shall provide a quality of service that meets user requirements.

5.8.3 See also sections: 4.5.5 (Maintain 24 hour Cache), and 4.6.7 (Provide Access to Information).

5.9 WIS-TechSpec-8: DAR Catalogue Search and Retrieval

5.9.1 This specification requires that each metadata catalogue host shall support the SRU (Search and Retrieve via URL) specification of the ISO 23950 Information Search and Retrieval Protocol. A WIS compliant SRU server shall support SRU version 1.1, the SRU searchRetrieve operation, the SRU Explain operation, the diagnostic schema for returning errors, and SRU Contextual Query Language (CQL) level 2.

5.9.2 In addition to full text search, a WIS compliant SRU server shall search: at least eight indexes as character strings (abstract, title, author, keywords, format, identifier, type, crs (Coordinate Reference System); at least five indexes as ordered dates (creationDate, modificationDate, publicationDate, beginningDate, endingDate); and the index "bounds" as geographic coordinates (decimal degrees, space delimited, in the order north, west, south, east).
Note: Guide to WIS 5.9 references the "WIS SRU Implementors Note".

5.9.3 The search service shall provide a quality of service that meets user requirements.

5.9.4 See also sections: 4.5.6 (Discovery Access and Retrieval), and 4.6.8 (Describe Information with Metadata).

5.10 WIS-TechSpec-9: Consolidated View of Distributed DAR Metadata Catalogues

5.10.1 GISCs should exchange metadata catalogue updates using version 2 of Open Archives Initiative - Protocol for Metadata Harvesting (OAI-PMH).

5.10.2 The exchange of metadata catalogue updates should satisfy that distributed instances of DAR Metadata do not diverge in content by more than one day. A mechanism for rapid update on an emergency basis should also be provided.

5.10.3 See also section 4.5.6 (Discovery Access and Retrieval).

5.11 WIS-TechSpec-10: Downloading Files via Dedicated Networks

5.11.1 This specification requires that data or products downloaded shall be represented in the manner prescribed by the relevant programme, including where appropriate the Manual on GTS (WMO-No. 386), Vol. 1, Part II, Attachment II-2 and other WMO manual(s) and the GTS file naming convention as noted in 5.1.6.

5.11.2 Data and products should be handled as specified in the Manual on GTS, Vol. I, Part I, 1.3 Design principles of the GTS, and other WMO manual(s), specific to the relevant programme.

5.11.3 See also sections: 4.5.4 (Disseminate Information to GISC Area), and 4.6.6 (Provide Information Intended for Global Exchange).

5.12 WIS-TechSpec-11: Downloading Files via Non-dedicated Networks

5.12.1 This specification requires that data or products downloaded shall be represented and communicated in a manner appropriate to the relevant programme.

5.12.2 Data and products should be handled as specified in the Manual on GTS, Vol. I, Part I, 1.3 Design principles of the GTS, and other WMO manual(s), specific to the relevant programme.

5.12.3 See also sections: 4.5.4 (Disseminate Information to GISC Area), and 4.6.6 (Provide Information Intended for Global Exchange).

5.13 WIS-TechSpec-12: Downloading Files via Other Methods

5.13.1 This specification requires that data or products downloaded shall be represented and communicated in a manner appropriate to the relevant programme.

5.13.2 Data and products should be handled as specified in the Manual on GTS, Vol. I, Part I, 1.3 Design principles of the GTS, and other WMO manual(s), specific to the relevant programme.

5.13.3 See also sections: 4.5.4 (Disseminate Information to GISC Area), and 4.6.6 (Provide Information Intended for Global Exchange).

5.14 WIS-TechSpec-13: Maintenance of Dissemination Metadata

5.14.1 This specification requires that dissemination metadata (including subscription information such as accounts and delivery particulars) shall be represented and communicated as prescribed by the host of the database of dissemination metadata.

5.14.2 Requests for changes to dissemination for information not part of the routine global exchange may be subject to the notification period for changes specified in GTS. Otherwise, changes to dissemination should apply within one day.

5.14.3 See also sections: 4.5.6 (Discovery Access and Retrieval), and 4.6.6 (Provide Information Intended for Global Exchange).

5.15 WIS-TechSpec-14: Consolidated View of Distributed Dissemination Metadata Catalogues

5.15.1 This interface is not yet required. This interface may be needed as part of a backup arrangement between centres.

5.15.2 See also section 4.5.6 (Discovery Access and Retrieval).

5.16 WIS-TechSpec-15: Reporting of Quality of Service

5.16.1 This specification requires that the reporting of quality of service shall be represented and communicated as prescribed by the host of the centralized reporting database.

5.16.2 Reports should be sent on a schedule determined by the centralized reporting manager based on the needs of WIS Centres.

5.16.3 See also sections: 4.5.7 (Network Connectivity of GISC); 4.5.8 (Coordinate Telecommunications in GISC Area); 4.5.9 (Recovery Arrangements of GISC), 4.5.10 (Performance Monitoring of a GISC); 4.6.9 (Recovery Arrangements of a DCPC); 4.6.10 (Performance Monitoring of a DCPC).

APPENDIX A – LIST OF ABBREVIATIONS

Cg	World Meteorological Congress
CBS	Commission for Basic Systems
DAR	Discovery, Access and Retrieval
DCPC	Data Collection or Production Centre
GDPFS	Global Data Processing and Forecast System
GISC	Global Information System Centre
GOS	Global Observing Systems
GTS	Global Telecommunication System
IGDDS	Integrated Global Data Distribution Service
MTN	Main Telecommunication Network
NC	National Centre
NMC	National Meteorological Centre
WIS	WMO Information System
WMO	World Meteorological Organization

APPENDIX B – SELECTED WMO DOCUMENTS RELEVANT TO WIS

Policy Documents

WMO-No. 15 Basic Documents No. 1 (2007 edition)
WMO-No. 49 Technical Regulations:
Volume IGeneral Meteorological Standards and Recommended Practices
Volume II – Meteorological Services for Air Navigation
Volume III – Meteorological Services for Hydrology
Volume IV – Quality Management
WMO-No. 60 Agreements and Working Arrangements
WMO-No. 508 Resolutions of Congress and the Executive Council
Executive Council Reports

International exchange of data and products

WMO facilitates the free and unrestricted exchange of data and information, products and services in real- or near-real time on matters relating to safety and security of society, economic welfare and the protection of the environment.

WMO-No. 837 Exchanging Meteorological Data — Guidelines on Relationships in Commercial Meteorological Activities. WMO Policy and Practice.
Cg-XII Resolution 40—WMO policy and practice for the exchange of meteorological and related data and products including guidelines on the relationships in commercial meteorological activities.
Cg-XIII Resolution 25—Exchange of Hydrological Data and Products
Annex IV – Geneva Declaration of Thirteenth World Meteorological Congress

Manuals

WMO-No. 9 Weather reporting:
Volume A – Observing stations
Volume C1 – Catalogue of Meteorological Bulletins
Volume C2 – Transmission Programmes
Volume D – Information for Shipping
WMO-No. 306 Manual on Codes
WMO-No. 386 Manual on the Global Telecommunication System (GTS), Volumes I & II
WMO-No. 485 Manual on the Global Data Processing and Forecasting Systems (GDPFS), Parts 1, 2 & 3
WMO-No. 544 Manual on Global Observing Systems (GOS)

Guides

WMO-No. 8 Guide to meteorological instruments and methods of observation
WMO-No. 100 Guide to climatological practices
WMO-No. 134 Guide to agricultural meteorological practices
WMO-No. 168 Guide to hydrological practices
WMO-No. 305 Guide on the Global Data-processing System
WMO-No. 471 Guide to marine meteorological services
WMO-No. 488 Guide on the Global Observing System
WMO-No. 611 Guide to WMO Binary Code Form GRIB 1 – Technical Report No.17 – May 1994
*** Guide to WMO Table-Driven Code Forms: FM 94 BUFR and FM 95 CREX
*** Guide to FM 92 GRIB Edition 2
WMO-No. 636 Guide on the automation of data-processing centres
WMO-No. 702 Guide to wave analysis and forecasting

WMO-No. 731	Guide on meteorological observation and information distribution systems at aerodromes
WMO-No. 732	Guide to practices for meteorological offices serving aviation
WMO-No. 750	Guide to moored buoys and other ocean data acquisition systems
WMO-No. 788	Guide on World Weather Watch Data Management
WMO-No. 834	Guide to public weather services practices
GTS	Guide on Internet Practices
GTS	Guide on VPN via the Internet between GTS centres
GTS	Guide on the use of TCP/IP on the GTS
GTS	Guide on Provisional Arrangements for the use of IP Addresses over the GTS
GTS	Guide on IT Security

APPENDIX C – APPROVED WIS CENTRES

APPENDIX C.1 Global Information System Centres (GISCs)

(none listed at this time)

APPENDIX C.2 Data Collection or Production Centres (DCPCs)

(none listed at this time)

APPENDIX C.3 National Centres (NCs)

(none listed at this time)

Recommendation 7 (CBS-Ext.(10))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM* (WMO-NO. 485)

THE COMMISSION FOR BASIC SYSTEMS,

Noting:

(1) The *Abridged Final Report with Resolutions of the Fifteenth World Meteorological Congress* (WMO-No. 1026),

(2) The *Abridged Final Report with Resolutions of the Sixty-second Session of the Executive Council* (WMO-No. 1059),

(3) The report of the meeting of the CBS Implementation Coordination Team of the Open Programme Area Group (OPAG) on Data-processing and Forecasting System (ICT-DPFS), (Tokyo, Japan, 13–17 September 2010),

(4) The *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485),

Considering the need:

(1) To review in the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485) the standardized verification system for long-range forecasts, in line with the establishment of regional climate centres (RCCs) and RCC-networks,

(2) To establish and include in the Manual new standardized procedures related to verification of both deterministic numerical weather prediction (NWP) and ensemble prediction systems, including the designation of a Lead Centre for Deterministic NWP Verification,

(3) To establish and include in the Manual a new designation of a centre for backtracking, and new procedures related to the Emergency Response Activities,

(4) To include in the Manual a new procedure related to the designation of RCCs and RCC-networks for climate sensitive areas that fall within the responsibilities of more than one regional association, for example, polar regions,

(5) To review in the Manual on GDPFS the sections related to exchange of products between centres, in line with the establishment and development of the WMO Information System,

Recommends that the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485), Volume I – Global Aspects, be amended as given in the annexes to the present recommendation, with effect from 1 June 2011;

Requests the Secretary-General to make the amendments, as given in the annexes to the present recommendation, to the *Manual on the Global Data-processing and Forecasting System*;

Authorizes the president of the Commission, in consultation with the Secretary-General, to make any consequent purely editorial amendments to the *Manual on the Global Data-processing and Forecasting System*.

Annex 1 to Recommendation 7 (CBS-Ext.(10))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM* (WMO-NO. 485)

The proposed amendment to the Manual on the GDPFS, Volume I, relates to the review of the standardized verification system for Long-range Forecasts (LRF), in line with the establishment of RCCs and RCC-Networks: amendments to Part II, Attachment II.8.

PROPOSED AMENDMENTS TO THE MANUAL ON THE GDPFS RELATED TO LONG-RANGE FORECASTS, VOLUME I, (WMO-No. 485)

Part II: Attachment II.8, Executive Summary shall be amended to read:
[…]

1.1 Diagnostics. The SVS includes ~~Information required incorporates~~ derived diagnostic measures and contingency tables. Estimates of the statistical significance of the scores achieved are also ~~required~~ included. Additional diagnostic measures are suggested but are not incorporated into the Core SVS as yet. ~~Use of the additional diagnostics is optional.~~

1.2 Parameters. Key variables and regions are proposed. However producers are not limited to these key parameters, thus all producers can contribute regardless of the structure of individual forecast systems. The parameters to be verified are defined on three levels. Levels 1 and 2 define the core SVS and are mandatory for GPCs.~~:~~

Level 1: Diagnostic measures aggregated over regions and for indices
Level 2: Diagnostic measures evaluated at individual grid-points
Level 3: Contingency tables provided for individual grid-points.

[…]

1.4 System details. Details of the individual forecast systems employed.

1.5 Exchange of verification information and the Lead Centres for SVSLRF

~~The~~ SVSLRF verification results generated by GPCs are made available through a web site maintained by the Lead Centre. The functions of the Lead Centre for SVSLRF include creating and maintaining ~~coordinated Web sites~~ a website for the LRF verification information so that potential users would benefit from a consistent presentation of the results. The address of the web site is http://www.bom.gov.au/wmo/lrfvs/.

2. Diagnostics

Three diagnostic measures are incorporated in the Core SVS - Relative Operating Characteristics, reliability diagrams and accompanying measure of sharpness, and Mean Square Skill Scores with associated decomposition. Estimates of the statistical significance in the diagnostic scores are also included in the Core SVS. The three diagnostics permit direct intercomparison of results across different predicted variables, geographical regions, forecast ranges, etc. They may be applied in verification of most forecasts and it is proposed that, except where inappropriate, all three diagnostics are used on all occasions by GPCs. Tabulated information at grid-point resolution is also ~~part of the core SVS~~ included but is not part of the core SVS. The tabulated information ~~will~~ may allow reconstruction of scores for user defined areas and calculation of other diagnostic measures such as economic value.
[…]

2.3 Mean Square Skill Score and decomposition. To be used in verification of deterministic forecasts. For Level 1, an overall bulk Mean Square Skill Score (MSSS) value is required and will provide a comparison of forecast performance relative to “forecasts” of climatology. The three terms of the MSSS decomposition provide valuable information on phase errors (through forecast/observation correlation), amplitude errors (through the ratio of the forecast to observed variances) and overall bias. For Level 2, quantities pertaining to the three decomposition terms should be provided. Additional terms relating to MSSS ~~are required as~~ form part of the Level 3 information.

2.4 Contingency tables. In addition to the derived diagnostic measures contingency table information provided at grid-points for both probability and categorical deterministic forecasts ~~form part of the core SVS. This information~~ constitutes Level 3 of the ~~exchange~~ SVSLRF and will allow RCCs and NMHSs (and in some cases end-users) to derive ROC, reliability, other probability based diagnostics and scores for categorical deterministic forecasts for user defined geographical areas.
[…]

3. Parameters

The key list of parameters in the ~~Core~~ SVS is provided below. Any verification for these key parameters should be assessed using the ~~Core~~ SVS techniques wherever possible. Many long-range forecasts are produced which do not include parameters in the key list (for example, there are numerous empirical systems that predict seasonal rainfall over part of/or over an entire, country). The ~~Core~~ SVS diagnostics should be used to assess these forecasts also, but full details of the predictions will need to be provided.

Forecast can be made using different levels of post-processing typically no-post-processing (raw or uncalibrated), simple correction of systematic errors (calibrated, i.e. calibration of mean and of variance) and more complex correction using hindcast skill (recalibrated, e.g. Model Output Statistics or perfect ~~prog~~ model approaches). ~~Most centres are currently issuing forecasts resulting from a simple calibration and so for sake of comparison on the Lead Centre web site scores for forecasts that were raw or calibrated (as specified in respective skill score section) are to be submitted. At the moment the team prefer to exclude forecast that were recalibrated, but GPCs are encouraged to apply the SVSLRF methodology and to display the results on their recalibrated forecasts on their web site.~~ Forecast producers should conduct verification on the forecast output provided to users (e.g. on the final product after application of post-processing). GPCs should

provide verification on the final GPC products (which may include post-processing) to the LC-SVSLRF. In this way forecast verification match the products which are made available by GPCs to RCC and NMHS.

3.1 Level 1: Diagrams and scores to be produced for regions

GPCs should supply ~~D~~diagrams (e.g. ROC and reliability curves) ~~are to be supplied~~ in digital format as specified on the Lead Centre for SVSLRF website.

3.1.1 Atmospheric parameters. Predictions for:

T2m (Screen Temperature) anomalies with standard regions (for GPCs):
[…]

Precipitation anomalies with standard regions (for GPCs):
[…]

3.1.3 Scores to be used for deterministic forecasts
~~Mean Square Skill Score (~~MSSS~~)~~ with climatology as standard reference forecast.
[…]

3.2 Level 2: Grid point data for mapping

3.2.1 Grid point verification data to be produced for each of the following variables. Verification should be provided on a 2.5°x2.5° grid.
T2m (Screen Temperature)~~T2m~~
Precipitation
SST (Sea Surface Temperature)

3.2.2 Verification parameters to be produced for deterministic verification
The necessary parameters for reconstructing the MSSS decomposition, the number of forecast/observation pairs, the MSE of the forecasts and of climatology and the MSSS are all part of the ~~core~~ SVS. Significance estimates for the correlation, variance, bias, MSE and MSSS terms should also be supplied.
[…]

3.4.1 Indices to be verified
Verification of Niño3.4 region SST anomalies is mandatory for GPCs. Other indices may ~~be added in due course~~ also be provided.

~~**4. Staged implementation**~~

~~In order to ease implementation, producers may stage the provision of the elements of the Core SVS according to the following recommendation.~~

~~a) Verification at levels 1 and 2 in the first year of implementation~~
~~b) Verification at level 3 by the middle of the year following implementation of levels 1 and 2~~
~~c) Level of significance by the end of the year following implementation of levels 1 and 2.~~

Part II: Attachment II.8, section 1 (Introduction) shall be amended to read:
The following sections present the detailed specifications for the development of a Standardised Verification System (SVS) for Long-Range Forecasts (LRF) within the framework of a WMO exchange of verification scores. The SVS for LRF described herein constitutes the basis for long-range forecast evaluation and validation, and for exchange of verification scores. It will evolve and grow as more requirements are adopted.

Part II: Attachment II.8, section 2 (Definitions), item 2.1 (Long-Range Forecasts) shall be amended to read:
[…]

Seasons have been ~~loosely~~ defined in the Northern Hemisphere as December-January-February (DJF) for winter (summer in the Southern Hemisphere), March-April-May (MAM) for spring (Fall in the Southern Hemisphere), June-July-August (JJA) for summer (winter in the Southern Hemisphere) and September-October-November (SON) for Fall (spring in the Southern Hemisphere). Twelve rolling seasons are also defined e.g. MAM, AMJ, MJJ. In the Tropical areas, seasons may have different definitions. Outlooks over longer periods such as multi-seasonal outlooks or tropical rainy season outlooks may be provided.
~~It is recognised that in some countries long-range forecasts are considered to be climate products.~~
This attachment is ~~mostly~~ largely concerned with the three-month or 90-day outlooks and the seasonal outlooks.

Part II: Attachment II.8, section 3 (SVS for Long-Range Forecasts) shall be amended to read:
Forecast can be made using different levels of post-processing typically no-post-processing (raw or uncalibrated), simple correction of systematic errors (calibrated, i.e. calibration of mean and of variance) and more complex correction using hindcast skill (recalibrated, e.g. Model Output Statistics or perfect ~~programme~~ prognosis approaches). Forecast producers should conduct verification on the forecast output provided to users (e.g. on the final product after application of post-processing). GPCs should provide verification on the final GPC products (which may include post-processing) to the LC-SVSLRF. ~~Most centres are currently issuing forecasts resulting from a simple calibration and so for sake of comparison on the Lead Centre web site scores for forecasts that were raw or calibrated (as specified in respective skill score section) are to be submitted. At the moment the team prefer to exclude forecast that were recalibrated, but GPCs are encouraged to apply the SVSLRF methodology and to display the results on their recalibrated forecasts on their web site.~~

3.1 Parameters to be verified
Verification of the ~~The~~ following parameters is mandatory for GPCs~~are to be verified~~:
[…]

(c) ~~Sea Surface Temperature (~~SST~~)~~ anomaly
[…]

It is recommended that three levels of verification be done (with level 1 and 2 being mandatory for GPCs):
[…]

3.1.1 Aggregated verification (level 1)
Large scale verification statistics are required in order to evaluate the overall skill of the ~~models~~ LRFs and ultimately for assessing their improvements over time. These are bulk numbers calculated by aggregating verification scores over all grid points within large regions; they will not necessarily reflect skill for any sub-region. For GPCs, ~~This~~ aggregated verification for the following ~~is performed over three~~ regions is mandatory:
[…]

3.1.2 Grid point verification (level 2)
The grid point verification is recommended for a regionalised assessment of the skill of the model. The verification latitude/longitude grid is recommended as being 2.5° by 2.5°, with origin at 0°N, 0°E. GPCs~~Verification~~ should ~~be~~ suppl~~ied~~y grid point verification to the Lead Centre for visual rendering. The formats for supplying derived verification are specified on the Lead Centre website.
[…]

3.1.3 Contingency tables (level 3)

Level 1 (mandatory for GPCs)			
Parameters (minimum for GPCs)	**Verification regions (minimum for GPCs)**	**Deterministic forecasts**	**Probabilistic forecasts**
[…]			
Level 2 (mandatory for GPCs)			
Parameters	**Verification regions**	**Deterministic forecasts**	**Probabilistic forecasts**
[…]			
Level 3			
Parameters	**Verification regions**	**Deterministic forecasts**	**Probabilistic forecasts**
[…]			

3.1.4 Summary of the ~~Core~~ SVS

The following gives a summary of parameters, validation regions and diagnostics that form the ~~core~~ SVS. The required periods, lead-times and stratification against the state of ENSO are given in section 3.2.

The number of realisations of LRF is far smaller than in the case of short term numerical weather prediction forecasts. Consequently it is essential as part of the core SVS, to calculate and report error bars and level of significance (see section 3.3.5).

~~In order to ease implementation, participating LRF producers may stage the introduction of the core SVS by prioritizing implementation of verification at levels 1 and 2.~~

~~Other parameters and indices to be verified as well as other verification scores can be added to the core SVS in future versions.~~

In order to handle spatial forecasts, predictions for each point within the verification grid should be treated as having an individual forecasts but with all results combined into the final outcome. The same approach is applied when verification is done at stations. Categorical forecast verification can be performed for each category separately.

Similarly, all forecasts are treated as independent and combined together into the final outcome, when verification is done over a long period of time (~~several~~ 10 or more years, for example).

Stratification of the verification data is based on forecast period, lead time and verification area. Stratification by forecast period should, for T2m and precipitation, be by 4 conventional seasons for Level 1. For Levels 2 and ~~&~~3 stratification should be on 12 rolling seasons (section 2.1) if available, otherwise 4 conventional seasons should be used. Verification results for different seasons should not be mixed. ~~Stratification by lead-time should include a minimum of two leadtimes, with lead-time not greater than 4 months~~Verification should be provided for all periods and lead times for which forecasts are supplied. ~~Forecasts with different lead times are similarly to be verified separately.~~ Stratification according to the state of ENSO (where there are sufficient cases) should be as follows:

[…]

3.3 Verification scores

~~The following verification scores are to be~~The MSSS and ROC verification skill scores are to be used.~~:~~

~~1) Mean Square Skill Score (MSSS)~~

~~2) Relative Operating Characteristics (ROC).~~

[…]

⇒ MSSS, provided as a single bulk number, is mandatory for level 1 verification in the core SVS. MSSS together with its three term decomposition are also mandatory for level 2 verification in the core SVS. ~~For the exchange of scores via the Lead Centre web site the MSSS and its decomposition term should be calculated using the raw forecasts and preferably not the calibrated ones.~~

3.3.2 Contingency tables and scores for categorical deterministic forecasts

For two- or three-category deterministic forecasts the ~~core~~ SVSLRF includes full contingency tables, because it is recognized that they constitute the most informative way to evaluate the performance of the forecasts. These contingency tables then form the basis for several skill scores that are useful for comparisons between different deterministic categorical forecast sets (Gerrity, 1992) and between deterministic and probabilistic categorical forecast sets (Hanssen and Kuipers, 1965) respectively.

The contingency tables may cover all ~~should be provided for every~~ combinations of parameters, lead times, target months or seasons, and ENSO stratification (when appropriate) at every verification point for both the forecasts and (when appropriate) damped persistence. […]

~~Contingency tables such as the one in Table 3 are mandatory for level 3 verification in the core SVS.~~

[…]

⇒ Contingency tables for deterministic categorical forecasts (such as in Table 3) form part of ~~are mandatory for~~ level 3 verification in the ~~core~~ SVS. These contingency tables can provide the basis for the calculation of several scores and indices such as the Gerrity Skill Score, the LEPSCAT or the scaled Hanssen and Kuipers score and others.

3.3.3 ROC for probabilistic forecasts

[…]

~~Hit rate (~~HR~~)~~ and false alarm rate ~~(~~FAR~~)~~ are calculated for each probability threshold Pn, giving N points on a graph of HR (vertical axis) against FAR (horizontal axis) to form the Relative Operating Characteristics (ROC) curve. This curve, by definition, must pass through the points (0,0) and (1,1) (for events being predicted only with >100% probabilities (never occurs) and for all probabilities exceeding 0% respectively). No-skill forecasts are indicated by a diagonal line (where HR=FAR); the further the curve lies towards the upper left-hand corner (where HR=1 and FAR=0) the better

[…]

⇒ Contingency tables for probabilistic forecasts (such as in Tables 5 and 6) form part of ~~are mandatory for~~ level 3 verification in the ~~core~~ SVS. For GPCs ROC curves and ROC areas are mandatory for level 1 verification in the core SVS while ROC areas only are mandatory for level 2 verification in the core SVS.

3.4 Hindcasts

In contrast to short- and medium-range dynamical Numerical Weather Prediction (NWP) forecasts, LRF are produced relatively few times a year (for example, one forecast for each season or one forecast for the following 90-day period, issued every month). Therefore the verification sampling for LRF may be limited, possibly to the point where the validity and significance of the verification results may be questionable. Providing verification for a few seasons or even over a few years only may be misleading and may not give a fair assessment of the skill of any LRF system. LRF systems should be verified over as long a period as possible in hindcast mode. Although there are limitations on the availability of verification data sets and in spite of the fact that validating numerical forecast systems in hindcast mode requires large computer resources, the hindcast period should be as long as possible. The recommended period for the exchange of scores is ~~advertised~~ provided on the Lead Centre web site (http://www.bom.gov.au/wmo/lrfvs/).

[…]

⇒ Verification results over the hindcast period are mandatory for the exchange of LRF verification scores. Producing centres have to send new hindcast verification results ~~as soon as~~ when their forecast system is changed.

3.5 Real-time monitoring of forecasts

It is recommended that there be regular monitoring of the real time ~~long range forecasts~~ LRFs. It is acknowledged that this real-time monitoring is neither as rigorous nor as sophisticated as the hindcast verification; nevertheless it is necessary for forecast production and dissemination. It is also acknowledged that the sample size for this real-time monitoring may be too small to assess the overall skill of the models. However, it is recommended that the forecast and the observed verification for the previous forecast period be presented in visual format to the extent possible given the restrictions on availability of verification data.

Real-time monitoring of forecast performance is an activity for the GPCs rather than the ~~Lead Centre~~LC-SVSLRF. GPCs are free to choose the format and content of real-time monitoring information.

Part II: Attachment II.8, section 4 (Verification data sets) shall be amended to read:

The same data should be used to generate both climatology and verification data sets, although the forecast issuing Centres/Institutes own analyses or reanalyses and subsequent operational analyses may be used when ~~other data are not available~~ these are locally preferred.

Many LRFs are produced that are applicable to limited or local areas. It may not be possible to use the data in either the recommended climatology or verification data sets for validation or verification purposes in these cases. Appropriate data sets should then be used with full details provided.

[…]

Part II: Attachment II.8, section 5 (System Details) shall be amended to read:

Information must be provided on the system being verified. This information should include (but is not restricted to):

1. Whether the forecast system is numerical, empirical or hybrid.
2. Whether the system forecasts ~~is~~ are deterministic or probabilistic
3. Model type and resolution.
4. Ensemble size (if applicable).

[…]

Part II: Attachment II.8, section 6 (Lead Centres for SVSLRF) shall be amended to read:

6. EXCHANGE OF VERIFICATION INFORMATION AND THE LEAD CENTRES FOR SVSLRF

The WMO Fourteenth Congress endorsed the designation by CBS (Ext. 02) of WMC Melbourne and the Canadian Meteorological Centre Montreal as Co-Lead Centres for verification of long-range and ~~SI forecast activities Congress~~ forecasts. The co-lead centre functions include creating and maintaining coordinated Web sites for the display of GPC LRF verification information, so that potential users would benefit from a consistent presentation of the results. The goal is to help the RCCs and NMHSs to have a tool for improving the long-range forecasts delivered to the public. Congress urged all Members to actively participate in that activity as either users or producers of LRF verification information to assure the use of the best available products.

6.1 Role of lead centre

6.1.1 Create, develop and maintain web-site (the "SVSLRF web site") to provide access to the GPC LRF verification information. The address of the web site is http://www.bom.gov.au/wmo/lrfvs/. The web-site will:

(i) Provide access to standardized software for calculating scoring information (ROC curves, areas, contingency table scores, hit rates, …).

(ii) provide consistent graphical displays of the verification results from ~~participating centres~~ GPCs through processing of digital versions of the results;

(iii) contain relevant documentation and links to the web sites of global-scale producing centres (GPCs);
[…]

Annex 2 to Recommendation 7 (CBS-Ext.(10))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM* (WMO-NO. 485)

The proposed amendments to the Manual on the GDPFS, Volume I, relate to the establishment of new standardized procedures related to verification of both deterministic NWP and EPS. These proposed amendments include:

- Standardized verification of deterministic NWP products: amendments to Part II, Attachment II.7, Table F;
- EPS verification requirements: amendments to Part II, Attachment II.7, Table F;
- Lead Centre for Deterministic NWP Verification (LC-DNV): Part II, new Attachment II.14.

PROPOSED AMENDMENTS TO THE MANUAL ON THE GDPFS RELATED TO STANDARDIZED PROCEDURES RELATED TO VERIFICATION OF BOTH DETERMINISTIC NWP AND EPS, VOLUME I, (WMO-No. 485)

Part II: Attachment II.7, Table F, sections I (Verification Against Analysis) and II (Verification Against Observations) shall be replaced by a single new section I (Standardized Verification of Deterministic NWP Products), with the existing formula; and rename section III (Standard Verification Measures of EPS) as section II. The new section I shall read as follows:

I – STANDARDIZED VERIFICATION OF DETERMINISTIC NWP PRODUCTS

1. Introduction

This section presents detailed procedures for the production and exchange of a standard set of verification scores for deterministic NWP forecasts produced by GDPFS centres. The goal is to provide consistent verification information on the NWP products of GDPFS participating centres for forecasters in the NMHSs and to help the GDPFS Centres compare and improve their forecasts. Scores will be exchanged between the participating producing centres via the Lead Centre for DNV. The Lead Centre functions, as described in Attachment II.14, include creating and maintaining a website for Deterministic NWP verification information, so that potential users will benefit from a consistent presentation of the results.

The term "deterministic NWP" refers to single integrations of NWP models providing products defining single future states of the atmosphere (as distinct from ensemble prediction systems where multiple integrations provide a range of future states).

The standardized verification should provide key relevant information appropriate to the state-of-the-art in NWP, while being as simple and as easy to implement as possible, and ensuring a consistent implementation across participating centres, in particular in the interpolation to verification grid, and use of a common climatology and set of observations.

2. Verification statistics

The following subsections define two sets of verification statistics. A minimum mandatory set shall be provided by all participating centres. A set of additional recommended statistics is also defined which all centres should provide if possible. The current specifications are for the verification of upper-air fields. The specifications will be expanded as recommended procedures for surface parameters are developed and in response to changing user requirements. The detailed procedures are required to ensure it is possible to compare results from the different participating centres in a scientifically valid manner.

3. Parameters

Extra-tropics

Mandatory
- Mean sea-level pressure
- Geopotential height at 850, 500 and 250 hPa
- Temperature at 850, 500 and 250 hPa
- Wind at 850, 500 and 250 hPa

Additional recommended
- Geopotential height, temperature, wind at 100 hPa
- Relative humidity at 700 hPa

Tropics

Mandatory
- Geopotential height at 850 and 250 hPa
- Temperature at 850 and 250 hPa
- Wind at 850 and 250 hPa

Additional recommended
- Relative humidity at 700 hPa

4. Forecast times

Scores shall be computed daily for forecasts initialised at 00 UTC and 12 UTC separately. For those centres not running forecasts from either 00 UTC or 12 UTC, scores may be provided for forecasts initiated at other times and must be labelled as such.

5. Forecast steps

Mandatory: forecast steps 24h, 48h, 72h, … 240h or end of forecast
Additional recommended: 12-hourly throughout forecast (12h, 24h, 36h, …)

6. Verification against analyses

6.1 Grid and interpolation

All parameters shall be verified against the centre's own analysis on a regular 1.5° x 1.5° grid.

In selecting the verification grid, consideration has been given to the variety of resolutions of current global NWP models, the resolved scales of models (several grid-lengths), the resolution of the available climatologies, the potential to monitor long-term trends in performance (including earlier, lower resolution forecasts) and computational efficiency.

Interpolation of higher resolution model fields to the verification grid shall be performed to retain features at the scale of the verification grid but not to introduce any additional smoothing. The following procedures shall be used:

– Spectral fields: truncate to equivalent spectral resolution (T120) for verification grid
– Grid point fields: use area-weighting to interpolate to verification grid

For scores requiring a climatology the climatology is made available via the LC-DNV website on the verification grid and needs no further interpolation.

6.2 Areas

Northern hemisphere extra-tropics	90°N - 20°N, inclusive, all longitudes
Southern hemisphere extra-tropics	90°S - 20°S, inclusive, all longitudes
Tropics	20°N - 20°S, inclusive, all longitudes
North America	25°N–60°N 50°W–145°W
Europe/North Africa	25°N–70°N 10°W–28°E
Asia	25°N–65°N 60°E–145°E
Australia/New Zealand	10°S–55°S 90°E–180°E

7. Verification against observations

7.1 Observations

All parameters shall be verified against a common set of radiosondes. The list of radiosonde observations for each area is updated annually by the CBS Lead Centre for radiosonde monitoring. The chosen stations' data must be available to all the centres and be of sufficient quality on a regular basis. Consultation with all centres (usually by electronic mail) is desirable before establishing the final list. The current list is available via the website of the LC-DNV. The LC-DNV will contact all participating centres when the new list is available and inform them of the date from which the new list shall be used.

The observations used for verification shall be screened to exclude those with large errors. In order to do this, it is recommended that centres exclude values rejected by their objective analysis. Moreover, centres which apply a correction to the observations received on the GTS to remove biases (e.g. radiation correction), should use the corrected observations to compute verification statistics.

7.2 Interpolation

Verification shall be made using the nearest native model grid point to the observation location.

7.3 Areas

The seven networks used in verification against radiosondes consist of radiosonde stations located in the following geographical areas:

Northern hemisphere extra-tropics	90°N - 20°N, inclusive, all longitudes
Southern hemisphere extra-tropics	90°S - 20°S, inclusive, all longitudes
Tropics	20°N - 20°S, inclusive, all longitudes
North America	25°N–60°N 50°W–145°W
Europe/North Africa	25°N–70°N 10°W–28°E
Asia	25°N–65°N 60°E–145°E
Australia/New Zealand	10°S–55°S 90°E–180°E

The list of radiosonde stations to be used for each area is updated annually by the CBS Lead Centre for radiosonde monitoring (see subsection 7.1)

8. Scores

The following scores are to be calculated for all parameters against both analysis and observation.

Wind

Mandatory:
– rms vector wind error

Other parameters:

Mandatory
– Mean error
– Root mean square (rms) error
– Correlation coefficient between forecast and analysis anomalies (not required for obs)
– S1 score (for MSLP only)

Additional recommended
– mean absolute error
– rms forecast and analysis anomalies
– standard deviation of forecast and analysis fields

8.1 Score definitions

The following definitions should be used

Mean error $$M = \sum_{i=1}^{n} w_i (x_f - x_v)_i$$

Root mean square (rms) error $$rms = \sum_{i=1}^{n} w_i (x_f - x_v)_i^2$$

Correlation coefficient between ~~observed and~~ forecast and analysis anomalies ~~trends~~

$$r = \frac{\sum_{i=1}^{n} w_i (x_f - x_c - M_{f,c})_i (x_v - x_c - M_{v,c})_i}{\left(\sum_{i=1}^{n} w_i (x_f - x_c - M_{f,c})_i^2\right)^{1/2} \left(\sum_{i=1}^{n} w_i (x_v - x_c - M_{v,c})_i^2\right)^{1/2}}$$

rms vector wind error $$rms = \sum_{i=1}^{n} w_i (\vec{V}_f - \vec{V}_v)_i^2$$

mean absolute error $$MAE = \sum_{i=1}^{n} w_i \left| x_f - x_v \right|_i$$

rms anomaly $$rmsa = \sum_{i=1}^{n} w_i (x - x_c)_i^2$$

standard deviation of field $$sd = \sum_{i=1}^{n} w_i (x - M_x)_i^2$$ where $$M_x = \sum_{i=1}^{n} w_i x_i$$

S1 score $$S_1 = 100 \frac{\sum_{i=1}^{n} w_i (e_g)_i}{\sum_{i=1}^{n} w_i (G_L)_i}$$

where:

x_f = the forecast value of the parameter in question

x_v = the corresponding verifying value ~~(observed)~~

x_c = the climatological value of the parameter

n = the number of grid points or observations in the verification area

$M_{f,c}$ = the mean value over the verification area of the forecast ~~climate~~ anomalies from climate

$M_{v,c}$ = the mean value over the verification area of the analysed ~~climate~~ anomalies from climate

$\vec{V}_f$ = the forecast wind vector

$\vec{V}_v$ = the corresponding verifying value

$$e_g = \left\{ \left| \frac{\partial}{\partial x} \left(x_f - x_v \right) \right| + \left| \frac{\partial}{\partial y} \left(x_f - x_v \right) \right| \right\}$$

$$G_L = \max\left(\left| \frac{\partial x_f}{\partial x} \right|, \left| \frac{\partial x_v}{\partial x} \right| \right) + \max\left(\left| \frac{\partial x_f}{\partial y} \right|, \left| \frac{\partial x_v}{\partial y} \right| \right)$$

where the differentiation is approximated by differences ~~on a 2.5° x 2.5° latitude/longitude~~ computed on the verification grid.

The weights w_i applied at each grid point or observation location are defined as

Verification against analyses: $w_i = \cos\phi_i$, cosine of latitude at grid point i

Verification against observations: $w_i = 1/n$, all observations have equal weight

9. Exchange of scores

Each centre shall provide scores monthly to the LC-DNV. Details of the procedure and the required format for the data are provided on the website of the LC-DNV. All scores (daily or 12-hourly) for all forecasts verifying within a month shall be provided as soon as possible after the end of that month.

10. Climatology

To ensure consistency between results from different centres a common climatology shall be used for those scores requiring a climatology. All centres shall use the climatology provided via the LC-DNV website.

A daily climatology of upper-air parameters are available for both 00 UTC and 12 UTC. This provides an up-to-date estimate of climate characteristics for each day of the year, including climate mean, standard deviation and selected quantiles of the climate distribution. These latter statistics are required for the CBS standardized verification of EPS forecasts.

The data is made available in Grib format. Information on access to the data and further documentation are provided on the LC-DNV website.

11. Monthly and annual averaged scores

Where average scores are required over a defined period, the averaging shall be made using the following procedures:

Linear scores (mean error, mean absolute error) - mean
Non-linear score should be transformed to appropriate linear measure for averaging
mean of MSE;
Z-transform for correlation

For a defined period, the average shall be computed over all forecasts verifying during the period. Averages shall be computed separately for forecasts initiated at 00 UTC and 12 UTC and both sets of average values provided.

Annual averages of the daily scores are included in the yearly Technical Progress Report on the Global Data-processing System. These statistics are for the 24, 72 and 120 h forecast and include the rms vector wind error at 850 hPa (tropics area only) and 250 hPa (all areas) as well as the rms error of geopotential heights at 500 hPa (all the areas except for tropics). A table of the number of observations per month should also be part of the yearly report.

12. Confidence Intervals

Bootstrapping*. Will be done by LC-DNV if daily scores are provided.

Note*: Introduction:

Any verification score must be regarded as a sample estimate of the "true" value for an infinitely large verification dataset. There is therefore some uncertainty associated with the score's value, especially when the sample size is small or the data are not independent. Some estimate of uncertainty (i.e. confidence intervals) must be used to set bounds on the expected value of the verification score. This also helps to assess whether differences between competing forecast systems are statistically significant. Typically confidence intervals of 5% and 95% are used.

Suggested method to calculate the Confidence Intervals (CI):

Mathematical formulae are available for computing CIs for distributions which are binomial or normal. In general, most verification scores cannot be expected to satisfy these assumptions. Moreover, the verification samples are often spatially and temporally correlated, especially at longer forecast ranges. A non parametric method such as the block bootstrap method handles spatially or temporally correlated data.

As described in Candille et al.(2007), a bootstrap technique for computing CIs involves recomputing scores numerous times after randomly extracting samples from the data set and then replacing them, again randomly, from the original data set. The correlation between forecasts on subsequent days is accounted for by extracting and replacing blocks of samples from the data set, rather than individual samples. Based on a calculation of the autocorrelation between forecasts on subsequent days, it is concluded that blocks of 3 days may be used to calculate the 5% and 95% confidence intervals.

References:

– WMO/TD No. 1485 Recommendations for verification of QPF.
– G. Candille, C. Côté, P. L. Houtekamer, and G. Pellerin, 2007: Verification of an Ensemble Prediction System against Observations, Monthly Weather Review, Vol. 135, pp2688 2699

13. Documentation

Participating centres shall provide to the LC-DNV information on their implementation of the standardized verification system annually, shall confirm to the LC-DNV any changes to its implementation (including the annual change of station list, changes in additional statistics) and changes in their NWP model.

Part II: Attachment II.7, Table F, section III (Standard Verification Measures of EPS), renamed as section II, shall be amended to read:

[…]

Probabilities

Probabilistic scores (excluding the CRPS) are exchanged in the form of reliability tables. Details of the format of the exchange of verification data ~~reliability tables~~ are provided on the website of the Lead Centre for verification of EPS.

List of parameters

[…]

Observations for EPS verification should be based on the GCOS list of surface network (GSN). Verification of precipitation may alternatively be against a proxy analysis i.e. short range forecast from the control or high-resolution deterministic forecast, e.g. 12-36h forecast to avoid spin-up problems.

[…]

Scores

Brier Skill Score (with respect to climatology) (see definition below*)
Relative Operating Characteristic (ROC)
Relative economic value (C/L) diagrams
Reliability diagrams with frequency distribution
Continuous Rank Probability Score (CRPS)

NOTES: Annual and seasonal averages of the Brier Skill Score at 24, 72, 120, 168 and 240 hours for Z500 and T850 should be included in the yearly Technical Progress Report on the Global Data-processing and Forecasting System.

In the case of CRPS, centres are encouraged to submit this for both EPS and the deterministic (control and high-resolution) forecast as well - CRPS for deterministic forecast is equal to the mean absolute error.

In Part II, add new Attachment II.14 as follows:

ATTACHMENT II.14

FUNCTIONS OF LEAD CENTRE FOR DETERMINISTIC NWP VERIFICATION (LC-DNV)

The Lead Centre functions include creating and maintaining a website for Deterministic NWP verification information, so that potential users will benefit from a consistent presentation of the results. The goal is to provide verification information on the NWP products of GDPFS participating centres for forecasters in the NMHSs and help the GDPFS Centres improve their forecasts. Congress urged all Members to actively participate in that activity as either users or producers of Deterministic NWP verification information to assure the best use of the available products.

Note: * The "deterministic NWP" refers to single integrations of NWP models providing products defining single future states of the atmosphere (as distinct from ensemble prediction systems where multiple integrations provide a range of future states).

The purpose of the LC-DNV shall be to create, develop and maintain the website to provide access to the Deterministic NWP verification information. The choice of verification statistics, the content of the documentation, the information on interpretation and use of the verification data will be determined and revised by the CBS.

1. The LC-DNV shall:
   - (a) Provide the facility for the GDPFS participating Centres to automatically deposit their verification statistics in the agreed format, and give all participating Centres access to these verification statistics
   - (b) Maintain an archive of the verification statistics to allow the generation and display of trends in performance
   - (c) provide specifications defining the format of the data to be sent by the GDPFS participating Centres to the LC-DNV (specification to be defined in consultation with the CG-FV)
   - (d) Monitor the received verification statistics and consult with the relevant participating centre if data is missing or suspect
   - (e) Provide on its website access to the standard procedures required to perform the verification
   - (f) Provide access to standard data sets needed to perform the standard verification, including climatology and lists of observations and keep this up to date according to CBS recommendation
   - (g) Provide on its website
     - o consistent up-to-date graphical displays of the verification results from participating Centres through processing of the received statistics
     - o relevant documentation and links to the websites of GDPFS participating Centres;
     - o contact details to encourage feedback from NMHSs and other GDPFS Centres on the usefulness of the verification information
2. The LC-DNV may also:
   - (a) Provide access to standardized software for calculating scoring information.

Annex 3 to Recommendation 7 (CBS-Ext.(10))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM* (WMO-NO. 485)

The proposed amendments to the Manual on the GDPFS, Volume I, relate to the establishment of a new designation and new procedures related to the ERA. These proposed amendments include:

- Designation of RSMCs with activity specialization in the provision of atmospheric modelling (for environmental emergency response and/or backtracking): amendments to Part I, Appendix I-1;

- Data provision by RSMCs with activity specialization in the provision of atmospheric modelling (for environmental emergency response and/or backtracking): amendments to Part II, Appendix II-7.

PROPOSED AMENDMENTS TO THE MANUAL ON THE GDPFS RELATED TO EMERGENCY RESPONSE ACTIVITIES, VOLUME I, (WMO-No. 485)

Part I: Appendix I-1, section 3 (The RSMCs with activity specialization are the following:), add "RSMC Vienna (backtracking only)" to the list of RSMCs with activity specialization in the provision of atmospheric modelling (for environmental emergency response and/or backtracking), as follows:

3. The RSMCs with activity specialization are the following:
[…]

Provision of atmospheric transport modelling (for environmental emergency response and/or backtracking)

RSMC Beijing
RSMC Exeter
RSMC Melbourne
RSMC Montreal
RSMC Obninsk
RSMC Offenbach (backtracking only)
RSMC Tokyo
RSMC Toulouse
RSMC Vienna (backtracking only)
RSMC Washington

Part II: Appendix II-7, section 2 (Basic set of products) shall be amended to read:

2. Basic set of products

~~Five~~ Seven maps consisting of:

(a) Three-dimensional trajectories starting at 500, 1 500 and 3 000 m above the ground, with particle locations at six-hour intervals (main synoptic hours up to the end of the dispersion model forecast);

(b) Time-integrated airborne concentrations within the layer 500 m above the ground, in Bq s m–3 for each of the three forecast periods;

(c) Total deposition (wet + dry) in Bq m–2 from the release time to the end of each of the three forecast periods~~the dispersion model forecast~~.

Part II: Appendix II-7, section 5 (General rules for displaying results), paragraph 4 (Specific guidelines for concentration and deposition maps:), item (a) shall be amended to read:

5. General rules for displaying results
[…]
Specific guidelines for concentration and deposition maps:
(a) Adopt a maximum of four concentration/deposition contours corresponding to powers of 10 with minimum values not less than 10 20 Bq s m-3 for time-integrated airborne concentrations and not less than 10 20 Bq m-2 for total deposition;

Annex 4 to Recommendation 7 (CBS-Ext.(10))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM* (WMO-NO. 485)

The proposed amendment to the Manual on the GDPFS, Volume I, relates to the designation of Regional Climate Centres (RCCs) and RCC-Networks for climate sensitive areas that fall within the responsibilities of more than one Regional Association (e.g. Polar Regions): amendments to Part II, Appendix II-10.

PROPOSED AMENDMENTS TO THE MANUAL ON THE GDPFS RELATED TO THE DESIGNATION OF RCCs AND RCC-NETWORKS, VOLUME I, (WMO-No. 485)

Part II: Appendix II-10 (Designation and mandatory functions of Regional Climate Centres (RCCs) and RCC-Networks), insert a new paragraph after paragraph 1, and rename paragraphs 2 and 3 as paragraphs 3 and 4. The new paragraph shall read as follows:

2. WMO RCCs or WMO RCC-Networks might be established, by request of the Members of the Regional Associations concerned, for climate-sensitive areas whose boundaries extend beyond or are outside those of a singlethat fall within the responsibilities of more than one Regional Association (e.g. Polar Regions).

Annex 5 to Recommendation 7 (CBS-Ext.(10))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM* (WMO-NO. 485)

The proposed amendment to the Manual on the GDPFS, Volume I, relates to sections related to exchange of products between centres, in line with the establishment and development of the WMO Information System (WIS): amendments to Part II, section 5.

PROPOSED AMENDMENTS TO THE MANUAL ON THE GDPFS RELATED TO THE EXCHANGE OF PRODUCTS BETWEEN CENTRES, VOLUME I, (WMO-No. 485)

Part II: section 5 (Exchange of products between centres), in paragraph 5.1 (Times of availability of products), items 5.1.1 and 5.1.2 shall be merged and amended to read: (delete NOTE)

5.1.1 Processed data (products) required for real-time and non-real time purposes shall reach the national Meteorological Service sufficiently quickly to be of effective use in its associated timescale. Both observational and processed data shall therefore be handled rapidly by both the GDPFS and the WIS/GTS (see also paragraph 2.3.2). On the WIS/GTS, transmission of observational data shall have priority over the transmission of processed data.

Part II: section 5 (Exchange of products between centres), in paragraph 5.2 (Programmes of output products), shall be amended to read:

5.2.2 Members shall establish programmes of output products for general distribution by their WMCs and/or RSMCs, taking into account requirements of other Members and the WIS/GTS operational arrangements required ~~capability of the GTS~~ to handle and distribute these products.
[…]

5.2.3 In order to avoid overloading the WIS/GTS, Members should limit requests by their NMCs for products, taking into account the following considerations:
[…]

~~5.2.4 Globally specialized RSMCs should tailor their products to regions to meet regional requirements and, if possible, to limit their size to avoid overloading the GTS.~~

Part II: section 5 (Exchange of products between centres), in paragraph 5.3 (Transmission priorities for GDPFS products), insert new sub-paragraph 5.3.1 instead of a NOTE, and rename sub-paragraphs 5.3.1 to 5.3.11 accordingly. Paragraph 5.3 shall be amended to read:

5.3.1 Transmission priorities for GDPFS products~~NOTE: The priorities listed~~ described in this section are intended as guidance to GDPFS centres on providing observational data and output products to the WIS/GTS in the proper sequence. As regards the relay and distribution of information by WIS centres~~automated telecommunication centres~~, the provisions of the Manual on the Global Telecommunication System and the Manual on WIS apply.

5.3.21 Transmission priorities for global and regional model products ~~from WMCs and RSMCs~~ **(merge existing sub-paragraphs 5.3.1 and 5.3.2; delete NOTE)**
5.3.2 1.1 Priorities for the transmission of global model output products should be used when several such WMC and RSMC products are available at the same time. ~~NOTE: Transmission Priorities for global model output products are given in Attachment II.3. 5.3.2~~ Priorities for transmission of regional model products should be based on the requirements for interregional exchange of RSMC products~~ on the MTN and its branches~~.

5.3.3 Transmission priorities after transmission outages on the MTN and its branches **(merge items (a) and (b), and rename them as sub-paragraph 5.3.3.1; delete NOTES (1 and (2))**
~~(a)~~ In case of WIS centre or communication link failure, WIS/GTS provisions for backup apply. After transmission outages that have disrupted the normal information exchange, normal transmission schedules of observational data should be resumed no later than the first main standard time of observation following the cessation of the outage. ~~(b)~~ Procedures for the transmission of accumulated meteorological data should not interfere with the resumption of normal transmission schedules. If these data are redundant, they should not be transmitted.

5.3.4 Transmission priorities for global and regional model products ~~from WMCs and RSMCs~~ after outages **(merge existing sub-paragraphs 5.3.4 and 5.3.5; delete NOTE)**

5.3.4.1 Global and regional model products from RSMCs accumulated due to ~~circuit~~ communication link disruption should be transmitted with the least possible delay.

~~5.3.5 Transmission priorities for regional model products from RSMCs after outages~~

~~5.3.5.1 Regional model products from RSMCs accumulated due to circuit disruptions on the MTN and its branches should be transmitted with the least possible delay. 5.3.5.2~~ The regional

model products should have a higher priority than global model products for transmission after outages on the MTN and its branches.

5.3.56 Priority of observational data over processed data **(merge existing sub-paragraphs 5.3.6 and 5.3.7; delete existing sub-paragraphs 5.3.7.2 and 5.3.8, and NOTE)**

5.3.56.1 On the MTN and its branches, transmission of observational data shall have priority over the transmission of processed data (in both analogue and digital form). 5.3.7 Transmission of products in binary, alphanumeric and pictorial form 5.3.7.1 Until such time as all centres are in a position to convert output products in GRIB, GRID and/or BUFR GRID code form into pictorial form, Members should transmit certain of their WMC and RSMC products also in pictorial form in addition to alphanumeric and/or binary form.

NOTES:
(1) Members are encouraged to transmit processed information in the GRID, GRIB and/or BUFR GRIB code forms.
(2) A minimum list for transmission of products in binary, alphanumeric and pictorial form is given in Attachment II.6.
(23) As Members develop the capability at their RSMCs centres for transforming these products from GRID, GRIB and/or BUFR GRIB to pictorial form, the pictorial transmission will be discontinued, where appropriate.

5.3.79 Procedures and formats for the exchange of monitoring results
[…]

5.3.8 10 Standards in the provision of international services by Regional Specialized Meteorological Centres (RSMCs) for atmospheric modelling in radiological environmental emergency response

5.3.810.1 The designated RSMCs with activity specialization in the provision of international services for atmospheric transport modelling in radiological environmental emergency response shall implement agreed standard procedures and products. NOTE: Standards in the provision of international services by RSMCs for atmospheric transport modelling, for radiological environmental emergency response are, given in Appendix II-7.

5.3.911 Standards in the provision of international services by Regional Specialized Meteorological Centres (RSMCs) for atmospheric transport modelling in backtracking

5.3.9 11.1 The designated RSMCs with activity specialization in the provision of international services for atmospheric transport modelling in backtracking shall implement agreed standard procedures and products. NOTE: Standards in the provision of international services by RSMCs for CTBT Verification support are given in Manual on GDPFS, Appendix II-9.

Part II: section 5 (Exchange of products between centres), delete paragraph 5.4 (Responsibilities of Members for providing information on their real-time data-processing activities)

Recommendation 8 (CBS-Ext.(10))

TERMS OF REFERENCE OF THE COMMISSION FOR BASIC SYSTEMS

THE COMMISSION FOR BASIC SYSTEMS,

Noting:

(1) The *Abridged Final Report with Resolutions of the Fifteenth World Meteorological Congress* (WMO-No. 1026),

(2) The final reports of the 2009 Meeting of Presidents of Technical Commissions (Geneva, 2–4 February 2009) and 2010 Meeting of Presidents of Technical Commissions (Geneva, 28–30 January 2010),

(3) The *Abridged Final Report with Resolutions of the Sixty-second Session of the Executive Council* (WMO-No. 1059),

(4) The *WMO Strategic Plan* (WMO-No. 1028),

Considering the new preamble to be incorporated into the WMO General Regulations on the general Terms of Reference of technical commissions as proposed by the Executive Council,

Recognizing that the Terms of Reference of technical commissions should be aligned with the long-term priorities of the Organization, the WMO results-based management approach and overall Organization objectives and strategic thrusts,

Recommends that the Terms of Reference of the Commission for Basic Systems should be amended as provided in the annex to the present recommendation;

Requests the Secretary-General to bring this proposal to the attention of Sixteenth Congress for its consideration and inclusion in the WMO General Regulations.

Annex to Recommendation 8 (CBS-Ext.(10))

TERMS OF REFERENCE FOR THE COMMISSION FOR BASIC SYSTEMS

The Commission shall be responsible for matters relating to:

(a) Cooperation with Members, other technical commissions and relevant bodies in the development and operation of integrated systems for observing, data processing, forecasting, telecommunications and data management. These activities shall be in response to requirements and in support of all WMO Programmes, particularly contributing to disaster risk reduction, and taking advantage of opportunities provided by technological developments;

(b) The assessment of opportunities for, and the provision of, a common infrastructure to meet the requirements defined by technical commissions and regional associations, as well as by organizations with whom WMO has relations, taking into account new applications of meteorology, hydrology, oceanography and related environmental sciences;

(c) (i) Development and implementation of the Public Weather Services Programme, with particular attention to end-to-end service delivery;
(ii) Development and implementation of the WMO Space Programme;
(iii) Contribution to the Development and implementation of the Global Framework for Climate Services;

(d) The processing, storage and retrieval of basic data for meteorological and related purposes including, in particular, the organization of the Global Data-processing and Forecasting System of the World Weather Watch;

(e) The development and application of systems and techniques to meet user requirements including those of operational weather analysis and forecasting and of services for environmental emergency authorities;

(f) Observational systems, facilities and networks (land, sea, air and space) as decided by Members including, in particular, all technical aspects of the WMO Integrated Global Observing System, particularly the global observing systems;

(g) Telecommunication networks, radio-frequency allocation and facilities for operational, research and applications purposes including, in particular, the organization of the WMO Information System, including the Global Telecommunication System of the World Weather Watch;

(h) The development and application of operational procedures, schedules and arrangements for the exchange of and access to weather, climate and water information (data and products), including warnings, required by all WMO Programmes, in particular, through the WMO Information System;

(i) The development and application of data management principles and procedures including monitoring and evaluation of the common infrastructure, in particular, of the World Weather Watch.

Recommendation 9 (CBS-Ext.(10))

REVIEW OF RESOLUTIONS OF THE EXECUTIVE COUNCIL BASED ON PREVIOUS RECOMMENDATIONS OF THE COMMISSION FOR BASIC SYSTEMS OR CONCERNING THE COMMISSION

THE COMMISSION FOR BASIC SYSTEMS,

Noting with satisfaction the action taken by the Executive Council on the previous recommendations of the Commission for Basic Systems or concerning the Commission,

Considering that some of the previous Executive Council resolutions are still valid,

Recommends that the Executive Council resolutions to be kept in force are Resolutions 2 (EC-LVI), 3 (EC-LIX), 4 (EC-LXI), 6 (EC-LXI) (only Recommendations 1, (CBS-XIV) 4 (CBS-XIV) and 10 (CBS-XIV) to be kept in force), 12 (EC-LXII) and 14 (EC-LXII).

ANNEXES

ANNEX I
Annex to paragraph 4.2.3 of the general summary

STRATEGY FOR THE EVOLUTION AND FUTURE HOSTING OF THE WMO DATABASE OF OBSERVATIONAL USER REQUIREMENTS AND OBSERVING SYSTEM CAPABILITIES (RRR DATABASE)

1. INTRODUCTION

1.1 As part of the Rolling Review of Requirements (RRR), WMO is maintaining a database on user requirements and observing system capabilities (referred in this document as the RRR Database). Its primary aim is to address the extent to which in situ and space-based observing system capabilities meet user requirements for observations. The RRR database was originally designed in collaboration with the Committee on Earth Observation Satellites (CEOS) and is maintained on the WMO Website[5].

1.2 The RRR database consists of two main components that contain information on: (i) technology free user requirements broken down by application areas; and (ii) surface- and space-based observing system capabilities. Initially it included requirements from different international organizations or programmes including ICSU, IGBP, IOCCG, UNEP, UNOOSA, but the current updated version of the RRR database only focuses on requirements from WMO and WMO co-sponsored Programmes.

User requirements

1.3 User requirements are collected for various application areas addressing WMO Programmes and co-sponsored programmes. For each application area[6], and for each required variable[7], the user requirements part of the RRR database includes information on: (i) horizontal resolution; (ii) vertical resolution; (iii) observing cycle; (iv) timeliness; and (v) accuracy. For each of these criteria three values determined by experts are provided:

(a) The “threshold” which is the minimum requirement to be met to ensure that data are useful;
(b) The “goal” which is an ideal requirement above which further improvements are not necessary; and
(c) The “breakthrough” which is an intermediate level between “threshold” and “goal” which, if achieved, would result in a significant improvement for the targeted application.

Observing system capabilities

1.4 For each component observing system (both surface- and space-based) and for each measured variable available from specific regions, the observing system capability part includes the following information on actual instrument performances: (i) horizontal resolution; (ii) vertical resolution; (iii) observing cycle; (iv) timeliness; and (v) accuracy.

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[5] : http://www.wmo.int/pages/prog/sat/Databases.html

[6] : The following application areas are currently considered in the Rolling Review of Requirements: (1) Global Numerical Weather Prediction (NWP), (2) High Resolution NWP, (3) Synoptic Meteorology, (4) Nowcasting and Very Short Range Forecasting, (5) Seasonal to Inter-annual Forecasts, (6) Aeronautical Meteorology, (7) Atmospheric Chemistry, (8) Ocean Applications, (9) Agricultural Meteorology, (10) Hydrology, (11) Climate Monitoring (GCOS) in the atmospheric, oceanic and terrestrial domains, (12) Climate Applications (Other aspects addressed by the CCl), (13) Climate Research (WCRP). In addition WMO is now considering adding the following application areas: (1) Global terrestrial requirements that are not already addressed by GCOS (non-GCOS requirements of GTOS), and (ii) Space Weather.

[7] : The database currently addresses 112 variables. Work is underway – initially through the ET-SAT in consultation with CEOS for the satellite part – for standardizing the names and definitions of the variables

Using the RRR database

1.5 Assuming the database is up-to-date and reflects the most current user requirements and the state-of-the-art performance of surface- and space-based observing systems, the RRR database can be used for the following:

(a) Reference material on user requirements for designing observing systems for the WMO application areas;

(b) Reference material on current observing system components and on their actual performances;

(c) Critical review by comparing the performance of the instruments with the user requirements, and identification of gaps in conjunction with the use of other tools such as Observing System Experiments (OSE) and Observing System Simulation Experiments (OSSEs). The critical review is particularly useful for producing the Statements of Guidance (SoGs) for each of the application areas which provide for a gap analysis and specific recommendations and priorities to address those gaps. SoGs are used in turn as inputs to develop and update the Implementation Plan for the Evolution of the global observing systems (EGOS-IP).

Perspective of the CBS Management Group

1.6 At its eleventh session, Geneva, 17–19 March 2010, the CBS Management Group acknowledged the role of such a RRR database in the context of WIGOS. It highlighted the need for a properly resourced WMO database for user requirements and observing systems capabilities to allow for regular update and maintenance. It preferred a web-based database which could be interactively updated. The Group agreed that a sustainable strategy for developing and maintaining the requirements and capabilities must be identified. These two components of the RRR database which are core to the RRR process, underpin the work of ET-EGOS for the development and evolution of the GOS itself as well as WIGOS. The Management Group therefore tasked the ICT-IOS with developing a proposal for implementing and maintaining the RRR database for presentation at CBS-Ext.(10).

2. CURRENT STATUS

2.1 The content of the RRR database is maintained by the Secretariat based on input provided by the CBS Expert Team on Evolution of the global observing systems (ET-EGOS) through appropriate contact points, and the Expert Team on Satellite Systems (ET-SAT) as concerns satellite capabilities.

User requirements

2.2 The “Requirements” part of the RRR database is relatively simple and manageable. Focal points from each of the application areas considered as part of the RRR are regularly reviewing the database on user requirements and providing input to the ET-EGOS for its updating. It has been recently updated, it is accessible online, currently as an Excel workbook[8], and could incorporate further updates as well as new application areas. High attention is paid to the harmonization of variable names, definitions and units across the application areas in order to ensure that, when requirements are addressing similar geophysical variables, they are expressed in a comparable way.

[8] : http://www.wmo.int/pages/prog/sat/Requirements/Observational-requirements_web.xls

Observing system capabilities

2.3 The "Capabilities" part is more complex and its sustainability is an open issue in its present form. The so-called CEOS-WMO Database on Observing Capabilities has not been maintained since several years and is now outdated.

2.4 Up-to-date reference information on space-based capabilities is included in the WMO Dossier on the Space-based Component of the Global Observing System (GOS-2010)[9], which is available on line. The dossier is updated twice a year and includes the following parts:

(a) An introduction;
(b) Volume 1: Satellite programme description (the January 2010 issue of Volume 1 was also published as a WMO/TD-No.1513 / SP-7) ;
(c) Volume 2: Earth Observation satellites and their instruments;
(d) Volume 3: Gap Analysis in the space-based component of the GOS;
(e) Volume 4: Estimated performance of products from typical instruments; and
(f) Volume 5: Compliance analysis of potential product performance with user requirements.

Relevant information on space-based capabilities, although not quality-controlled by the WMO Secretariat, can also be found in:

(a) The CEOS Earth Observation Handbook[10], maintained by the European Space Agency (ESA) for the Committee on Earth Observation (CEOS), with interactive access; and
(b) The ESA Earth Observation portal[11].

Other relevant databases within the WMO Secretariat

2.5 The WMO Secretariat is currently developing a so called "Country Profile Database" to enhance the ability to follow the status of and development needs of the Members. The database will permit improved coordination, as well as the efficiencies for surveys and knowledge management across programmes and regions.

2.6 Two other databases are also planned to be developed as part of the WIGOS implementation process, i.e.: (i) a standardized database providing a single access point to all the WMO observational standards, guidelines, best practices, procedures, etc.; and (ii) a database describing all the observing systems components and respective networks contributing to WIGOS and providing end users with relevant metadata that are crucial for the WIGOS operation as well as for the WIS Data Discovery, Access and Retrieval (DAR) services.

2.7 Independently of the developments that would be undertaken on the RRR database, there is a possibility that all the databases maintained by the WMO Secretariat, including the observation user requirements database, be integrated into a single database managed by the Secretariat. This would require that appropriate resources for developing and operating the database, including in terms of staff, would be made available.

3. CHALLENGES

3.1 Maintaining and operating the RRR database remains a challenge for a number of reasons:

(a) **Collecting up-to-date information on user requirements**: Designated contact points for each programme area must be pro-active in seeking input within their communities and relay up-to-date information to the database through ET-EGOS. Some application areas are better reflecting the current user requirements than others. While ET-EGOS is routinely seeking input from the contact points, problems remain in some cases;

[9] : http://www.wmo.int/pages/prog/sat/Refdocuments.html#spacebasedgos
[10] : http://www.eohandbook.com/
[11] : http://www.eoportal.org/about.html

(b) **Deriving/Collecting information on observing system capabilities**: Obtaining information on the surface-based observing system capabilities in a format suitable for the database is more difficult than for the space-based observing system. A statistical approach based on a sufficient number of observing platforms reporting from specific regions that cover different national territories or ocean exclusive economic zones is needed in order to deduce the performance of the surface-based observing networks in terms of horizontal resolution. Similarly, information from individual observations and profiles need to be available in order to statistically derive vertical resolution, observation cycle, and timeliness information. While GTS monitoring information is available, the way the information is presently structured does not always permit to easily and automatically derive the required information. The way information on the accuracy of the instruments is produced must be properly documented, if not standardized. The different methods of observation used by different countries make it difficult to produce good estimates of the accuracy of the measurements. The geographical organization of the observing system capabilities database could probably be optimized in order to facilitate the computation of the required information for insertion in the database;

(c) **Entering available information into the RRR database**: A user friendly interface must be available to permit entering and validating updated information with minimal effort. Some quality control checks must be made, or built-in list of values implemented, to ensure consistency in the naming of the variables and to avoid duplication in both the "Requirements" and "Capabilities" parts of the RRR database;

(d) **Querying the RRR database**: A reliable database management system permitting to automatically query and display the content of the RRR database via the web must be available. Currently only an export of the RRR database content is made available via the web, and real-time queries via the web are not possible. The WMO Secretariat should also be able to query the RRR database in order to perform a critical review and provide related information to ET-EGOS experts for review. The tools presently used for producing the critical review charts are difficult to manage and are time consuming;

(e) **Updating and using the RRR database**: Dedicated staff must be available for routinely entering new information in the RRR database to make sure it is reflecting the most recent user requirements and observing system capabilities. Staff must also be available to produce the critical review which is time consuming as noted above. Required staff resources at the WMO Secretariat are currently not available;

(f) **Reliability**: The RRR database must be fully operational 24h every day and staff must be available to monitor the database to make sure it is properly running and available to outside users.

3.2 The ICT-IOS recognized that there are a number of issues to consider in order to eventually be in a position to make an appropriate proposal to the CBS, including:

(a) Quality management in a way consistent with the WMO Quality Management Framework to permit the running of a reliable and well documented RRR database;

(b) Engagement of experts in their own application areas for the collection of user requirements;

(c) Engagement of the regional associations and appropriate groups of experts in all technical commissions, as well as Members, for the collection of information on the performances of the instruments, especially for the surface-based observing systems;

(d) Roles and responsibilities of the different actors for the overall coordination, operations and maintenance, updating, querying, and monitoring of the RRR database. In particular, the

structure of the future database must make it possible for designated persons to easily submit information to the database according to appropriate access rights and privileges;

(e) Funding requirements, and identification of funding sources.

4. OPTIONS FOR EVOLUTION OF THE RRR DATABASE

4.1 Despite the challenge of operating and maintaining the current RRR database, the WMO Secretariat is committed to make sure the database is truly operational and serves its purpose well. This can be realized either through a database running from the WMO Secretariat or through a system hosted and operated by a WMO Member on behalf of the WMO. The requirements for hosting the RRR database are proposed in section 6 below.

4.2 Two different approaches have been investigated for the hosting, and operations of the RRR database, i.e.: (i) a centralized approach whereby the database resides at one centre, and that centre is responsible for its operations, maintenance, and updating; and (ii) a distributed approach whereby different centres responsible for specific parts of the database (e.g. satellite, surface-based, regional or specialized networks, etc.) may be involved for the operations, maintenance, and updating of the database. Several organizations have expressed readiness to support the WMO RRR process and could consider hosting at least part of the RRR database.

4.3 As part of the distributed approach for the RRR database, it is proposed that the WMO Secretariat continues to host the observational requirements part of the RRR database.

4.4 ICT-IOS decided to establish a small ad hoc task group lead by Lars Peter Riishojgaard (United States, OPAG-IOS Chair), John Eyre (United Kingdom, ET-EGOS Chair), Michael Kalb (United States, ET-SAT Chair), Klaus Jürgen Schreiber (Germany), Jerome Lafeuille (WMO Secretariat), and Etienne Charpentier (WMO Secretariat) to develop a strategy for developing, maintaining, operating, and hosting the RRR database, draft a letter to the potential candidates (i.e. NASA, EUMETSAT, EUMETNET, and the JCOMM in situ Observing Platform Support centre (JCOMMOPS)), and propose a formal evaluation process to be submitted to the CBS in 2010 (see Item 8). The Terms of Reference of the task group are provided in the Annex to this Strategy.

5. STRATEGY FOR DEVELOPING, MAINTAINING, OPERATING, AND HOSTING THE RRR DATABASE

5.1 High-level architecture

Specifications for the overall RRR database and its management will be prepared by the Secretariat in consultation with the ICT-IOS ad hoc task group on the RRR Database. The RRR database is proposed to be developed as detailed in the figure below with:

(a) The observational requirements part of the RRR database, hosted by the WMO Secretariat;

(b) The space-based observing system capabilities part of the RRR database hosted by a space agency on behalf of the WMO;

(c) The surface-based observing system capabilities part of the RRR database hosted by another agency with experience with regard to the management and monitoring of surface-based observing systems;

(d) A portal, hosted by the WMO Secretariat, linking the different component databases and monitoring the updates.

Basic specifications and roles and responsibilities of the different actors are detailed in the sections 6 to 7 below.

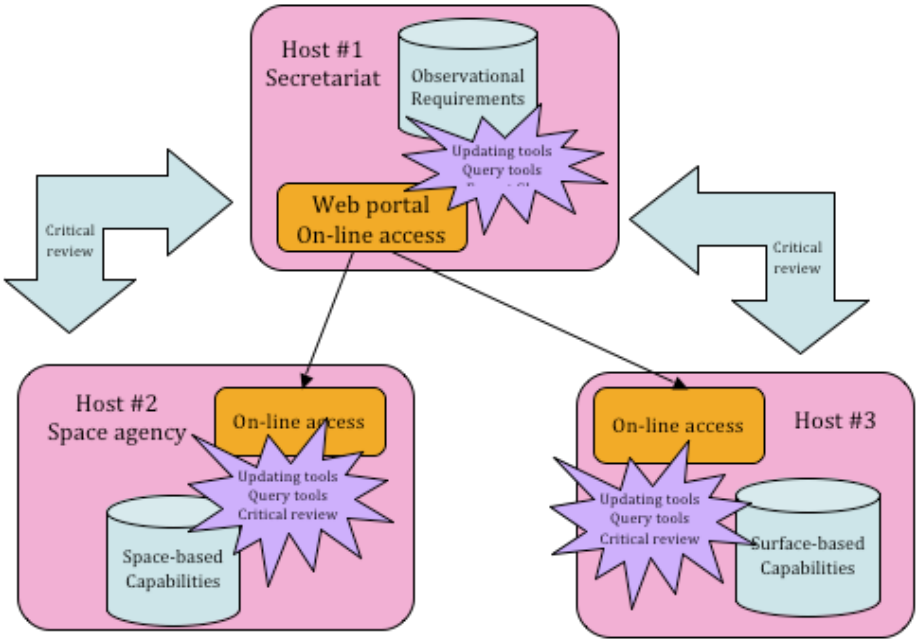


Figure 1: Overview of the distributed databases

5.2 Timeline

The following timeline is proposed for the development of the RRR database:

(a) 1–15 July 2010: Strategy and basic specification prepared by the ad hoc task group on the RRR Database;

(b) 1 July–31 August 2010: Technical specifications prepared by the Secretariat in consultation with the ad hoc task group on the RRR Database;

(c) 1 September 2010–October 2010: Seeking candidates for hosting the space-based and surface-based observing systems capabilities parts of the RRR database based on the Technical Specifications prepared by the Secretariat;

(d) November 2010: Strategy presented to CBS-Ext;

(e) November–December 2010: Evaluation of the proposals by the ad hoc task group on the RRR Database based on criteria defined in Section 8 below;

(f) January 2011: Recommendation by the ad hoc task group on the RRR Database regarding the hosts presented to the Secretary-General for formal approval; selected hosts formally requested to proceed with the developments, and MoU established;

(g) 2011: Development of the different components by the hosts;

(h) 2012: Testing and tuning of the different components;

(i) CBS session in 2012: Application fully operational and demonstration presented to the CBS session.

5.3 Funding

User requirements and overall coordination

The user requirements part of the RRR database, its development, maintenance, and routine management of its content will be fully supported by the WMO Secretariat.

Space-based capabilities

It is expected that most of the resources needed to run, maintain, and manage content of the space-based observing system capabilities parts of the RRR database will be provided by the host.

Surface-based capabilities

Some limited resources might be made available by the WMO Secretariat to the host of the surface-based observing system capabilities parts of the RRR database to assist for: (i) developing the application; and (ii) running and maintaining the application and the database content. These costs shall not exceed CHF 50k for the initial developments, and CHF 25k yearly for the running costs.

6. BASIC SPECIFICATIONS FOR HOSTING THE SPACE-BASED/SURFACE-BASED OBSERVING SYSTEM CAPABILITIES

Any NMHS/institution/agency proposing to host the space-based observing system capabilities part of the RRR database on behalf of the WMO would have to commit to:

(a) Developing the database possibly based on software and tools already existing at the host. The database shall be based on the relational model that will be proposed by WMO;

(b) Making the database available on-line via the web and permitting to query information from it based on standard query forms, and to perform a critical review of how space-based/ surface-based observing systems address the user requirements. Corresponding web pages shall be displayed as WMO pages with appropriate logo (and possibly using a “wmo.int” URL) to make it clear that this is a WMO application. Details on what query forms to offer, and how the critical review should be performed will be documented by the Secretariat in consultation with the ad hoc Task Group on the RRR Database;

(c) Providing tools for easily managing content of the database, i.e.: (i) on-line – password protected – screens available via the web permitting designated experts to edit the database and make small changes as required; and (ii) import tools to permit substantial changes;

(d) Making sure the database is available operationally 24h everyday. Staff must be available to monitor the database to make sure it is properly running and available to outside users. Contact point shall also be available to report on possible problems, and provide assistance as needed;

(e) Performing routine maintenance of the database application, including correction of bugs, software/hardware upgrades as needed;

(f) Making database documentation available on-line, including rationale, technical specifications, description of the database, user manual, and description of quality control procedures and processes;

(g) Implementing version control of the RRR Database including related documentation changes/updates for the variables and requirements, to ensure the traceability and consistency of its application by the users.

Detailed technical specifications will be provided by the Secretariat in consultation with the ad hoc Task Group on the RRR Database.

7. ROLES AND RESPONSIBILITIES

Roles and responsibilities of the different actors for the overall coordination, operations and maintenance, updating, querying, and monitoring of the RRR database are detailed in the table below.

Contact point	Roles and responsibilities
WMO Secretariat	• Coordinate the management of the overall RRR Database; • Host a portal providing access to and monitoring of all components and tools of the RRR Database; • Host requirements part of the RRR database, including: o Provision of the database on-line via the WMO Website; o Updating of the database per input provided by authorized experts; o Quality control of the content, and adjustment as necessary in consultation with appropriate experts; o Operations and monitoring so that it is operationally available via the WMO Website; o Regularly exports a text form in suitable format for importing into other databases as necessary; • Overall responsibility for maintaining up-to-date content of the capabilities parts of the RRR database through support from the hosts of the surface- and space-based capabilities databases.
Space agency hosting the space-based observing system capabilities part of the RRR database	• Host space-based observing system capabilities part of the RRR database, including: o Operations and monitoring so that it is operationally available via a web server with appropriate WMO branding, query tools, and standard reports; o Updating of the database per input provided by the Secretariat and authorized experts on ad hoc basis; o Quality control of the content, and adjustment as necessary in consultation with appropriate experts and the WMO Secretariat; o Routine evaluation of the database content, identification of missing information, and pro-active role on behalf of the Secretariat in seeking relevant information from appropriate experts in consultation with the Secretariat; o Regularly exports a text form in suitable format for importing into other databases as necessary; o Submission of a statistical summary report on a yearly basis to the Secretariat about the database content and its degree of currency.
Agency hosting the surface-based observing system capabilities part of the RRR database	• Host surface-based observing system capabilities part of the RRR database, including: o Operations and monitoring so that it is operationally available via a web server with appropriate WMO branding, query tools, and standard reports; o Updating of the database per input provided by authorized experts on ad hoc basis; o Quality control of the content, and adjustment as necessary in consultation with appropriate experts and the WMO Secretariat; o Routine evaluation of the database content, identification of missing information, and pro-active role on behalf of the Secretariat in seeking relevant information from appropriate experts in consultation with the Secretariat; o Regularly exports a text form in suitable format for importing into other databases as necessary; o Submission of a statistical summary report on a yearly basis to the Secretariat about the database content and its degree of currency.

Table 1. Roles and responsibilities of database hosts

The roles and responsibilities of those providing information and/or monitoring the RRR database content are detailed in Table 2 below.

ET-EGOS Points of contact in each Application Area	• Regularly liaise and coordinate with appropriate experts, Groups, and expert teams in the considered application area to collect information on user requirements and seek consensus; • Provision on a yearly basis to the Secretariat of observational user requirements regarding the considered application area; • Regularly check the content of the RRR database on-line and make sure the observational user requirements part is up to date; • Suggest changes to the RRR database content on ad hoc basis as appropriate through the Secretariat; • Analyse the content of the RRR database for the critical review and gap analysis.
ET-EGOS National Contact Points	• Check the content of the surface-based observing system capabilities part of the RRR database for their geographical region of interest, and make sure the information available on-line is correct and up to date; suggest changes as appropriate through the Secretariat.
Monitoring centres	• One or more monitoring centre(s) will be designated for providing statistical information on observing systems capabilities to the Secretariat. The information will then be quality controlled and imported into the observing systems capabilities parts of the RRR database; Each monitoring centre will provide the required information based on observational data they are receiving and using.
ET-EGOS	• Analyse the content of the RRR database for the critical review and gap analysis in liaison with the appropriate application area contact points; • Suggests evolutions to the RRR database structure and tools.
ET-AWS	• Check the content of the surface-based observing system capabilities part of the RRR database regarding RBCN, RBSC, and other AWS networks, and make sure the information available on-line is correct and up to date; suggest changes as appropriate through the Secretariat.
ET-AIR	• Check the content of the surface-based observing system capabilities part of the RRR database regarding AMDAR, and make sure the information available on-line is correct and up-to-date; suggest changes as appropriate through the Secretariat.
ET-SBRSO	• Check the content of the surface-based observing system capabilities part of the RRR database regarding surface-based radar systems, and make sure the information available on-line is correct and up to date; suggest changes as appropriate through the Secretariat.
ET-SAT	• Check the content of the space-based observing system capabilities part of the RRR database, and make sure the information available on-line is correct and up-to-date, in particular as regards satellite missions and instruments characteristics; suggest changes as appropriate through the Secretariat.
ET-SUP	• Check the content of the space-based observing system capabilities part of the RRR database, and make sure the information available on-line is correct and up-to-date, in particular as concerns satellite-derived products; suggest changes as appropriate through the Secretariat.

JCOMM	• Check the content of the surface-based observing system capabilities part of the RRR database regarding marine and ocean observing systems, and make sure the information available on-line is correct and up-to-date; suggest changes as appropriate through the Secretariat.
GCOS	• Check the content of the surface-based observing system capabilities part of the RRR database including GSN, GUAN and GRUAN networks, and make sure the information available on-line is correct and up-to-date; suggest changes as appropriate through the Secretariat.
Members	• Check the content of the surface-based and space-based observing system capabilities part of the RRR database regarding the systems they are operating, and make sure the information available on-line is correct and up-to-date; suggest changes as appropriate through the Secretariat.

Table 2. Roles and responsibilities of information providers

8. EVALUATION OF THE CANDIDATES

The ICT-IOS ad hoc task group on the RRR Database will objectively evaluate the responses from the solicited candidates according to the following criteria as well as other possible criteria deemed necessary for the sustainability of technical solutions, resources and commitments and approved by the Chair of the OPAG-IOS:

Criteria	**Weight**
Addressing the required specifications	10
Commitment for the development of the database	10
Long term commitment	10
Cost to WMO	10
WMO branding	5
Timeliness of response for including new requirements; flexibility for future evolutions	5
Updating and human resources made available for the management of the database content	10
User access	10
TOTAL	***70***

After evaluation, the ad doc task group will submit a recommendation to the Secretary-General of WMO for approval.

Annex

THE STRATEGY FOR THE EVOLUTION AND FUTURE HOSTING OF THE WMO DATABASE OF OBSERVATIONAL USER REQUIREMENTS AND OBSERVING SYSTEM CAPABILITIES

TERMS OF REFERENCE OF THE ICT-IOS AD HOC TASK GROUP ON THE RRR DATABASE

The ad hoc task group on the Rolling review of Requirements (RRR) Database shall:

1. Develop a strategy for developing, maintaining, operating, and hosting the RRR database, including rationale, timeline, funding requirements, and possible funding sources;

2. Define basic specifications for hosting: (i) the space-based observing system capabilities; and (ii) the surface-based observing system capabilities of the RRR database;

3. Define roles and responsibilities of the different actors for the overall coordination, operations and maintenance, updating, querying, and monitoring of the RRR database;

4. Provide appropriate input to the Secretariat for drafting a letter to potential candidates (i.e. NASA, EUMETSAT, EUMETNET, and JCOMMOPS);

5. Define criteria and objectively evaluate the responses from the solicited candidates and submit a recommendation to the Secretary-General of WMO for approval;

6. Submit a document describing the process to the CBS in 2010;

7. Work mainly by email, and teleconference and seek unanimous agreement amongst the ad hoc task group on the strategy and way forward.

The ad hoc task group is comprised of the following people:

- Lars Peter Riishojgaard (United States, OPAG-IOS Chair) – ad hoc task group leader
- John Eyre (United Kingdom, ET-EGOS Chair)
- Michael Kalb (United States, ET-SAT Chair)
- Klaus Jürgen Schreiber (Germany)
- Jerome Lafeuille (WMO Secretariat)
- Etienne Charpentier (WMO Secretariat)

ANNEX II
Annex to paragraph 4.2.5 of the general summary

TERMS OF REFERENCE OF THE REGIONAL REPRESENTATIVES IN THE COMMISSION FOR BASIC SYSTEMS OPEN PROGRAMME AREA GROUP ON INTEGRATED OBSERVING SYSTEMS

1. To represent the Region in the CBS Open Programme Area Group on Integrated Observing Systems (OPAG-IOS) and provide information on the regional implementation plans to the OPAG-IOS and its expert teams, as appropriate;

2. To advise OPAG-IOS on the observational data requirements of Members of the Region regarding the regional observing systems and WIGOS;

3. Act as a Point of Contact (PoC) to ET-EGOS for the development and implementation of the Plan for the evolution of global observing systems and for the monitoring of a progress in the evolution of the regional aspects of observing systems;

4. To report to OPAG-IOS on all matters concerning regional aspects of global observing systems, such as:

   a. Performance of the regional observing systems;
   b. Deficiencies of the regional observing systems;
   c. Proposals to improve the performance of the regional observing systems;
   d. Amendments to regulatory material related to the GOS (including the Pub.9 – Volume A and the Manual and Guide on the GOS);

5. Provide feedback to the regional association on the issues identified by OPAG-IOS and its expert teams.

ANNEX III
Annex to paragraph 4.2.29 of the general summary

TERMS OF REFERENCE OF THE EXPERT TEAM ON SATELLITE UTILIZATION AND PRODUCTS (ET-SUP)

In support of the strategy to improve satellite data utilization, ET-SUP shall:

(a) Monitor the progress of satellite data availability and use by WMO Members, related issues and expectations, with the aim to publish findings and recommendations in a WMO Technical Document;

(b) Provide advice and support to the development and implementation of WIGOS, with a view to promote standardization of satellite measurements and product generation algorithms and validation procedures, from a user's perspective;

(c) Coordinate with ET-SAT and ET-EGOS on the evolution of the space-based component of Global Observing Systems;

(d) Initiate activities to improve the availability of operational and R&D satellite data according to user needs, monitor these activities in close coordination with the relevant CGMS working group(s) and with WIS activities;

(e) Review present and future R&D satellite data and products including their availability and potential applications, and provide advice with a view of increased utilization by WMO Members;

(f) Assess and further the concept of Sustained Co-ordinated Processing of Environmental Satellite Data (SCOPE);

(g) Review the needs of WMO Members for information regarding access to and utilization of satellite data, and related training opportunities;

(h) Keep under review the needs of WMO Members for training in satellite meteorology and engage with the Management Group of the Virtual Laboratory for Education and Training in Satellite Meteorology (VLab) to address these needs, towards full utilization of satellite data from operational and R&D satellites, in accordance with the 2009–2014 Virtual Laboratory Training Strategy;

(i) Prepare documents to assist Members, summarizing the results from the above activities.

ANNEX IV
Annex to paragraph 4.2.30 of the general summary

EXPERT TEAM ON AIRCRAFT-BASED OBSERVATIONS (ET-AIR) WORKPLAN FOR 2009–2012

	Task	Action
1.	Contribute to the development and implementation of concept of WIGOS and provide relevant advice and support to the chair of OPAG-IOS.	Address relevant items of WIGOS Implementation Activities, agreed by EC-WG/WIGOS-WIS-2.
2.	Coordination with the AMDAR Panel.	Monitor work being undertaken by AMDAR Panel Science and Technical Sub-group and Training and Outreach Sub-group; Report to the AMDAR Panel through AMDAR Panel Sessions.
3.	Develop future governance for AMDAR Programme.	Examine requirements and make proposals to CBS and AMDAR Panel; Make proposals for further integration of AMDAR into WWW.
4.	Develop an AMDAR data policy.	Analyse the current status and requirements and develop proposal for data policy to CBS; Develop guidelines for third party data providers such as TAMDAR.
5.	Steer the implementation of WIGOS PP for AMDAR and develop Standard Practices for AMDAR.	Make proposals for further integration of AMDAR into WIGOS; Coordinate WIGOS AMDAR PP activities with established AMDAR programmes on the: (a) Development of a standardized BUFR Template for AMDAR; (b) Application of WMO Metadata relevant to AMDAR; (c) Development of a standardized Quality Management Framework for AMDAR data; (d) Validation and preparation for intercomparison of available water vapour sensor performance, in coordination with CIMO; (e) Update of the AMDAR Reference Manual WMO-No. 958; (f) Development of the framework for generic software specification for AMDAR.
6.	Steer the implementation of WIGOS PP for AMDAR.	Coordinate WIGOS AMDAR PP activities; Make proposals for further integration of AMDAR into WIGOS.

ANNEX V
Annex to paragraph 4.2.30 of the general summary

EXPERT TEAM ON REQUIREMENTS AND IMPLEMENTATION OF AWS PLATFORMS (ET-AWS) WORKPLAN FOR 2009–2012

	Task	Action
1.	To contribute to the development and implementation of concept of WIGOS and provide relevant advice and support to the chair of OPAG-IOS.	Address relevant items of WIGOS Implementation Activities agreed by EC-WG/WIGOS-WIS-2.
2.	Develop and maintain the requirements and specifications for automated observations networks in collaboration with ET-EGOS and application areas.	Monitor and update AWS Functional Specifications (FS) for all WMO-related Programmes. Update on request the list of basic set of variables to be reported by a standard AWS for multiple users.
3.	Develop the requirements and standards for a basic, robust AWS suitable for less developed, remote and extreme climate conditions, taking advantage of advances in technology.	Prepare recommendations for addressing challenges facing the operation of AWS Networks. Report on advances in AWS technology. Review challenges, solutions and advances in liaison with HMEI. Cooperate with JCOMM to work towards establishing an international forum of users of satellite data telecommunication systems.
4.	Develop requirements for the integration between AWS and space-based observations.	Identify list of AWS geophysical parameters suitable for validation or integration with satellite observations. Develop a proposal for a pilot intercomparison.
5.	Develop the requirements for automated observations to address the deficiencies of AWS following the migration from manual observations.	Collaborate with CIMO ET-ST&MT to publish guidelines and procedures to assist in the transition from manual to automatic surface observing stations. Prepare a gap analysis for automated observations following the transition from manual observations. Review with subject area specialists including JCOMM, CAgM, CHy, CCl and GCOS.
6.	Develop AWS metadata catalogues for real-time exchange through WIS.	Prepare requirements for AWS metadata for WIS based on BUFR descriptors. Liaise with IPET-DRC to implement the metadata in BUFR tables.
7.	Develop guidelines for the siting classification of surface observing stations.	In coordination with CIMO and other relevant TCs, finalize the guideline materials for Members.

8.	Review BUFR descriptors related to AWS measurements according to requirements.	Review BUFR descriptors and propose new ones as needed. Coordinate implementation with IPET-DRC of BUFR template for SYNOP/AWS reporting. Validate BUFR templates for AWS data from n-minute period and for representation of nominal values. Develop guidelines for the implementation of national station identifiers and investigate the necessity of WMO Publication No. 9, Volume A be adapted to include National Station Identifiers.
9.	Monitor advances in AWS technology and develop guidance for integration into AWS networks.	Review progress and advances in AWS technologies. Develop guidance to deal with integration of third party AWS networks.

ANNEX VI

Annex to paragraph 4.2.30 of the general summary

EXPERT TEAM ON THE EVOLUTION OF GLOBAL OBSERVING SYSTEMS (ET-EGOS) WORKPLAN FOR 2009–2012

	Task	Action
1.	To contribute to the development and implementation of concept of WIGOS and provide relevant advice and support to the chair of OPAG-IOS.	Address relevant items of WIGOS Implementation Activities agreed by EC-WG/WIGOS-WIS-2.
2.	Survey and collate user requirements for observations for WMO and WMO-sponsored programmes.	Review and update CEOS/WMO database of user requirements for observations, through Points of Contact for application areas.
3.	Survey and collate observing systems capabilities for surface-based and space-based systems that are candidate components of WIGOS.	Review and update CEOS/WMO database of observing system capabilities, in collaboration with other OPAG IOS ETs.
4.	Maintain Rolling Review of Requirements (RRR) for observations in several application areas, using subject area experts, including appropriate liaison with CAS, JCOMM, CAeM, CAgM, CHy, CCl and GCOS.	Continue RRR process for 12 application areas and expand to new areas as required: review and update as necessary Statements of Guidance on the extent to which present/ planned observing system capabilities meet user requirements, through Points of Contact on application areas.

5.	Prepare and maintain reviews of OSEs, OSSEs and other studies undertaken by NWP centres and to provide information for consideration by ET-EGOS and OPAG-IOS.	Rapporteurs on Impact Studies and NWP experts, review results of impact studies relevant to the evolution of GOS. Organize and hold next NWP Impact Studies Workshop in 2012.
6.	Promote CBS activities in support of GCOS goals.	Review the implications of the 2010 update of the GCOS Implementation Plan for the activities of CBS. Bring relevant issues to the attention of the ET-EGOS. Support GRUAN planning.
7.	Prepare a new version of the Implementation Plan for the Evolution of the global observing systems (EGOS-IP), fully responding to the "Vision for the GOS in 2025". Update current version of the IP during this transition period.	Based upon monitoring of the progress in the Evolution of the GOS and after successful endorsement of the "Vision for the GOS in 2025" by CBS-XIV, that the ET-EGOS prepare a new version of the EGOS-IP that will incorporate the information included in the Vision.

ANNEX VII
Annex to paragraph 4.2.30 of the general summary

EXPERT TEAM ON SURFACE BASED REMOTELY-SENSED OBSERVATIONS (ET-SBRSO) WORKPLAN FOR 2009–2012

	Task	Action
1.	To contribute to the development and implementation of concept of WIGOS and provide relevant advice and support to the chair of OPAG-IOS.	Review WIGOS IP to extract ET SBRSO actions. Establish WIGOS Implementation Task that facilitates improved exchange of data and products not directly owned by NMHSs (where restricted license agreements exist).
2.	Assess the new potential capabilities of SBRS observing systems, in terms of their operational implementation.	Work closely with CIMO ET-RSUATT to ensure current developments in SBRSO systems is up to date and limitations of SBRSO systems in terms of measurement integration period and extent of observation are fully understood.
3.	Assess the status of implementation of and plans for SBRS observing systems by WMO Members.	Request from members the status of implementation of operational Wind Profiler, GNSS IWV and Microwave Radiometer Networks. SBRSO Questionnaire to be created sent to Members and returns analysed. Plus encourage late Weather Radar Questionnaire responses.

	Task	Action
4.	Document the above capabilities and implementation status/plans, through updates to the WMO/ CEOS database of observing system capabilities.	Analyse results of Weather Radar / Lightning and SBRSO questionnaires relating to system accuracy, review conclusions of analysis by CIMO/CBS ET members and then upload results to WMO-CEOS Database for Observing System Capability. Develop procedures for the routine collection of information regarding the status of SBRSO systems.
5.	In collaboration with ET-EGOS, assess the contribution of SBRS observing systems to meeting the user requirements for observations for all application areas represented by WMO and WMO-sponsored Programmes.	Review the 10 SoGs with respect to the '5' operational SBRSO Systems and report on the suitability of each of the SBRSO Systems for each Application Area.
6.	Make recommendations on how the integration of such observing systems within the GOS might be taken forward.	Contribute to the development of the new EGOS-IP, providing feedback on the development of the draft.
7.	Assess the systems for collection and distribution of data from SBRS observing systems, and make appropriate recommendations.	Develop a proposal for the development of regional data centres for the collation, processing and exchange of Weather Radar Data (strongly aligned with WIS evolution).
8.	Monitor the status of operational networks of SBRS observing systems and provide technical advice on such systems, including both operational and R&D systems, to WMO Members and RAs.	Report on the operational networks and on key developments in SBRS observing systems to OPAG-IOS, drawing attention to actions required by CBS to promote the development of such systems within the WIGOS. Respond to requests for advice on SBRS observing systems from other CBS entities, as necessary.

ANNEX VIII
Annex to paragraph 4.2.30 of the general summary

EXPERT TEAM ON SATELLITE SYSTEMS (ET-SAT) WORKPLAN FOR 2009–2012

	Task	Action
1.	To contribute to the development and implementation of concept of WIGOS and provide relevant advice and support to the chair of OPAG-IOS.	Advise on integration of operational and R&D environmental satellites within WIGOS and in particular: - Inter-calibration, including GSICS WPP, - Satellite instrument standardization, in collaboration with CIMO Theme Leaders on Satellite Observations.

	Task	Action
2.	Review capabilities of operational and R&D satellites.	Prepare an update of current/planned satellite missions. Update the Gap Analysis of the space-based component of the GOS. Identification of opportunities and/or problem areas concerning satellite plans.
3.	Assist CBS on coordinating global planning of satellite missions to implement the Vision for the GOS in 2025.	Review the Implementation Plan of Evolution of the GOS (space aspects). Provide advice on implementation of the Vision for the GOS, as concerns space-based aspects and observation strategies.
4.	Make recommendations with respect of transition of relevant R&D instruments to operational environmental satellites.	Develop recommendations on opportunities for transition of relevant R&D missions to operations. Develop recommendations for increased use of R&D mission data.
5.	Assess system capabilities for access and use of environmental satellites in particular in developing countries (with ET-SUP).	Provide assessment of capabilities and suggestions for improvements.
6.	Space Weather Input to the Inter-programme Coordination Team on Space Weather.	Prepare input to the Inter-programme Coordination Team on Space weather.
7.	Advise CBS on other relevant matters.	Provide advice on radio frequency utilization.

ANNEX IX
Annex to paragraph 4.2.30 of the general summary

EXPERT TEAM ON SATELLITE UTILIZATION AND PRODUCTS (ET-SUP) WORKPLAN FOR 2009–2012

	Task	Action
1.	Monitor the use of satellite data & products across WMO Members, with focus on the needs of less well developed Members through a biennial questionnaire.	Prepare Biennial questionnaire, analyse the responses and compare with input from VL COEs. Develop findings and recommendations, provide advice to regional associations on follow-up actions and prepare a Technical Document for publication.
2.	Contribute to the development and implementation of WIGOS concept and provide relevant advice and support to the chair of OPAG-IOS.	Evaluate the WIGOS SAT Pilot Project (GSICS). Provide advice on integrated products using space/surface observations.

	Task	Action
3.	Review user implications of the evolution of the space-based GOS.	Review user implications of the evolution of the space-based GOS.
4.	Improve data availability from operational and R&D satellites through monitoring and guidance to the RARS and IGDDS projects.	Prepare feedback on the progress of RARS and IGDDS. Provide Guidance to the RARS and IGDDS Implementation Groups for their future activities.
5.	Improve data availability from operational and R&D satellites in response to user needs at the regional level.	Provide regional reports on requirements for data access, in coordination with regional rapporteurs. Provide recommendations for enhancing user-provider interaction on the data content of dissemination means.
6.	Promote the wide use of established and standard satellite data formats, processing techniques and tools.	Develop guidance to the Task Force on Satellite Data Codes. Prepare a list of useful software tools for satellite data analysis and ensure it is adequately maintained.
7.	Promote utilization of R&D satellite data & products by WMO Members.	Review the relevance and availability of R&D data for operational use, indicate the priorities and provide recommendations for improved availability, information and training, especially for developing countries.
8.	Expand the use of satellite data and products through extending the concept of SCOPE-CM to other application areas.	Prepare recommendations for the extension of satellite data and products to other thematic areas, based on lessons learnt from SCOPE-CM.
9.	Support the provision of up-to-date and comprehensive on line information describing satellite plans, systems, products, and means of access.	Develop material for inclusion in WMO web pages and training actions. Make recommendations on links with relevant on-line resources.
10.	Support implementation of the Virtual Laboratory (VL) Training Strategy, relying on the VL Management Group, to meet the training needs of WMO Members.	Review regularly the VL status, its activities and plans. Including training resources, courses, meetings, newsletters, etc. Prepare guidance to meet users' needs, especially from less developed Members. Contribute to training resource development.

ANNEX X
Annex to paragraph 4.2.46 of the general summary

PROPOSAL FOR A SPACE-BASED ARCHITECTURE FOR CLIMATE MONITORING

The WMO Space Programme is proposing the development of a space-based architecture for climate monitoring. The proposed architecture will enhance, and is modelled after, the end-to-end system which has been created over the past fifty years for weather observations, research, modelling, forecasting, and services. Given the complexity of the climate system, and the emerging requirements of the WMO Integrated Global Observing System (WIGOS), as well as the needs of the Global Framework for Climate Services (GFCS) effort, discussion and feedback will be sought from multiple partners. In addition to the operational space agencies, the Global Climate Observing System (GCOS) and the Coordination Group for Meteorological Satellites (CGMS), special efforts will be made to reach out to the research and development space agencies as well as the climate research community.

The outline shown below lists the proposed contents of a concept document describing the major components which have been identified to date for inclusion in such an end-to-end system. CBS feedback on the outline and its components is being sought, as well as an endorsement to proceed as indicated above.

DRAFT OUTLINE OF THE CONCEPT DOCUMENT

1. Introduction

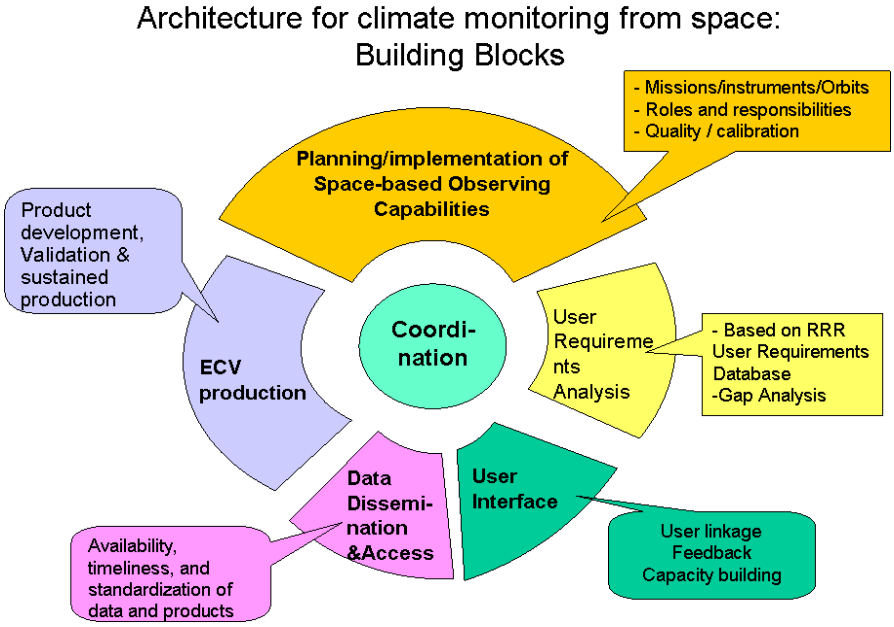
- WMO EC-LXII request to develop an architecture for climate monitoring from space
- Purpose of this document: to provide basis for consultation and, ultimately agreement, on processes and capabilities, to be implemented or maintained and activities to be pursued, in order to monitor climate from space in a globally coordinated and efficient framework
- Structure of the document

2. Motivation

2.1 Background: Climate change, WCC-3 and GFCS
2.2 Satellite system evolution and climate monitoring from space
2.3 Current assets from operational and R&D agencies for climate monitoring from space
2.4 A call for a global architecture for climate monitoring from space

3. A structured approach

3.1 Functional components (include definitions)
- User requirements analysis
- Observing capabilities (operational, research/demonstration, transition, calibration)
- ECV product generation (sustained for mature products, and experimental)
- Data dissemination and access (availability, standardized form)
- User interface (user uptake, feedback monitoring)
- Coordination (overall governance, communication)



3.2 Cross-cutting considerations

- High-level conceptual design only at this stage, the detailed design should be evolving
- Long-term dimension: start from current, implement plans, develop long-term vision
- Build on existing assets, highlighting incremental effort (what we have, what we need)
- Acknowledge evolving science and ensure linkage with science community
- Acknowledge evolving technology and avoid being bound to current technical approaches
- Acknowledge and integrate R2O process
- Avoid bureaucracy: acknowledge CEOS and CGMS leadership and build on them
- Balance between best-effort and commitment (agreement to a process, with a plan)
- Need to be responsive to user needs
- Need robustness for sustained acquisition/production of mature observations & products
- Quality assurance an integral part of the sub-systems

4. User Requirements Analysis component

4.1 Input

- User requirements for observations are expressed by representative user communities, and kept under regular review following a well established process (RRR, acknowledged in the GEO WE SBA).
- The requirements address geophysical variables (e.g. ECVs) rather than value-added products. Requirements are not for specific instruments either; they are in principle technology-free, thus not limited to space-based observation
- Requirements should specify: variables, units, resolution (space and time), accuracy, continuity. They are consolidated in a database maintained by WMO
- For climate monitoring, the primary requirements source is GCOS
- Additional observational requirements may be driven by GFCS services at some stage (e.g. for downscaling)
- WCRP research requirements may also be a relevant input

4.2 Requirements analysis

- Selecting the subset of requirements to be addressed by space
- Comparison of requirements with inventory of existing/planned observation capabilities, Gap Analysis
- Need to coordinate and guide this process

5. Observation capabilities component

A comprehensive architecture should encompass operational capabilities and research or demonstration capabilities. In addition to these research and operational capabilities, a process should also be defined to facilitate transition from research to operational status when appropriate. Quality assurance should be inherent to these elements.

5.1 Operational capabilities

(a) Principles

- Operational status should be understood as offering a clear long-term continuity perspective, which entails the in principle commitment that the capability, or an equivalent, will be maintained enabling to serve an operational community in a sustained manner
- Should address all ECVs to the extent there are mature observation capabilities including atmosphere, ocean, land, cryosphere
- Follow the GCOS Climate Monitoring Principles for satellite observations
- CGMS is the main mechanism by which space agencies coordinate their operational programmes

(b) Assets and planned evolution

- Current CGMS baseline defines committed elements in GEO, LEO for the GOS
- Proposed evolution of the CGMS baseline to serve climate monitoring, guided by the WMO vision for 2025 (detailing missions, orbits and assignments)
- The CGMS baseline should ultimately describe the space-based component of WIGOS
- Can be described in terms of actual constellations (sets of satellites with e.g. coordinated orbits), or in terms of virtual constellations (sets of instruments distributed on different satellites but supporting similar missions) mapped with thee CVs

5.2 Research

(a) Principles

- Twofold: Missions for climate research (atmospheric/climate process studies) and missions for technology demonstration
- No firm perspective of continuity
- Research missions respond to a science plan reviewed by the climate community
- CEOS is the main mechanism of space agencies to establish a global leadership

(b) Assets and evolution

- National plans of the various agencies
- CEOS virtual constellations mapped with the ECVs

5.3 Transition process

- Attention is required to avoid misunderstanding of the “Research to Operations” paradigm
- Research and Operations are both needed and equally important to successfully deliver climate-related measurements
- An operational follow-on should be considered for capabilities that have been successfully demonstrated from the point of view of performance, reliability, affordability, maturity, user uptake, and societal benefit
- Does not prejudge any transfer of tasks or budgets among entities, which is an internal matter for each agency or country, although joint ventures among R&D and operational entities are strongly encouraged, at least for a transition mode
- The goal is that ultimately one party is in a position to take a long-term commitment
- The appropriate level for a long-term commitment may be the state (e.g. WMO Member through its PR) if the agency is not in a position to commit beyond a programme lifecycle or a budget cycle

5.4 Quality assurance: calibration/inter-calibration

Applicable to all observation components (See QA4EO) with the aim to generate

Fundamental Climate Data Records (FCDRs)

- GSICS (CMA, CNES, EUMETSAT, ISRO, JAXA, JMA, KMA, NASA, NOAA)
- CEOS WGCV (Cal/Val sites)
- GRUAN, SADE, ARM etc. may support this activity
- WMO-BIPM collaboration plans

6. ECV Product Generation component

6.1 Goal: to ensure sustained provision of validated and quality-controlled ECVs products (Thematic Data Records)

6.2 Existing initiatives
- SCOPE-CM
- ESA CCI
- World Data Centres (e.g. GAW DLR data centre on aerosols)
- Only address a few ECVs for the time being

6.3 What we need:
- Maintain a mapping of the available/planned production of ECV products as well as "Additional Climate Variables (ACVs) if required
- Stimulate development of new products to fill gaps on priority needs
- Stimulate transition process according to maturity (see maturity index)
- Ensure Validation (peer review)
- Sustained production with quality control
- Reprocessing

6.4 Possible coordinating role of the SCOPE-CM and the (future) CEOS Climate WG, in parallel or jointly, with focus on operational or development aspects, respectively

7. Data Dissemination and Access component

7.1 Scope: Ensure accessibility of observations and products in suitable forms

7.2 Key areas of standardization:
metadata, catalogue interoperability, formats

7.3 Acknowledge dual use (climate and real-time services) and consider active distribution as well along standard protocols (Direct Readout or rebroadcast)

8. User Interface component

8.1 Should seek feedback, monitor deliverables and compare with user requirements
- Linkage with science community
- Linkage with operational climate monitoring and seasonal forecasting
- Linkage with GEO/GEOSS user community

8.2 Support user uptake: capacity-building including training

9. Coordination functions

9.1 For each component
Some coordination function is needed for every component. Tentatively:

User requirements analysis	WMO/CBS and GCOS
Observation capabilities	CGMS (operational) and CEOS (other), GSICS and CEOS WGCV for quality assurance aspects
ECV Product generation	SCOPE-CM and the (future) CEOS Climate WG
Data Dissemination and Access	WMO/WIS programme via CBS
User Interface	GCOS-WCRP

9.2 Overall governance
- To manage evolution of the plan and support the agreed process
- To administer and monitor the commitments of each contributor
- To ensure smooth interaction among components
- To support communication/outreach, visibility
- To maintain a long-term Vision
- Link with GEO/GEOSS

DEVELOPMENT PROCESS AND TIMELINE

The definition of the architecture will be initiated through the development of the Concept Document involving extensive consultation of relevant parties, with the aim to collect feedback, to refine the concept, and broaden its support, taking advantage of the following international events:

- September 2010 GCOS Steering Committee
- October 2010 CEOS Plenary
- November 2010 Asia-Pacific Conference, GEO plenary, CGMS, CBS-Ext.(10)
- January 2011 Workshop on Continuity and Architecture Requirements, AMS
- March 2011 CBS/IOS ET-SAT and ET-SUP

Following this consultation phase, and subject to positive recommendation by CBS-Ext.(10), the concept document will be submitted to the Consultative Meeting on High-level Policy on Satellite Matters and to WMO Congress in May 2011, for approval.

A detailed definition phase would then follow, during which the processes will be refined, with a definition of target capabilities and role assignments for each building block. During this phase, it is expected that the various components of the activities would be led respectively by the following entities:

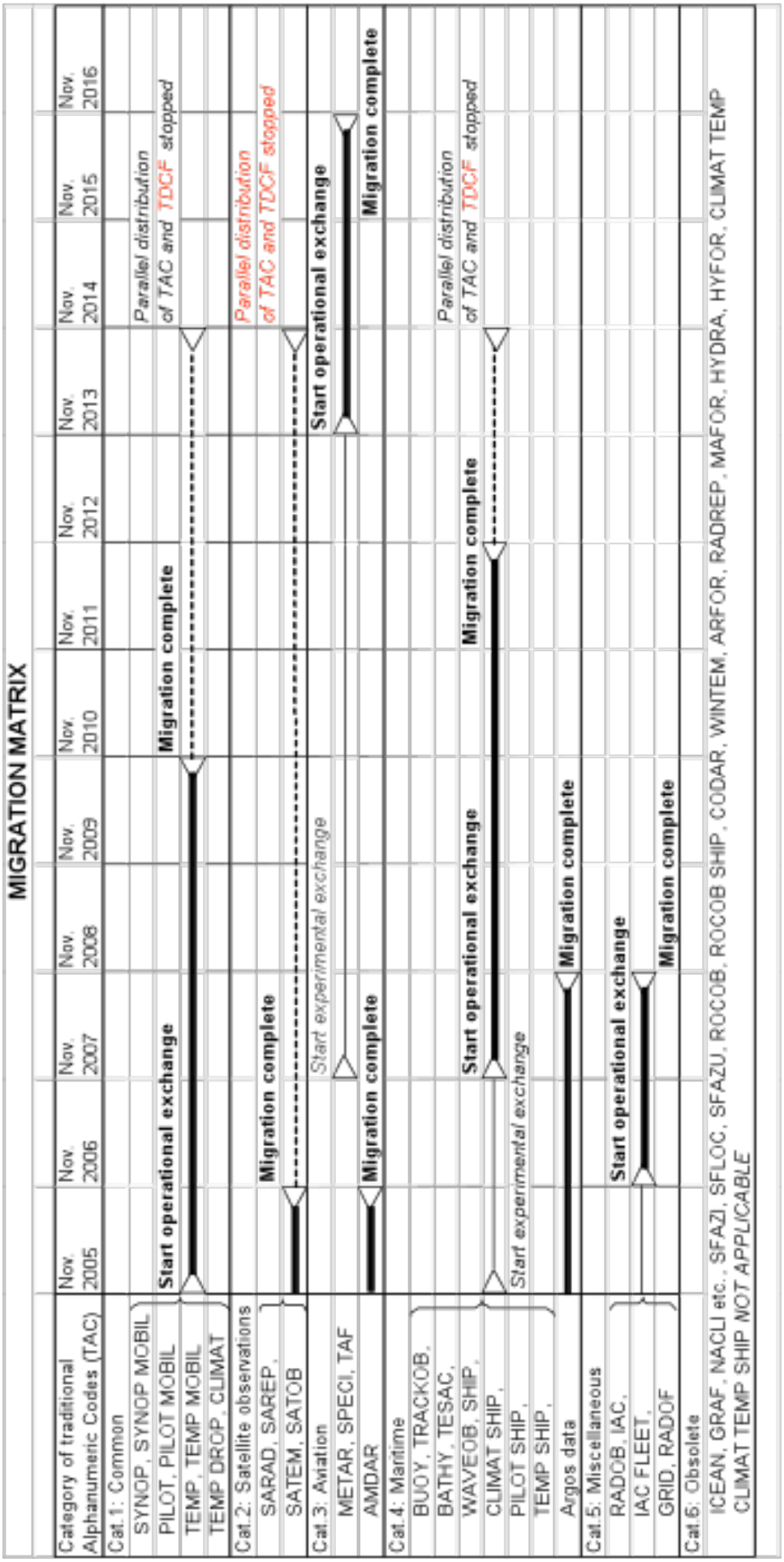
- User requirements analysis: WMO/CBS and GCOS
- Operational space-based observation capabilities: CGMS
- Research space-based observation capabilities: CEOS
- Quality assurance: calibration/validation: GSICS and WGCV
- ECV Product Generation: SCOPE-CM, CEOS-CWG
- Data Dissemination and access: WMO/WIS
- User interface: GCOS and WCRP

The outcome of this detailed definition phase would be reviewed, in the fourth quarter of 2011, by CGMS, CEOS, GCOS, and the WCRP. After completion of the review cycle, a report on the Architecture for Climate Monitoring from Space would be presented to the sixty-fourth WMO Executive Council session in June 2012 for approval.

ANNEX XI
Annex to paragraph 4.3.14 of the general summary

MIGRATION MATRIX BEING CONSIDERED BY THE INTER-PROGRAMME EXPERT TEAM ON DATA REPRESENTATION AND CODES (IPET-DRC)

Notes: XChanges (marked in red) to the migration matrix recommended by the IPET-DRC


MIGRATION MATRIX
Category of traditional Alphanumeric Codes (TAC)
Nov. 2005
Nov. 2006
Nov. 2007
Nov. 2008
Nov. 2009
Nov. 2010
Nov. 2011
Nov. 2012
Nov. 2013
Nov. 2014
Nov. 2015
Nov. 2016
Cat.1: Common
SYNOP, SYNOP MOBIL
PILOT, PILOT MOBIL
TEMP, TEMP MOBIL
TEMP DROP, CLIMAT
Start operational exchange
Migration complete
Parallel distribution
of TAC and TDCF stopped
Cat.2: Satellite observations
SARAD, SAREP,
SATEM, SATOB
Migration complete
Parallel distribution
of TAC and TDCF stopped
Cat.3: Aviation
METAR, SPECI, TAF
AMDAR
Start experimental exchange
Start operational exchange
Migration complete
Migration complete
Cat.4: Maritime
BUOY, TRACKOB,
BATHY, TESAC,
WAVEOB, SHIP,
CLIMAT SHIP,
PILOT SHIP,
TEMP SHIP,
Argos data
Start operational exchange
Start experimental exchange
Migration complete
Migration complete
Parallel distribution
of TAC and TDCF stopped
Cat.5: Miscellaneous
RADOB, IAC,
IAC FLEET,
GRID, RADOF
Start operational exchange
Migration complete
Cat.6: Obsolete
ICEAN, GRAF, NACLI etc., SFAZI, SFLOC, SFAZU, ROCOB, ROCOB SHIP, CODAR, WINTEM, ARFOR, RADREP, MAFOR, HYDRA, HYFOR, CLIMAT TEMP
CLIMAT TEMP SHIP NOT APPLICABLE

(1) Aviation Codes require ICAO coordination and approval, except for AMDAR.
(2) SAREP and RADOB require coordination by the ESCAP/WMO Typhoon Committee.
(3) For category 5, codes need to be reviewed in order to decide whether or not they should be migrated to BUFR/CREX.
(4) Codes in category 6 are not to be migrated.
(5) All dates above are meant as "not later than". However, Members and Organizations are encouraged to start experimental exchange, and, if all relevant conditions (see below) are satisfied, to start operational exchange as soon as possible.

– ***Start of experimental exchange*** means: data will be made available in BUFR (CREX) but not operationally, i.e. in addition to the current alphanumeric codes, which are still operational.
– ***Start of operational exchange*** means: data will be made available in BUFR (CREX) whereby some (but not all) Members rely on them operationally. Still the current alphanumeric codes will be distributed (parallel distribution).
– ***Migration complete*** means: at this date the BUFR (CREX) exchange becomes the standard WMO practice. Parallel distribution of TAC and TDCF may continue and will be discontinued within a zone in accordance with step-by-step arrangements made between the NMHS concerned.
– ***Parallel distribution of TAC and TDCF stopped*** means: at this date parallel TAC and TDCF distribution is terminated. For archiving purposes and at places where BUFR (CREX) exchange still causes problems the alphanumeric codes may be used only for the exchange of data between two NMHSs.

Relevant conditions to be satisfied before experimental exchange may start:
– Corresponding BUFR/CREX-tables and templates are available;
– Training of concerned testing parties has been completed;
– Required software of testing parties (encoding, decoding, viewing) is implemented;

Relevant conditions to be satisfied before operational exchange may start:
– Corresponding BUFR/CREX-tables and templates are fully validated;
– Training of all concerned parties has been completed;

Relevant conditions to be satisfied before TAC ceasing may end:
– All required software (encoding, decoding, viewing) is operational.

ANNEX XII
Annex to paragraph 4.4.14 of the general summary

STRATEGY FOR THE SEVERE WEATHER FORECAST DEMONSTRATION PROJECT

Background

The SWFDP was originally designed in 2004. The two main ideas driving the project are still valid today:

– Ensure that valuable forecast information readily available in the World Weather Watch regarding severe weather occurrence was effectively used in operations by developing countries; and

– Develop the potential of the 3-layer structure of the GDPFS, with the “Cascading Forecasting Process”.

Initially the goals set for the SWFDP (CBS-XIII) included:

– Improve severe weather forecasting;

– Improve lead-time of warnings;

– Improve interaction of NMHSs with media and with disaster management and civil protection authorities;

and also:

– Improve the skill of products from GDPFS Centres through the provision of feedback.

They were encompassed in the WMO "Vision of Improved Severe Weather Forecasting in Developing Countries" which was stated by Cg-XV in 2007:

> *"NMHSs in developing countries are able to implement and maintain reliable and effective routine forecasting and severe weather warning programmes through enhanced use of NWP products and delivery of timely and authoritative forecasts and early warnings, thereby contributing to reducing the risk of disasters from natural hazards."* (Cg-XV, 2007)

The SWFDP contributes directly to WMO's strategic thrusts of Service Delivery and Capacity-building, and to two of WMO's highest priorities as recommended by EC-LXII (2010), i.e., capacity-building and disaster risk reduction.

Progress

It is widely recognized that the development of the SWFDP so far has been highly successful. Two regional subprojects have been implemented, in 2006 in Regional Association I and in 2009 in Regional Association V, and the first one is now reaching a stage where transition to full operational status can be envisaged. These two projects have incorporated significant steps forward in the direction of the stated goals of the project; furthermore, they have demonstrated that within the SWFDP framework a tremendous contribution can be achieved in transferring meteorological technology into Operations.

It is worth analysing the reasons for the success of the SWFDP so far. One of them is that an efficient management framework has been put in place: each subproject has been managed at the right level, namely in this case the regional level, with appropriate guidance from the project Steering Group, and with considerable and highly efficient support from the WMO Secretariat. Good project management practices have been encouraged, including the setting up of a continuous improvement cycle, with regular reporting and evaluation of progress and objective identification of technical gaps.

A second reason for success is technical, in that the initial choice to develop and build upon a 3-layer cascading process has proven to be a good one, perfectly well in line with today's operational meteorology.

At this point it should be strongly underlined that the most critical condition for success has been the engagement of high quality and efficient leading centres at the regional level. The role and functions of these centres as focal point and central hub for all information exchange between the various global, regional and national partners have been essential, including the production of coordinated forecast guidance. The experience acquired with the SWFDP will actually be used to redefine the role of a regional centre.

An important aspect underlying the positive outcome of the SWFDP is that it is highly cost-effective. The budget of the project has been rather on the frugal side, and even taking into

account the substantial in-kind contributions of the global and regional centres involved, the overall total cost is much less than what is generally expected for this type of project resulting in this level of outcome.

The SWFDP initially focused on improving the information flow to, and through, the forecast offices of the participating Members. As the project progressed it became evident that, to leverage the optimum benefit from these improvements on the technical side, the engagement of the user community in the design and delivery of products was essential. Thus the service delivery element of the project developed; this works to collect feedback from users and to try and get users involved in a continuous evolution in the design of products and the delivery of services.

One can recall that the expectations regarding the SWFDP were very high almost from the start, to a point that a failure to achieve the goals would have been rather disappointing. This is so because some of today's main challenges were at stake, namely, the ability to deliver services in support of disaster risk reduction and for capacity-building in the actual meteorological world. The SWFDP concept was tailored to contribute to meet these challenges in an efficient cost-effective way, and it is very satisfactory that its validity could be demonstrated in a rather short period of time.

Future

EC-LXII (2010) gave various directions regarding the SWFDP's further development. The goals of the project should be updated as follows.

– Contribution to service delivery and to capacity-building;

– Improved severe weather forecasts, including accuracy and lead time, which should remain a priority area;

– Improved severe weather warning services, encompassing accuracy and lead time, according to identified user needs. This implies the further development of the use of probabilistic information, and the continuation of effort to enhance the feedback loop with end-users;

– Improved capacity to deliver Public Weather Services;

– Targeting other applications and progressively extending the scope to include, e.g., Aviation, Marine, Agriculture, and Hydrology;

– Finally, special attention should be given to ensuring sustainability, following the appropriate conclusion of the demonstration phase.

To work towards these updated goals some extensions to the existing project mechanism are required.

Strategy

1. On the technical side:

– Increased use should be made of high resolution NWP (as it becomes available) and of ensemble products. The SWFDP framework has been identified as highly suitable for the evaluation of products developed by GIFS-TIGGE, and this should be actively pursued;

– Nowcasting and very short-range forecasting tools should be introduced into the projects, including satellite-based products;

– A special effort on training in forecasting techniques should continue to be made, and even further developed, focused on the needs of the individual subprojects. Relevant local case studies should be used.

2. Regarding PWS developments:

– Explore new and enhanced formulation of warnings, including the use of uncertainty estimates;

– Extend the range of warning services and, in particular, establish continuous interactions with disaster management organizations;

– Further effort on training in service delivery is required. It should be noted that, amongst other benefits, this would help to enhance the feedback loop with the users at national level, which is one of the weaknesses identified to date.

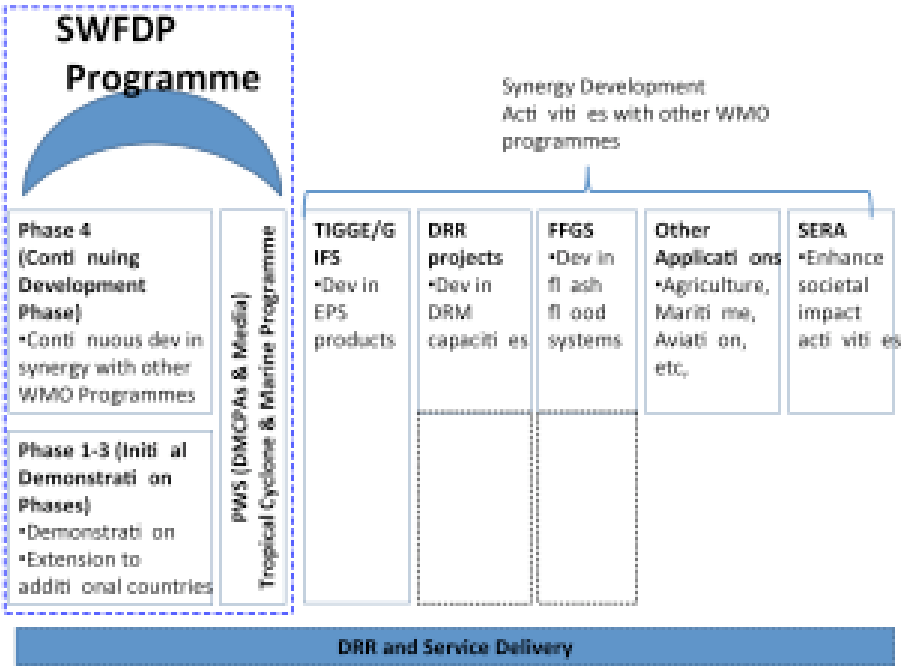
3. Developments for other applications

The range of targeted applications should be progressively extended, resources permitting, to transfer the benefits of the SWFDP to other users sectors in society, in synergy with other WMO Programmes and according to local needs and priorities, without distracting from the central focus on severe weather.

4. Sustainability:

The CBS Steering Group for the SWFDP recommended the introduction of a “Phase 4” concept in the Overall Project Plan, namely, a transition phase of matured regional projects into a fully operational activity. Ongoing training will be needed, which should take place on an annual basis and should become sustainable within the Regions.

During this Phase 4 the management of the activity should be transferred to the normal operational management structure within the regional association. The overall structure of the extended SWFDP concept is illustrated by the diagram below.



5. Funding:

Substantial in-kind contributions from participating global and regional centres are expected to continue, as will the regular budget allocations from relevant programmes and VCP for project management, initial training and workshops. However, these are far from being sufficient to support the coming phases of the SWFDP, and anticipated development of new projects, as the difficulties already experienced in the previous phase abundantly demonstrate. Additional funding is critical to sustain the necessary enhancement to the training effort. Support to correct critical deficiencies in technical capacities at some participating NMHs will also be required.

Extrabudgetary funding should be sought from those sources that have shown interest in investing in developing NMHSs of developing countries for disaster risk reduction goals. To achieve this, WMO needs to invest in promoting the SWFDP and its successes via coordinated resource mobilization mechanisms at international and regional levels.

Finally, two important milestones are suggested for the continuation of the project. The first one would mark the introduction of at least one project in every RA, and this could happen before the end of 2013. The second one would correspond to the transition to operations (phase 4) of again at least one project in every RA, and this could be reached by the time of or soon after Congress-XVII in 2015.

ANNEX XIII
Annex to paragraph 4.4.45 of the general summary

OUTLINE OF A REVISED *MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM*

These revisions follow the discussion in the *Abridged Final Report with Resolutions and Recommendations of the Fourteenth Session of the Commission for Basic Systems* (WMO No. 1040), general summary, paragraphs 6.3.49 to 6.3.56.

PART I – PURPOSE AND ORGANIZATION OF THE WMO GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM (GDPFS)

1. PURPOSE OF THE GDPFS

The Global Data-processing and Forecasting System is the world wide network of operational centres operated by WMO Members, delivering a wide range of products for applications related to weather, climate, water and environment. The functions, organizational structure and operations of the GDPFS are designed in accordance with Members' needs and their ability to contribute to, and benefit from, the system. A key objective is to facilitate cooperation and the exchange of information, thereby also contributing to building capacity amongst Members from developing countries.

This shall be achieved through:

– Making available numerical weather prediction products (analysis and forecast, including probabilistic information) and climate modelling and prediction information;
– Making available specialized products tailored for specific applications;
– Ensuring that the necessary additional information is available for an appropriate use of the above. This includes non real time information such as:
  - Systems and products description and characteristics;
  - Verification and monitoring results.

The GDPFS is a results-oriented structure, aimed at ensuring that scientific and technological advances made in meteorology and related fields are transferred as efficiently as possible in operational conditions for the benefit of WMO Members. It provides a framework to ensure that products and services delivered within its scope meet stated requirements, agreed at the appropriate level, on operational quality and reliability.

The GDPFS makes full use of the latest research and development in numerical weather prediction. The advances in NWP since the previous full edition of this Manual in 1992 have been tremendous: higher accuracy, higher resolution, longer lead-time, wider range of relevant applications. Consequently the emphasis in operational meteorology has shifted towards the implementation of more and more sophisticated and diverse numerical models and applications, for an ever increasing variety of users.

The main support for the exchange and delivery of GDPFS products is the WIS. One of the key features of the WIS compared to the GTS is the expansion of the range of centres which can connect to the system; this feature will help to support the continuous increase in the range of GDPFS applications.

2. ORGANIZATION OF THE GDPFS

The GDPFS is composed of a variety of operational centres committed to perform specific operational activities, and to enable WMO Members to benefit from them. The activities can be either for general purpose or specialized for various types of applications; operational coordination activities (often referred to as Lead Centre activities) are also part of the GDPFS. The functions and commitments associated to each category of activity are detailed in part II of the Manual.

– General purpose activities:
  2.1.1. Global NWP
  Run deterministic global numerical weather prediction operationally and make it available on the WIS
  2.1.2. Limited area NWP
  2.1.3. Global ensemble prediction
  2.1.4. Limited area ensemble prediction
  2.1.5. Nowcasting
  Post-processing of observation and numerical model output
  2.1.6. Seasonal and climate numerical prediction
  GPC business
  2.1.7. Wave and storm surges numerical forecasting

– Specialized activities:
  2.2.1. Coordination of high impact weather forecasts (e.g. Pretoria in the SWFDP for SE Africa)
  2.2.2. Climate prediction and information
  RCC business
  2.2.3. Generation of LRF MME products
  2.2.4. Tropical Cyclone forecasting
  2.2.5. Volcanic ash warning and prediction for aviation
  2.2.6. Response to Marine Environmental Emergencies
  2.2.7. Response to Nuclear Environmental Emergencies
  2.2.8. Response to non-Nuclear Environmental Emergencies
  2.2.9. Sand and Dust Storm warning and prediction
  2.2.10. …
– Coordination activities:
  2.3.0. Coordination of deterministic NWP verification
  Collect standard verification statistics from GDPFS centres producing global NWP and make them available on a dedicated website
  2.3.1. Coordination of EPS verification results

2.3.2. Coordination of LRF verification results
2.3.3. Coordination of wave forecast verification
2.3.4. Coordination of GOS observation monitoring results (surface, upper-air, etc.)
2.3.5. Coordination of GCOS observation monitoring results (GSN and GUAN)
2.3.6. …

A given GDPFS centre can perform several types of GDPFS activities.

Where appropriate, the centres contributing to an activity of a given type can be organized as a coordinated network, or sub-system. A given GDPFS centre can contribute to several sub-systems.

3. COORDINATION WITH OTHER SYSTEMS OR PROGRAMMES

In many cases the activities undertaken by GDPFS centres are constitutive of the operational component of a system developed under another structure or programme, either by WMO on its own or jointly with other international organizations. In such cases, the regulations pertaining to these activities should cover both:

– The specific requirements defined by the relevant structure (e.g. CCl for the Regional Climate Centres (RCCs), ICAO International Airways Volcano Watch Operations Groups (IAVWOPS-g) and International Volcanic Ash Task Force (IVATF) for the Volcanic Ash Advisory Centres (VAACs)); and

– The general GDPFS criteria regarding operational quality and reliability, verification, documentation and compliance (cf. II.1).

The coordination mechanism to that effect is not the same across all the categories of activity; it is specified for each activity in part II of the Manual.

PART II – SPECIFICATIONS OF THE GDPFS ACTIVITIES

1. OVERALL REQUIREMENTS

Description in general terms of the functions which are always required (details to be given in paragraph. 2):

1.1. Acquisition of observational data
  i. Real time quality control
  ii. Non real time monitoring and reporting
1.2. Product dissemination via the WIS
1.3. Products verification *(in accordance with specific procedures where available, e.g. SVS-LRF)*

User oriented

1.4. Providing and keeping up-to-date documentation on system and products *(preferably on a website)*
1.5. Reporting on compliance *(preferably by maintaining appropriate status of implementation information available on a website)*

2. SPECIFIC FUNCTIONS

For every activity listed in Part I (2.1.1 to 2.3.6):

- *Le cas échéant:* designation of the system or network involved (e.g. GMDSS, VAAC, SDS-WAS)
- Description of the required functions and implied commitments, or reference to appropriate documentation where it exists:
  - Mandatory functions

        - Geographical area of responsibility where appropriate
    - Mandatory product dissemination
    - Mandatory verification results
    - Mandatory status of implementation information

Additional recommended functions and products to be mentioned in Attachment

Example for activity 2.1.1, global NWP

- The centres participating in activity 2.1.1, global NWP, shall:
    - Prepare global analyses of the three-dimensional structure of the atmosphere
    - Prepare global forecast fields of basic and derived atmospheric parameters
    - Make available on the WIS a range of these products. The minimum list to be made available, including parameters, forecast range, time steps, production time window and frequency, is given in Appendix XXX
    - Prepare verification statistics according to the standard defined in Appendix XXX', and make them available to the centre(s) participating in the coordination of deterministics NWP verification
    - Make available on a website up-to-date information on the characteristics of its global NWP system. The minimum information to be provided is given in Appendix XXX''

Example for activity 2.3.1, coordination of deterministic NWP verification

- The centre(s) participating in activity 2.3.1, coordination of deterministic NWP verification, shall be designated as Lead Centre(s) for deterministic NWP verification
- These centre(s) shall:
    - Provide the facility for the GDPFS Centres producing global NWP to automatically deposit their standardized verification statistics as defined in Appendix XXX, and give all participating Centres access to these verification statistics
    - Maintain an archive of the verification statistics to allow the generation and display of trends in performance
    - Monitor the received verification statistics and consult with the relevant participating centre if data is missing or suspect
    - Provide access to standard data sets needed to perform the standard verification, including climatology and lists of observations and keep this up to date according to CBS recommendation
    - Provide on its (their) website(s):
        - consistent up-to-date graphical displays of the verification results from participating Centres through processing of the received statistics
        - relevant documentation including access to the standard procedures required to perform the verification, and links to the websites of GDPFS participating Centres
        - contact details to encourage feedback from NMHSs and other GDPFS Centres on the usefulness of the verification information
- These centre(s) may also provide access to standardized software for calculating scoring information.

PROCEDURES FOR MODIFICATIONS

For every activity listed in part I (2.1.1 to 2.3.5):

- Indication of the body responsible for defining the requirements listed in paragraph 2
  In case of joint responsibility: indication of the coordination mechanism (e.g. for RCCs: joint CCl–CBS/DPFS task team; for VAAC : ???, etc.)

Example for activity 2.1.1, global NWP

- The functions required from GDPFS centres running global NWP shall be proposed by the ICT of the CBS OPAG on Data-processing and Forecasting Systems, subject to CBS approval and EC decision

Example for activity 2.3.1, coordination of deterministic NWP verification

– The functions required for the coordination of deterministic NWP verification shall be proposed by the CBS coordination group on forecast verification, subject to CBS approval and EC decision

– Indication of the body responsible for monitoring compliance

Example for activity 2.1.1, global NWP
– The compliance of the GDPFS centres running global NWP shall be monitored by the ICT of the CBS OPAG on Data-processing and Forecasting Systems, who will report to CBS accordingly

Example for activity 2.3.1, coordination of deterministic NWP verification
– The compliance of the centre(s) participating in the coordination of deterministic NWP verification shall be monitored by the CBS coordination group on forecast verification, who will report to CBS accordingly

PART III – GDPFS IMPLEMENTATION

1. *For every activity listed in Part I (2.1.1 to 2.3.6):*
– List of centres and relevant web address with status of implementation information

2. *For every centre contributing to the GDPFS:*
– List of activities undertaken.

ANNEX XIV
Annex to paragraph 4.5.1.3 of the general summary

WMO GUIDING PRINCIPLES FOR SERVICE DELIVERY

1. Purpose

The purpose of this document is to propose Guiding Principles for Service Delivery that will assist National Meteorological and Hydrological Services (NMHSs) in the provision of weather-, climate- and water-related services that incorporate user needs and performance metrics. While there is no prescriptive way to provide services, the Guiding Principles aim to improve service delivery by sharing best practises between NMHSs and to increase focus of WMO Programmes on service delivery in accordance with the WMO Strategic Plan.

2. Introduction

Effective service delivery is a fundamental requirement for NMHSs if they are to meet national needs. However, there are many different interpretations of the concept of service delivery as it relates to the provision of weather-, climate- and water-related services. Several of these are defined and discussed in this paper with the intent of forging an international WMO Guiding Principles for Service Delivery.

3. Principles guiding effective Service Delivery

(a) User engagement and feedback is essential in designing and delivering effective services;

(b) Sharing best practises leads to effective and efficient service design and implementation;

(c) Service concept applied to all WMO activities and culture change is essential to ensure the success of service delivery;

(d) Partnership with other international and regional organizations that are also engaged in delivering services is essential in maximizing the use of weather, climate and water information for decision-making.

4. Attributes of effective services

Effective services should be:

(a) Available: at time and space scales that the user needs;

(b) Dependable: delivered regularly and on time;

(c) Usable: presented in user specific formats so that the client can fully understand;

(d) Useful: to respond appropriately to user needs;

(e) Credible: for the user to confidently apply to decision-making;

(f) Authentic: entitled to be accepted by stakeholders in the given decision contexts;

(g) Responsive and flexible: to the evolving user needs;

(h) Sustainable: affordable and consistent over time; and

(i) Expandable: to be applicable to different kinds of services.

5. The role of WMO in the Guiding Principles for Service Delivery

5.1 WMO provides international coordination and sets standards for weather-, climate- and water-related products and supporting services. This includes observations, data quality, and telecommunications. The data underpinning meteorological and related products require international coordination and validation to guarantee that they meet the needs of the product generating centres. The communication systems that move data and products globally are coordinated through WMO. The assessment, and objective verification of products that are generated by one country and used by others may also be coordinated by WMO and the results shared and used in the process of improving the quality of products for all.

5.2 WMO also provides guidance for service delivery which is used to good effect by all Members. However, Guiding Principles for Service Delivery are required to provide a more uniform and structured approach for WMO and its NMHSs on service development and delivery applicable to all weather, climate and water information.

5.3 NMHSs deliver a wide range of weather-, climate- and water-related services to meet a broad range of needs. In the majority of these cases needs are defined nationally, the major exceptions being services for international aviation and shipping, which conform to international standards and defined user requirements. Providing an international strategy through WMO will enable NMHSs to improve national service delivery by sharing better practises and supporting mutually agreed guidelines, and by increasing the user targeting of the services.

5.4 The Guiding Principles on Service Delivery will also help enable capacity-building within NMHSs in order to make best possible use of resources. This is achieved by focusing the assignment of resources to countries with the greatest need for assistance in service improvements, or to relevant Secretariat activities required to underpin and coordinate this capacity-building.

6. What drives the priority of Service Delivery in NMHSs?

6.1 The public and political assessments of the effectiveness of NMHSs occur continuously. These depend largely on how effectively the NMHSs meet the service delivery standards of the

nations they serve. Confidence in NMHSs derives from demonstrated capability to deliver services in a way that meets national and public needs. It is not enough that staff within the NMS or NHS consider the services they provide to be world-class, highly accurate or even perfectly usable and relevant to their community's needs, what is required is that the community receives services that meet their needs. This requires concerted effort for direct communication and engagement with the users.

6.2 The ability of an NMS or NHS to meet national service delivery needs is put to its most critical test when an extreme hydrometeorological event occurs and then even the best forecast, issued on time, is no defence in the event of a national disaster if no one used that forecast. Providing effective warning, forecast and assessment products and services depends on a system that engages users, the problems, the risks and the values throughout the process. Most of the utility of weather, climate and water information, added or lost in the value-chain of decisions and actions between the physical phenomena and their subsequent impact, occurs in communicating the information to users and in the behaviour of users in response to that information, and ultimately in the effect of their decisions in societal and economic outcomes. If the user cannot make changes or there is no effect on the outcome, the information is of little direct value. Value can be increased by improving the forecast, by improving communication, and by improving the decision-making process. If the currently available information is underutilized, value will likely accrue if the communication or decision-making process is improved. Service delivery is about providing the service that the users actually use because it meets their needs.

6.3 Countries make choices about which services their NMHSs will deliver. Generally, NMHSs must meet the key public needs in such a way as to have the greatest beneficial impact on their community. In one sense, this makes prioritization straightforward for NMHSs because it is clear that the activities that contribute most to the safety of life and property have the highest priority. However, the risks are not always obvious to national governments and are rarely objectively or continuously assessed.

7. Elements of service delivery for WMO

7.1 The WMO Strategic Plan emphasizes enhancing the capabilities of Members to provide and use weather, climate, water and environmental applications.

7.2 WMO Programmes, as part of the Guiding Principles on Service Delivery, should adopt improving service delivery as part of their responsibility to assist NMHSs, including by encouraging them to:

(a) Evaluate user needs and decisions, including drivers to:

- Increase understanding and acting upon societal and economic requirements for impact-related weather, climate, water and air quality services;
- Increase training and provision of guidance material to enhance NMHSs and partner organizations' ability to deliver useful services;
- Expand the use of weather, climate and hydrological services;
- Improve the decision-making capability of Members by providing appropriate inputs to Members, including through integrated early warning of sector specific impacts, and information related to climate risk management and adaptation to climate change;

(b) Develop and improve Service Delivery mechanisms to:

- Improve relevant, timely, cost-effective and useful products and services that can be used beneficially by WMO Members;

- Increase collaboration and cooperation between NMHSs, sectors and government agencies whose day-to-day activities are affected by weather and climate and which can benefit from improved weather, climate and water services;

(c) Define service outcome effectiveness to:

- Effectively use performance management approaches, tools and methods;
- Ensure more people take effective action in response to information received;
- Increase participation of NMHSs in Members' meteorological and hydrological risk management activities;

(d) Establish governance practices by:

- Ensuring that information is received and acted upon;
- Learning from successful outcomes;
- Sharing responsibility with all the partners engaged in Service Delivery.

8. Evolving User Needs

8.1 Service delivery must focus on collaborative problem solving which requires full engagement between providers and users. Service delivery is a complex issue and there are gaps in how services are delivered. These gaps need to be addressed and reduced. A service for a particular sector involves a broad partnership of producer and user organizations, meteorologists and related scientists, and practitioners from user sector and supporting organizations. It provides an opportunity to interlink global, regional and national information systems; to provide comprehensive modelling and analytical capability to address problems at regional and local scales, and to provide for a distributed decision-relevant research and development capability. It is the latter, which sets this service apart from the traditional, exclusively science-based forecasting service. Each service must be adapted to the sector it serves.

8.2 With evolving needs of users, in order to stay relevant, NMHSs need to adapt themselves to user requirements. Implicitly, although service delivery is part of the role of NMHSs and collaborating organizations on technical matters, it should ideally be a partnership between environmental and social organizations. As such, one approach is to create a mechanism, which may be in the form of a real or virtual co-location of providers and users of weather, climate and water information who work together, iteratively, to deliver timely, effective and user specific services. It brings together the operational capacity of providers and users of weather, climate and water information and services. The mechanism, which may be called a "platform", an "approach" or a "framework", integrates environmental and user-specific data to determine impacts on the public and social and economic sectors such as energy grid management, construction sites, flood control and urban inundation agencies, emergency responders including the police and fire services, hospitals, transportation, accident management and control, airports, harbours, etc. The benefit to users would be an operational network that evolves to meet specific user needs, forecasts systems targeted to user decisions and an integrated system that aligns weather, climate and water information with social, economic and other user-specific information. A public service "platform", "approach" or "framework" would provide the opportunity to focus on strengthening ground-based observation systems, strengthening surveillance, creating integrated early warning and assessment systems for weather, climate and hydrological forecasting systems, and providing fast, efficient and unified service delivery. The "platform", "approach" or "framework" (representing all the operational providers and users) is instrumental in setting requirements for research and development.

8.3 The net effect should include strengthening partnerships with key user sectors and government ministries. The aim would be to realize tangible and quantifiable benefits to communities by exploiting new operating partnerships between user and provider to share responsibility for effective delivery of services. This would include the development of new tools and methods to strengthen dialogue and collaboration between provider and user, especially the implementation of more interactive early warning and forecasting systems for weather, climate and water, which are integrated into every level of governance from the community level to the national infrastructure.

8.4 By distinguishing between service delivery and production, emphasis is placed on information sharing, joint information dissemination, joint research and training, and joint product development between the service provider and the user. In addition to the information generated by the NMS, the platform would also seek to integrate data from outside partners, both national and international, so that users have access to all relevant information through a single source with which they can work directly.

9. Responsibilities of WMO Members

WMO Members will:

9.1 Rely on technological advancement to optimize forward looking service delivery, and this will be particularly important in building capacity in service delivery in developing countries.

9.2 Agree on minimum guidelines and approaches for the development and provision of weather, climate or hydrological services. The approaches may be nationally determined, monitored and evaluated and results should be exchanged among WMO Members. The evaluation should include user assessment of the services intended for their use.

9.3 Transfer knowledge through advanced capacity-building approaches (e.g., by engaging in regional partnerships and documentation of best practices).

9.4 Engage in regional focus on user needs through information platforms (e.g., METEOALARM in Europe), regional workshops and forums for different user sectors.

9.5 Develop acceptable metrics to determine the effectiveness of NMHSs' service delivery and agreed programmes that monitor and assess service quality and effectiveness.

9.6 Exchange information between NMHSs on their effectiveness in engaging users and measuring outcomes as a means of capacity-building.

9.7 Understand better the relevance of their services judged in the context of user needs. The information will be used to improve the efficiency and effectiveness of all WMO Programmes, and, as a consequence, of all Members. Quality management is an important element of these Guiding Principles.

9.8 Establish a time-frame for reviewing the Guiding Principles.

10. Implementation of the Guiding Principles

Taking into consideration the strong coordination aspect of service delivery, the following activities, among others, need to be undertaken to apply these Guiding Principles:

(a) Establish an approach within the NMHS to respond to needs of selected user communities;

(b) Conduct a survey of NMHS service delivery priorities, and develop an inventory of existing good practices;

(c) Apply the new approach to at least one priority service;

(d) Evaluate the results of service quality taking into account the guidelines and approaches (see 9.2) and user satisfaction.

11. Definitions related to provision of weather, climate and water

11.1 NMHSs (always used in the plural) – National Meteorological Services (NMSs) and National Hydrological Services (NHSs); NMS – A National Meteorological or Hydrometeorological Service; NHS – A National Hydrological Service.

11.2 Users – Users are individuals or organizations with responsibilities for decisions and policies in sectors that are sensitive to weather, climate and water and for whom products and services are provided by NMHSs or collaborating organizations. If the user has paid directly for the service, he/she is generally called a customer.

11.3 Providers – Individuals or entities that produce or acquire weather, climate or water information or products that are then supplied in support of users' needs in this regard. NB: Providers may include NMHSs, Collaborating Organizations, other meteorologically-relevant agencies and the private sector, but this present strategy focuses only on WMO NMHSs.

11.4 Collaborating Organization – An organization or entity (e.g. a University, a specialized non-government centre, a relevant government agency) of a WMO Member that provides complementary/additional weather, climate or water information to NMHSs or directly to users, under terms and conditions that have been mutually agreed.

11.5 Product – A product is basic information such as observations, datasets, or information that is created by an analysis or forecast process. For example, products include a warning of a tropical cyclone, a forecast of heating degree days for the next five days, a seasonal forecast, a time series, a climatological normal, a hydrological risk map, a satellite image, etc.

11.6 Service – A service is a product delivered or activity that is carried out (advice, interpretation, etc.) that meets the needs of a user or that can be applied by a user. A true service is therefore based on an understanding of the user's requirements, provides information, products and advice that is tailored for the user, e.g. in terms of timing, format, or content, and maintains a dialogue with the user. Providing a user access to a tropical cyclone warning in a convenient and timely manner is a non-user-specific service. Providing a customer access, for a commercial fee, to the five-day forecast of degree heat days, for example, is also a non-user-specific service. Both government and non-government entities supply weather-, climate- and water-related services (see also 3.3 and 3.4 above).

11.7 Service Development – A service should be co-developed by the user and the provider of the weather, climate and water products, a process which reflects the increasing importance of user-defined products and services, which integrate weather, climate and water information into user decision support systems.

11.8 Service Contract – Services may be provided as a public good; on a contractual basis to certain users or on a commercial basis to a fee paying customer. In all cases there is an implicit or explicit contract between the provider and user of the services to strive to meet the needs of the user.

11.9 Fit for Purpose – Within the implicit or explicit contract between the provider and user, and resulting from an extensive dialogue between the provider and user, 'Fit for Purpose' implies a clear understanding and agreement in terms of:

- What is the information need?

- How will the information be provided?
- How will the information be used?
- The risks inherent in the decisions to be made using the information;
- The strengths and weaknesses of the information being provided (including verification and inherent uncertainties).

11.10 Service Delivery Process – The service delivery process describes the end-to-end activity of:

- Preparing and delivering the service;
- Ensuring that the service is fit for purpose;
- Establishing a feedback system that monitors the user/customer needs and their feedback on the quality of the service provided; and,
- Managing the service performance continuously for service improvement over time, with respect to current and evolving user requirements.

ANNEX XV
Annex to paragraph 7.1 of the general sumamry

COMMISSION FOR BASIC SYSTEMS TECHNICAL CONFERENCE

"End-to-End Service Delivery: From Observations to Services, the Way Users Need Them"

(Windhoek, Namibia, 19–20 November 2010)

Final Report

1. Introduction

A Technical Conference on End-to-End Service Delivery (TECO-E2E) was organized in conjunction with CBS-Ext. (10) in Windhoek, Namibia from 19 (p.m.) to 20 November 2010. The TECO-E2E aimed to demonstrate the end-to-end role of CBS, which mirrors and supports that of NMHSs in delivering to users in different sectors the weather, water and climate information and services that they require for their purposes. The TECO-E2E also took stock of the complementary role of GEO in ensuring that earth observations and information are available and accessible to meet the needs of a broader community of users, and explored how we can work together better within CBS and with GEO to optimize meeting end user needs.

2. Structure of TECO

The TECO-E2E was chaired by the Vice President of CBS. It comprised presentations from representatives from acorss CBS and invited guests, as well as panel discussions. The programme followed the chain from users through systems and services and back to users, with a focus on disaster risk reduction.

3. The Users (part 1)

The Session started by considering "Who are users, what information and services do they need and how do they want it delivered?". The breadth and diversity of users was demonstrated by example, ranging from those who require services to support safety, health and food supply, to a wide range of socioeconomic sectors, such as transport and energy through to major events management, public policy and enforcement.

Starting and ending with users, the President of CBS described the functioning of CBS through providing basic systems and services via World Weather Watch (since 1963) and Public Weather Services (since 1994) as an end-to-end service support mechanism, including support for a seamless multi-scale, multi-hazard approach to Disaster Risk Reduction (DRR). He defined 'end-to-end services' as 'from user to user' and showed how the roles and work programmes of the OPAGs spanned the chain from user requirements through to user satisfaction. Importantly, he emphasized that services are only of value to users if they fulfil a need, whether it be real or perceived.

The GEO Secretariat presented the systems of systems approach of GEOSS, focused on sharing and making accessible observations and information to meet the needs of users across nine Societal Benefits Areas (SBAs). Building on the contributed systems of Members and Participating Organizations, such as WMO, GEOSS advocates the exchange and use of observations and information by users across all SBAs. The Basic Systems of WMO and its Members are a key contribution of data and expertise in GEOSS, and contribute to many of its early achievements. Working together with GEO at a national level will reinforce the key role of NMHSs in meeting national-level needs for weather, water and climate information and services, building on their close relationships with their user communities, which often span all GEO SBAs.

Some important perspectives on users were highlighted through the panel discussion:

- Availability, dependability, usability and credibility are critical success factors for the effective uptake of services by users.
- To really understand user needs, we need to get to know our users (human to human) and relate to their world, their problems and their issues.
- To ensure services deliver their intended message, we need to ensure that they are properly and fully interpreted.
- User feedback is essential; we must be prepared to listen and to accept criticism.
- Modern channels of service delivery, such as the internet, make vast amounts of information available to users, but quality is less readily controlled. Technology may become a barrier to genuine user engagement. Quality of information needs to be matched to quality of presentation.
- In some countries there are indigenous, cultural or folklore-based, weather predictions. Rather than dismiss such approaches we should work with these communities to introduce them to more scientific approaches to weather forecasting.

4. The Integrated Observing Systems

The role of the Integrated Observing Systems (IOS) as part of the end-to-end mechanism was demonstrated, showing how user requirements are captured and how the value of different types of observations are evaluated, and how these in turn inform the development of observing systems solutions. The Rolling Review of Requirements (RRR) and its impact on the GOS of the future, and the Observing System Experiments (OSE) and the contribution of impact studies to the evolution of the GOS, formed the basis for ensuring that the observing systems available to, and used by NMHSs evolve with changing user requirements and are best positioned to meet possible future needs. The design of future observing solutions also benefit from synthetic observations experiments and close monitoring of technological advances.

Some important issues and challenges were highlighted through the panel discussion:

- The difficulty of accurately specifying "measurement capabilities" for observing systems where the relation between the measurement and the relevant geophysical quantity is complex (e.g. precipitation radars). On this issue it is particularly important to work closely with CIMO.
- The need to retain the technology-free nature of the user requirements database underpinning the RRR.
- NWP metrics are quantitative, relatively easily conveyed and therefore very powerful assessment tools. They should be used to provide guidance where appropriate, but care should be exercised NOT to have them misused to assess observing systems targeted at other applications.
- There is therefore a need to strengthen the way in which user requirements for non-NWP applications are captured in the RRR.
- Improved interactions need to be developed with other technical commissions and amongst all the CBS OPAGs to ensure that the RRR accurately captures all user requirements and observing system capabilities. This will be even more important as we broaden the application areas (e.g. GFCS) and move toward the implementation of WIS and WIGOS.
- The network of networks concept, at the GEOSS level and at a national level, introduces many challenges and opportunities. Defining and sustaining base high quality networks that meet key needs, especially for climate, DRR and other designated high priority needs, are critical.

5. The Information Systems and Services

Information Systems and Services (ISS) embrace the breadth of the end-to-end mechanism that is CBS. The session addressed in a very practical and direct way some issue of key interest to NMHSs in implementing WIS, including developing and preparing data for the WIS, techniques for accessing the WIS, and how the WIS will look to users.

The following issues were highlighted in the presentations and discussion:

- Now that the WIS is approaching technical maturity, there is an urgent need for a guide aimed at non-technical users of the WIS.
- The different roles of WIS centres are not clear to most members.
- There are several classes of user for WIS: public access, registered users (from NMHS and other institutions that participate in WMO Programmes and, potentially GEO programmes), those creating and maintaining metadata, and those administering the WIS centres.
- Although GISCs have technical means of limiting access to groups of data, the only data policies in place at present are those for "essential data" and "additional data." Setting the data access policies is a task for the Programmes (or Congress).
- Clarity of expectations regarding level of service is required, embracing:
    - the timeliness and availability needs of Programmes;
    - monitoring to ensure that these standards are being met;
    - the quality expectations of the data content that is exchanged over WIS;
    - mechanisms to monitor quality and to initiate corrective action by those responsible for the data.

6. The Severe Weather Forecast Demonstration Project (SWFDP)

The SWFDP is a successful example of an end-to-end mechanism for production of user-focused products and delivery to users. A four part presentation highlighted the SWFDP concept and developments; a Global Centres contribution to the SWFDP including GIFS-TIGGE aspects; the role of the Regional Centres; as well as views of a participating NMHS and user representative perspectives.

Issues that were highlighted in the presentations and discussion include:

- SWFDP concept aims to improve early warning systems in NMHSs where there is a huge gap in using modern forecasting technology, and it works (e.g. effective warning services for disaster management in Mozambique).
- The leading regional centre plays a key role in the SWFDP process through providing a portal, linking global and national centres, and facilitating training.
- The sustainability of SWFDP depends on the region's ability to keep up with international developments in forecasting and early warning practices.
- SWFDP could be a vehicle for enhanced implementation of an end-to-end data-exchange-production-services system.
- 'SWFDP' has become a very strong brand and can facilitate securing resources. It should not be discontinued.

7. The Users (Part 2)

User perspectives from user-representatives in the health (Madagascar) and disaster management sectors (Mozambique) were presented, focusing on what information was needed to assist in decision-making and how that information should be presented. PWS delivery to end users in China was highlighted. The Session examined each of the many delivery channels in terms of their respective strengths and weaknesses. Specific themes that emerged included the desirability of having Standard Operating Procedures for PWS delivery, and the extra emphasis on training and capacity-building given the complex role of the forecaster in interpreting weather information for users.

Important issues and challenges highted were:

- There is a very broad range of users, both in terms of timescales and variety of endeavour.
- Many societies have an increased vulnerability to severe weather with potentially significant adverse socio-economic impact.
- NMHSs need to proactively communicate with users; to explain what they can do and learn about the users needs.
- Weather information dissemination channels should be two-way mechanisms; each channel has specific strengths and weaknesses.
- End to end services implies a continuing cycle of improvement joined with progress; like the double helix it implies constant evolution and growth in NMHS capacities and user services.

The WMO Disaster Risk Reduction program is a good example of a horizontal end to end approach. It aims at leveraging WMO research and operational capacities to address the information challenge in disaster risk management at all levels. Through the various prototypes put in place as well as through recent interactions with Humanitarian Agencies, it was found that:

- Institutional mechanisms between all of the partners at the international level need to be adapted.

- A systematic approach is required for the identification of the needs of humanitarian agencies.
- A mechanism is needed to facilitate the development of products and services by the NMHSs and RSMCs that could be disseminated through the humanitarian agencies information systems.
- In times of crises there is a strong need for an effective mechanism that ensures provision of official information and warnings to humanitarian agencies based on clear operational procedures.

8. Key Messages

The TECO-E2E highlighted some key messages for CBS in better performing its end-to-end (or user to user) role in supporting NMHSs.

From the OPAG-IOS perspective:

1. Rebalance the workload involved in updating the RRR databases between the expert teams within OPAG-IOS. Strengthen the link to the regional associations.

2. Strengthen the collaboration across the OPAGs in order to improve the way non-NWP requirements are captured in the RRR.

3. Establish formal links to various OPAGs and ETs in other technical commissions to further develop the way in which “observing system capabilities” are represented in the RRR databases.

From the OPAG-ISS perspective:

4. Publish guidance on the use of WIS that is suitable for non-technical users.

5. Identify the service levels needed for the different internal and external services provided by CBS, and include these in Rolling Reviews of Requirements and monitoring procedures.

6. Clarify the data policies that Programmes in all Commissions will need WIS to support.

From the OPAG-DPFS perspective:

7. Retain the principles applied in the project development so far: realism, pragmatism, and also ambition and application of the various people and services involved. Do not jeopardize the project by wanting to do too much too quickly.

8. Continue to build up on the SWFDP model, paying particular attention to ensuring sustainability, and progressively extending the range of targeted applications to transfer the benefits of the SWFDP to other users sectors in society.

From OPAG-PWS perspective:

9. The four elements of the services chain would be better represented through a re-organization of the PWS OPAG.

10. The OPAG should address the changing role of the forecaster and the implications for the skills and competencies needed and thus for training and capacity-building.

11. Recognizing the need to identify both internal and external users, the PWS OPAG should work with the Chairs of the other OPAGs within CBS to streamline service delivery within the work of the Commission.

From a DRR perspective:

12. It is recommended that the Commission, when appropriate in partnerships with other technical commissions:

    - Further develop probabilistic forecasts, products and services as well as develop approaches to communicating probabilistic information and background material for experts and non-experts users.
    - Initiate a process to gather and analyse statistics on hydro-meteorological disasters.
    - Initiate a process to quantify the contribution that weather, water and climate to disaster risk reduction.
    - Continue to develop new partnerships and maintain and improve existing ones.
    - Initiate a process to analyse strengths and weaknesses of existing institutional mechanisms.

In closing, the Chair reflected that the world we live and work in is changing, as is our user community. We need to build skills to meet these evolving user needs and capabilities. CBS, as the biggest Commission, deals with every aspect of delivering services to users and needs to recognize and act on these changes. This can only happen if we put users first and last in all our endeavours.

APPENDIX

LIST OF PARTICIPANTS

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