WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS

SECOND MEETING OF THE INTER-PROGRAMME TASK TEAM ON FUTURE WMO INFORMATION SYSTEMS

FINAL REPORT

MONTEREY, CALIFORNIA, 28 AUGUST - 1 SEPTEMBER 2000

DISCLAIMER

Regulation 42

Recommendations of working groups shall have no status within the Organization until they have been approved by the responsible constituent body. In the case of joint working groups the recommendations must be concurred with by the presidents of the constituent bodies concerned before being submitted to the designated constituent body.

Regulation 43

In the case of a recommendation made by a working group between sessions of the responsible constituent body, either in a session of a working group or by correspondence, the president of the body may, as an exceptional measure, approve the recommendation on behalf of the constituent body when the matter is, in his opinion, urgent, and does not appear to imply new obligations for Members. He may then submit this recommendation for adoption by the Executive Council or to the President of the Organization for action in accordance with Regulation 9(5).

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Executive Summary

The second meeting of the Inter-programme Task Team on Future WMO Information Systems reviewed current and emerging technologies that could have an impact on development of future WMO information systems. This included the rapid proliferation of the Internet and its associated technology (TCP/IP, routers, Web browsers), low cost satellite communication systems, portable programming languages (Java), and Extensible Markup Language (XML). The team also considered a number of technologies and examples of specific systems that have utilised these technologies in their construction.

Considering possibilities offered by modern technology and the requirements of all WMO Programmes the team developed a vision for the future WMO information system. The system should:

- include the support for ad hoc requests as well as routine distribution of information,
- include a dataset catalogue to enable users to locate data and products they require,
- conform to open, global standards to the greatest extent possible.

Distribution of ad hoc non-routine products should be accomplished via request/reply or "pull" systems. Routine collection and dissemination should be accomplished via a "push" system, which could be implemented via a combination of technologies. The “push” and “pull” systems, operating in parallel, should be available to all users of WMO data and products.

The experts developed a logical topology for the future WMO information system that is significantly different than the current GTS and includes new definitions for participating centres. It would rely upon a combination of public and private networks and utilise international protocols and standards and off-the-shelf software.

The team defined three levels of participating centres: Global Information System Centres, Specialised Product Centres and National Centres. Several Global Information System Centres (GISC) would form the top level of the future system. These centres would collect all observations and products intended for global distribution from supplying centres within their area of responsibility. They would combine observations into large aggregated datasets which would be disseminated through a variety of technologies including hierarchical store and forward systems, satellite broadcast, and perhaps network multicast. Several dozen centres would serve as Specialised Product Centres (SPC). Existing RSMCs would function as SPCs. However, many additional centres would also serve as SPCs, including suppliers of special observations (e.g. ARGOS, ARINC), research projects, and centres producing products related to a specific discipline. National Centres would form the foundation of the future WMO information system. Many National Centres would be part of an NMHS but others would have national responsibility for functions falling within WMO Programmes but located outside of the NMHS.

The team recommended further examination of successful implementations of promising new technologies by those outside of the WMO community and initiation of pilot projects that utilise critical aspects of these technologies. It recommended that development of a WMO catalogue of products be pursued as a high priority. It noted that the conceptual vision developed by the team could be implemented with existing technology but felt that to do so satisfactorily may require changes in responsibilities between Members, and between centres as they are currently configured.

1. ORGANIZATION OF THE MEETING

1.1 Opening remarks

1.1.1 The second meeting of the Inter-programme Task Team on Future WMO Information Systems opened at 0900 on Monday 28 August 2000 at the Naval Postgraduate School in Monterey, California, USA. Dr G. Love (Australia), chair of the team, opened the meeting. Dr T. Tsui welcomed the participants to Monterey and to the USA. Mr D. McGuirk welcomed the participants on behalf of the Secretary-General and outlined the objectives of the meeting.

1.2 Adoption of the agenda

1.2.1 The meeting adopted the agenda as reproduced in the beginning of this report.

2. DEVELOPMENT OF A WMO GUIDE ON DATA MANAGEMENT

2.1 Dr Love discussed the efforts on developing a draft WMO Guide on Data Management being undertaken by Australia. At the previous meeting of this team (November 1999) he had indicated that he and some officers of the Bureau of Meteorology would attempt to prepare draft of the WMO Guide on Data Management. The background to the task was that Cg XII had noted the need for such a document and had asked CBS to oversee its preparation.

2.2 Dr Love noted that the Guide was not intended to prescribe in detail how WMO information system and services should be designed and operated, but rather it should give an overview of the structure and elements of current WMO data management activities, and indicate where these might be headed in the first decade of the 21st century. It should also include a general discussion of the more traditional ideas on quality control and integrity of data without duplicating material provided by other technical commissions.

2.3 Dr Love reported that while he had had some success at preparing material on the more traditional aspects of data management, he had experienced considerable difficulty in developing useful text relating to data management principles and practices appropriate for the new generation technologies. The team felt that at this stage any document that could be prepared would either be too general to be of use, or would cover much of the same material already covered by the guides of the Commissions for Hydrology, Climatology or Basic Systems. The team agreed that work on this task be suspended pending further direction on the goals of a WMO Guide from CBS or Congress.

3. INTERRELATIONSHIPS BETWEEN WMO INFORMATION SYSTEMS

3.1 The task team considered the issue of the inter-relationship between the information systems which support the:

- World Weather Watch;
- WMO Programmes other than the those managed by CBS; and
- Broader environmental community beyond WMO.

3.2 The team noted that the WWW's primary requirement is for an information system focused on the collection of observational data, and the exchange of products based on these data, in real time. This exchange is underpinned by Resolution 40 (Cg XII), which relates to conditions applying to the free and unrestricted exchange of meteorological and related data and products, and is generally achieved via the GTS.

3.3 The requirements of the Technical Commissions other than CBS are met, in part, by the WWW's real-time datasets exchanged via the GTS, and also by exchange via the Internet. The Internet is used for the ad-hoc exchange of files and for the routine downloading of specific files held on Member's servers (including satellite data and data types not generally exchanged on the GTS).

3.4 Beyond the WMO programmes environmental data are exchanged using the Internet as well as through private communication networks. The display of environmental data is increasingly being done through the use of so-called Geographical Information System (GIS) technologies. GIS appear to be particularly useful where data are not changing dynamically over short periods of time, where data are essentially two-dimensional and where there no underlying physical principles that relate the different variables that must be considered by the display routine. Furthermore, the Team noted that the use of GIS technologies is widespread, and increasing rapidly as GIS capabilities are extended. There is some possibility that these deficiencies, which currently limit the usefulness of GIS for meteorological applications, may be addressed within the next 5 years or so.

3.5 The Team discussed the issue of the extent to which the convergence of data management technologies could lead to the availability of an integrated, GIS-based system capable of meeting the requirements of all three areas; the WWW, WMO Programmes not managed by CBS, and the broader environment community. In this discussion it was noted that that there may be some advantage in maintaining a logical separation of the WMO's system for exchanging data from others. This separation could possibly be supported by modern security features (e.g. firewalls, virtual channels, encryption, etc.), rather than relying on relatively expensive technologies which are unique to the WMO (such as GTS message switches, communication lines leased on a bilateral basis, etc). Before replacing any operational systems however, modern security systems should be studied in detail to identify the best solution for the issues faced by the WMO.

4. REVIEW OF TECHNOLOGIES APPLICABLE TO WMO INFORMATION SYSTEMS

4.1 The experts reviewed current and emerging technologies that could have an impact on development of future WMO information systems. This included the rapid proliferation of the Internet and its associated technology (TCP/IP, routers, Web browsers), low cost satellite communication systems, portable programming languages (Java), and Extensible Markup Language (XML). The team considered a number of technologies and examples of specific systems that have utilised these technologies in their construction. It should be noted that none of the systems considered could be applied to WMO requirements without substantial adjustment and/or expansion.

Open-Source Software

4.2 The experts considered the proliferation of open-source software and operating systems. They noted that LINUX, an open-source operating system was extremely reliable, robust and easy to install. Open-source database management systems, such as PostgreSQL are also available. The experts felt that this software development technology offered the possibility of very inexpensive yet powerful software and recommended that well-tested open-source solutions be considered whenever they are available. They also agreed that WMO could benefit from the experience the open-source community has gained in the collaborative development of software, such as arbitration of proposals through expert groups assigned to specific topic areas.

Multicasting

4.3 The experts considered several protocols and technologies for delivery of data. They reviewed the state of the art in multicasting and noted that considerable work is underway to advance this technology. However, the team concluded that there appear to be significant problems with current implementations of multicasting that would preclude its global use within the near-term future.

HTTP and FTP

4.4 The meeting noted that HTTP is increasingly being used to deliver large files over the Internet and its applicability to WMO requirements should be investigated. Likewise, they noted that there are new technologies available to facilitate transport of large files. Netscape's "Smart Download" was one example that provides a powerful and more flexible alternative to FTP. It allows the transfer of large files to be accomplished in many independent stages. The process can be interrupted at any time and resumed at a later time. Transfers that are interrupted for any reason, such as by communications failures or power outages can also be resumed where they left off. Thus, transfers that might take many hours can be reliably completed.

XML

4.5 Extensible Markup Language (XML) is a relatively new language for encoding documents <u>and datasets</u> for the World Wide Web. XML describes a class of data objects called XML documents and partially describes the behaviour of computer programs which process them. XML is an application profile or restricted form of SGML, the Standard Generalised Markup Language [ISO 8879]. XML is rapidly being developed for a wide range of applications, including document production, dynamic creation of HyperText Markup Language pages (HTML), and intersystem data exchanges. XML, a tagged markup language similar to HTML, is the universal format for structured documents and data on the Web. XML is mainly intended to allow users to define terms and variables in their own documents, thus allowing them to encode the information of their documents or data much more precisely. HTML defines how documents should be presented for display. XML allows application programs to also determine the intended meaning of data within a document. Thus, data values within an XML document could be given meaning. For example, documents could include values defined as latitude, longitude, elevation, etc., thus enabling applications to search for documents that pertain to user-defined geographic areas.

4.6 XML is a project of the World Wide Web Consortium (W3C), and the development of the specification is *being* supervised by their XML Working Group. The v1.0 specification was accepted by the W3C as Recommendation on Feb 10, 1998. XML Linking Language (XLink) Version 1.0 was accepted by the W3C as Recommendation 3 July 2000 which provides a set of optional modules that provide sets of tags & attributes, or guidelines for specific tasks. Further information on XML can be found at http://www.w3.org/TR/REC-xml.

Unidata IDD

4.7 The experts considered recent improvements in Unidata's Internet Data Distribution (IDD) system. They were reminded the IDD is a national scale, distributed, collaborative, near real-time, application of the Internet and TCP/IP protocols that currently delivers data continuously to about 160 universities and research institutions for use in research and education. It has been in operation since 1994. The IDD system is implemented with Unidata's freely available Local Data Manager (LDM) software, designed for Unix systems. The system works by relaying products through a routing tree of LDM nodes at universities. A product can be nearly any size from a few bytes to many megabytes, limited only by disk capacity and network bandwidth. Currently the data stream commonly distributed to most IDD sites comprises more than 1/2 million products per day.

4.8 An event-driven architecture is used rather than polling or scheduled delivery to assist in timely delivery of products. Mechanisms for enhancing reliability include use of TCP, a product queue at each relay node and the provision of back-up servers to continue delivery through network outages. Recent innovations allow the system to handle data at a significantly higher rate. Additional features include data on individual product latencies, duplicate product detection and elimination, use of pattern matching for local filing and decoding of products, host based security, and ability to change configuration details while the system is running. Current limitations of the system include manual maintenance of routing configurations, lack of support for product priorities, and dependence on Unix operating system features. Further information can be found at http://www.unidata.ucar.edu/projects/idd/ and http://www.unidata.ucar.edu/packages/ldm/.

4.9 The experts reiterated the interest in this system that was shown at their previous meeting and strongly recommended that its potential applicability to WMO requirements be formally evaluated through one or more pilot implementations.

Inexpensive satellite and Internet broadcast

4.10 The experts considered the recent implementation of new technologies to broadcast meteorological products. EMWIN (Emergency Managers Weather Information Network) provides an example of a very cost-effective method for the reception of real-time operational data and products. The data stream provides warnings, advisories, forecasts and a range of graphics covering the Southwest Pacific. EMWIN is broadcast through two mechanisms. A broadcast via satellite can be received through hardware and software costing approximately US$1500. A broadcast via the Internet can be received through any Internet-connected PC equipped with an inexpensive (less than US$100) software package. Once received, either broadcast can be viewed with a simple Web browser.

EUMIN UNIDART

4.11 Mr Stanek informed the meeting of the European Meteorological Information Network (EUMIN) Uniform Data Request Interface (UNIDART) draft project plan in the framework of EUMETNET. The exchange of routine data within the European meteorological community is well organized within the framework of the GTS and bilateral agreements sharing the same standards. For access to data stored in the databases of the NMCs and European centres, however, each service uses its own conventions, thus making Europe-wide searches very complex and time-consuming. Therefore, it has been suggested to implement a uniform user interface (UNIDART) within the EUMIN framework to provide access to the databases. The interface will be based on standard Web technologies. Thus it can be used through widely available Web browsers.

4.12 It is not the intention of UNIDART to replace well-defined GTS exchange. Rather it is meant to provide a tool for individual access to data needed to support NMCs and European centres in operations, research and development, and commercial activities. The interface is intended to provide access to all kinds of meteorological databases: observational data, reports, image data, model output and climate data. The interface will be designed to serve users in the NMCs, at ECMWF and EUMETSAT, and external users, respecting their organizational or individual rights to access the data.

4.13 The uniform interface will be performed through client-server functions. The client would utilise standard Web browsers and the server would act as a request broker, which accepts user requests, decomposes them using stored metadata and formulates standardised requests to the diverse databases operated by members. It is hoped that UNIDART will soon move from a project proposal to a formal project.

UCAN

4.14 Dr Robbins informed the group of the Unified Climate Access Network (UCAN), a collaborative effort between six Regional Climate Centers (RCC), the National Water and Climate Center (NWCC), and the U.S. National Climatic Data Center (NCDC). A primary goal of UCAN is to provide the user with a uniform view of the climate data resources of the participating agencies. Without knowledge of UCAN system architecture, dataset location, or dataset availability a user can specify query parameters that determine data availability, extract data from heterogeneous data archives, process the data using standard software modules, and return data products from a distributed network of metadata and data servers.

4.15 The RDBMS lies at the heart of all requests for information. The RDBMS includes information describing station location, data network information, period of record, data quality and completeness, stored data elements, and data network archive location(s). Local data archive centre RDBMS content is synchronised to a master archive maintained by the NCDC and augmented by information about the local, state, and federal data networks not stored at the national level. These updates are performed across heterogeneous computer systems utilising heterogeneous RDBMS engines by distributing content changes across the hierarchy and signalling systems to reload their local metadata caches.

4.16 Seamless access to UCAN data inventories is required to enable users to specify delivery of data or data products without a-priori knowledge of where the data are archived. A user simply enters a station identifier(s) or geographic location(s), required data elements, type of post-processing to apply to the data (product specification), and an output format to obtain a packaged product tailored to their specification. The information is returned to the user comprised of data obtained from a single station at the specified location, data from the most climatologically representative nearest location, or as composite information from multiple stations. Furthermore, the data returned to the user may be serviced by one or more archive centres without the users' knowledge of where the data were originally archived. Redundant data sources improve reliability and system response in the case of network or data centre failure.

4.17 This dynamic and distributed system is implemented as a framework of CORBA (Common Object Request Broker Architecture) modules that define a common programming interface for all the data sources and metadata requests. The CORBA objects function as the adapters to different database systems and allow a diversity of underlying information. Tools built on top of these objects allow users to query the system in several ways. Interactive queries are most commonly accomplished using a forms-based Web browser interface or a graphical interface implemented in Java. The raw CORBA interface allows locally developed user application programs (models, simulations, or external processing routines) to communicate directly with the UCAN RDBMS and data handling modules.

5. VISION OF FUTURE WMO INFORMATION SYSTEMS

General considerations

5.1 A major achievement of the WMO has been the creation of a policy environment supporting the free and unrestricted exchange of meteorological and related data, and the implementation of an information system to put this policy into practice. Currently this WMO information system comprises:

- Three World Meteorological Centres (WMCs) and 39 Regional Specialised Meteorological Centres (RSMCs) for the preparation of products for global and regional distribution. These WMCs and RSMCs collect data from, and provide data and products to, National Meteorological Centres (NMCs) which in turn address the national requirements for these;
- 32 Regional Telecommunication Hubs (RTHs) which manage the Global Telecommunication System (GTS) that moves the data and products between the WMCs, RSMCs and NMCs. The GTS consists of a Main Trunk Network (MTN) carrying high volume traffic between 18 of the larger centres and a range of other non-MTN links;
- A large number of centres (including WMCs, RSMCs and NMCs) use the Internet for the ad-hoc exchange of data and products on a request-reply basis, and for the routine access to datasets that, for a variety of reasons (including capacity limitations), cannot be carried on the GTS.

This is an effective but extremely complex and expensive system, with a two-level hierarchy of communication system centres and a three-level hierarchy of data processing centres. The most significant challenges for the system's managers are to respond appropriately to evolving requirements and technological changes occurring in the information systems arena.

5.2 If the WMO is to continue to support the practical implementation of its data exchange policies it will need to plan properly to ensure that its information system maintains its relevance into the future. The technologies available for the collection, exchange and management of information are changing at an unprecedented rate, and with this change comes the opportunity to access a broader range of meteorological data and information, more rapidly and at lower cost, than has previously been possible. The development and implementation of new systems to take best advantage of these emerging technologies will, however, challenge the WMO's ability to plan and coordinate the activities of its Members.

5.3 The WMO's future information system must fully meet the requirements of the World Weather Watch (WWW), which include the real-time capability to:

- collect and exchange the global set of meteorological and related observations;
- distribute globally the meteorological and related products derived from the global observational database.

This functionality must be provided in such a way as to enable the timely, reliable and secure exchange of data and products in a cost effective manner.

5.4 The GTS currently operates using a "store and forward" system by which data and products are forwarded from one Regional Telecommunication Hub (RTH) to the next in accordance with pre-agreed switching tables. RTHs also pass data on to adjacent National Meteorological Centres (NMCs) as agreed between the RTH and NMC. It is noted that WMO programmes are increasingly seeking the capability to make ad hoc requests for data and products, a capability that is being explored with non-standardised, Internet-based request-reply systems.

The WMO's future information system will include the capability for ad hoc requests as well as routine distribution of meteorological and related datasets and information.

5.5 The Team noted that a major impediment to the development of effective request-reply systems for meteorological data and products, whether Internet-based or supported by the GTS, is the absence of a standard for high level or catalogue-level metadata. Development of such a standard to describe meteorological and related data is required to enable search engines to find target datasets. To provide information sufficient for users to determine if a product is useful the directory should provide far more detailed descriptions of products than the current Catalogue of Bulletins. At the same time it should define datasets at a relatively high level and not as individual messages or files.

5.6 The development of such a standard is not a trivial task, it would require specialist expertise and it would be best developed in parallel with the development of the request-reply system using the standard. Finally, it was noted that there is a draft ISO geographical metadata standard under development (ISO Technical Committee 211, Working Group 3, draft 19115) that will support meteorological and related data, and that the WMO's efforts in this area should take account of this emerging ISO standard. However, a detailed WMO "community profile" would be necessary to utilise the ISO standard. The experts recommended that a group with the necessary interdisciplinary expertise undertake development of this profile.

> The WMO's future information system will include a dataset catalogue that will enable users to locate the meteorological and related data and products that they require.

5.7 The Team discussed the issue of standards more generally, noting that in the past the WMO has, through necessity, developed global standards in areas of meteorology where other international standards organisations, or industry, have provided none. It was noted that compared to the global market for information systems the global meteorology community is a relatively small one. Consequently, the final cost of systems built to such standards could be relatively high when compared with systems providing similar functionality but marketed much more widely. One example considered by the Team was the cost of building and maintaining a GTS message switch.

> The WMO's future information system will conform to open, global standards to the greatest extent possible.

5.8 Currently WMO members have three options for upgrading their GTS message switches:

a) they may purchase a system from a small number of vendors (for many language groups there will be only one possible vendor);
b) they may engage their own technical staff to develop such a system; or,
c) they may be able to call on assistance from another WMO Member to implement that Member's switch in their own centre.

In general these switches are now workstation-based (usually using the UNIX operating system), though there is a move to implement some switches in the PC environment (often using the LINUX OS). The Team noted that it is increasingly possible to develop information systems using open source code (for operating systems, databases, browsers, etc), and that with proper management such solutions could be more cost effective as well as technically superior to those currently available.

> In developing the WMO's future information system attention should be given to include open source code components as alternatives to proprietary, or member written component applications.

5.9 The WMO's current information system comprises a diverse mixture of technologies because each Member is able to implement solutions which best meet local conditions while also meeting WMO standards. In the GTS, leased telecommunication lines negotiated on a bilateral basis predominate. In RA VI however a consortium has been established to negotiate a more favourable charge rate for the capacity to meet the bandwidth requirements of a group of Members than could be achieved if a series of bilateral links were established. Elsewhere in the world there are a number of GTS circuits implemented over the Internet and a significant volume of data is exchanged between Members using satellite point to multi-point systems.

> In acquiring communications bandwidth consideration will be given to all technically viable alternatives for providing the bandwidth in the most cost effective manner. Such alternatives will include, *inter alia*, consideration of the public Internet, private leased lines and satellite broadcast. These will be managed and funded through national or bilateral agreements, regional consortia and possibly a global consortium for bandwidth leasing.

5.10 Current practice for the exchange of data and products on the GTS is to consolidate these into bulletins prior to their passage through the GTS. The topology of the GTS requires that bulletins may need to be switched through a number of RTHs before all their users are able to access them. Special monitoring exercises on the GTS show that while a number of centres may aim to collect the global set of observations, there are losses around the system which prevent this situation being completely realised. Due to the large number of bulletins being exchanged, and due to the large number of message switches which must be fully coordinated, it seems unlikely that the present GTS, given its topology, can ever reasonably be expected to deliver the full set of global data to each of the global modelling centres. Modern communication protocols and systems would allow centres to combine observations into files and move a smaller number of larger files directly between these centres and all of the centres that require a global dataset. This in turn calls for a different network topology than is found in the GTS and a different way of exchanging datasets.

> Technical, as well as organisational considerations will determine the topology of the WMO's future information system.

5.11 Establishing the capability to move large files from point-to-point would also enable datasets that are currently moved via the Internet to be more properly managed on the WMO's information system. This should include data and products that are exchanged routinely and that are exchanged on an ad hoc basis via a request-reply mechanism.

> The WMO's future information system will include the capability to move large files from sender to recipient without having to comply with predetermined routing maintained through message switches.

The Vision

5.12 The team refined their vision of the Future WMO Information System and determined that it should provide an integrated approach to meeting the requirements of:

- Routine collection of observed data
- Automatic dissemination of scheduled products, both real- and non-real-time
- Ad-hoc non-routine applications (e.g. requests for non-routine data and products)

The system should be:

- Reliable
- Cost effective and affordable for developing as well as developed Members
- Technologically sustainable and appropriate to local expertise
- Modular and scalable
- Flexible - able to adjust to changing requirements and allow dissemination of products from diverse data sources

The system should also support:

- Different user groups and access policies
- Integration of diverse datasets
- Data as well as network security
- Ad hoc as well as routine requests for data and products ("pull" as well as "push")
- Timely delivery of data and products (appropriate to requirements)

5.13 Routine collection and dissemination should be accomplished via a "push" system, which could be implemented via a combination of technologies. It could include store and forward systems, point to point communications (including use of simple technologies such as e-mail) and satellite DCP and broadcasts. Push systems are the most appropriate approach for both the routine collection of observations and the routine dissemination of observations and other products. However, the collection of observations from the many possible suppliers and dissemination of products from a few suppliers to many recipients are different problems best met through different logical topologies. Furthermore, distribution of ad hoc non-routine products should be accomplished via request/reply or "pull" systems. The “push” and “pull” systems, operating in parallel, should be available to all users of WMO data and products.

5.14 The future WMO information system would rely upon a combination of public and private networks and would ensure coordinated development and operation of the participating systems through reliance on international protocols and standards and off-the-shelf software. It would define participating centres according to their functions and responsibilities. The system would include three levels of responsibilities: Global Information System Centres, Specialised Product Centres and National Centres. The flow of data and products between these centres is illustrated in figures 1 through 3. Figure 1 outlines the collection of observations and products, Figure 2 illustrates the dissemination of products (both routine and non-routine), and Figure 3 provides a simplified view of the various categories of information flow.

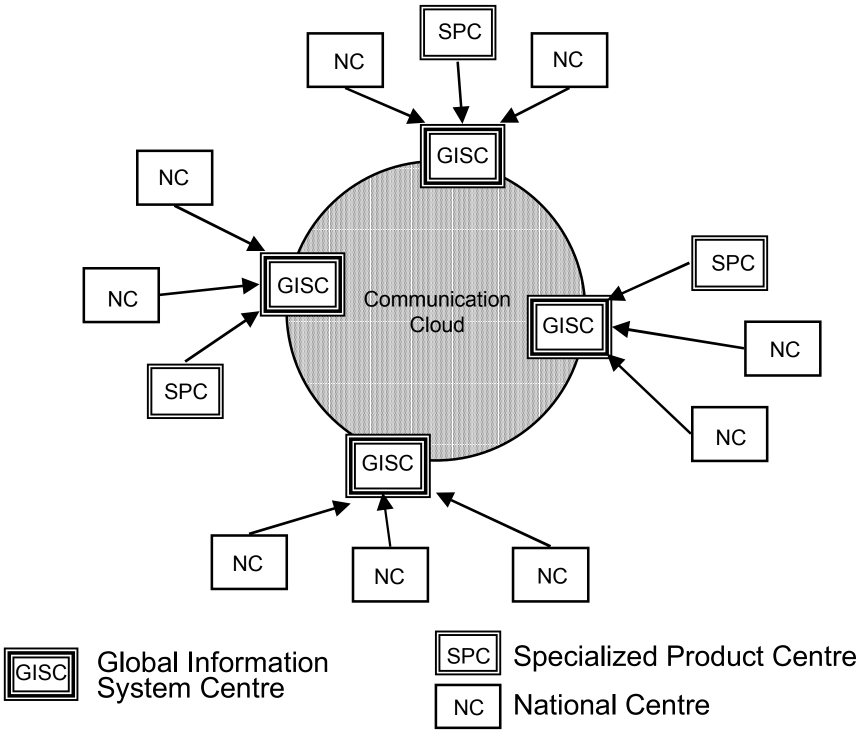

Figure 1. Data and product collection

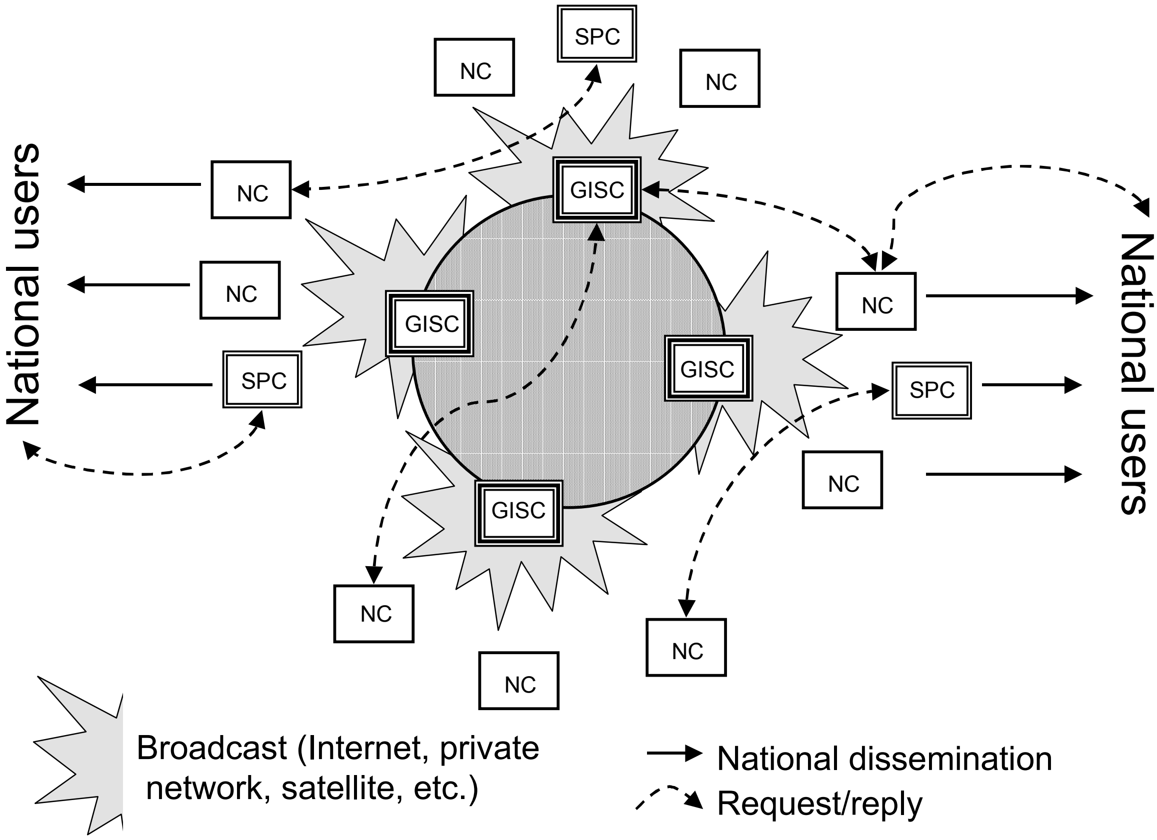

Figure 2. Data and product distribution

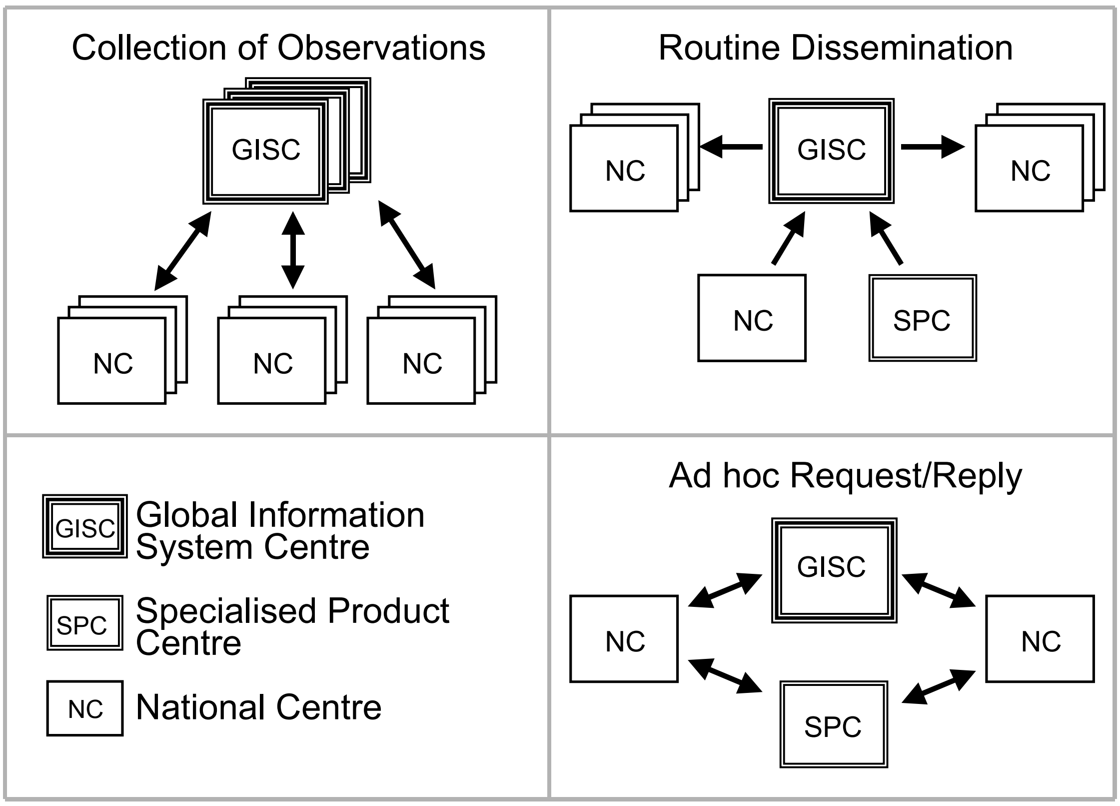

Figure 3. Overview of communication topologies

Global Information System Centres

5.15 Several (perhaps 4 to 10) Global Information System Centres (GISC) would form the top level of the future WMO information system. These centres would collect all observations and products intended for global distribution from supplying centres within their area of responsibility. Each supplier, which could be an NMHS, organisation (e.g. ARGOS, ARINC), research project, et cetera, would send its observations to its designated GISC. Observations would be combined into large aggregated datasets. The GISC would then forward its datasets to all of the other GISCs. The collection of observations would thus be organised into a series of star networks connected by a logical ring between the GISCs at the top. The experts did not believe it was necessary to standardise the physical links and protocols to be used between all of the suppliers and collectors, and recommended that that these instead be decided by bilateral agreement to best match the requirements and capabilities of the parties involved. They noted that this approach is currently used between a number of NMHSs with effective results.

5.16 The experts assumed that the GISCs would usually be located within or closely associated with a centre running a global data assimilation system or having some other global commitment. However, the proposed architecture does not dictate that this be a requirement.

5.17 Dissemination of products through a store-and-forward based push system implemented as a single layer would, in many cases, require excessive resources at some centres. Therefore product dissemination would probably be best addressed through a variety of technologies including hierarchical store and forward systems similar to the current GTS message switches, satellite broadcast, and perhaps network multicast. High capability recipients requiring large-volume products could be served by one mechanism while less developed recipients with less demanding requirements could be served by another.

5.18 The responsibilities of a GISC can be summarised as follows. Each GISC would:

a. Collect observational data and products that are intended for global exchange from national centres within their area of responsibility, reformat as necessary and aggregate into data products that cover their responsible area
b. Collect products that are intended for global exchange from Specialised Product Centres within their area of responsibility
c. Receive data and products intended for global exchange from other Global Information Systems Centres
d. Disseminate the entire set of data and products agreed by WMO for routine global exchange (this dissemination can be via any combination of the Internet, satellite, multicasting, etc. as appropriate to meet the needs of Members that require its products)
e. Hold the entire set of data and products and make it available via WMO request/reply (“Pull”) mechanisms
f. Provide around-the-clock connectivity to the public and private networks at a bandwidth that is sufficient to meet its global and regional responsibilities.
g. May perform the functions of a Specialised Product Centre and/or a National Centre

Specialised Product Centres

5.19 Several dozen centres would serve as Specialised Product Centres (SPC). Existing RSMCs would function as SPCs. However, many additional centres would also serve as SPCs. This would include suppliers of special observations (e.g. ARGOS, ARINC), research projects, and centres producing products related to a specific discipline. SPCs would:

a. Collect special programme-related data and products as appropriate
b. Produce agreed products
c. Provide products intended for global exchange to their responsible Global Information System Centre
d. Disseminate products not intended for global exchange in whatever manner is agreed upon between the centre and the users of the product

e. Support access to its products via WMO request/reply ("Pull") mechanisms in an appropriate manner (i.e. dynamically-generated products would require around-the-clock connectivity to the Internet)
h. May perform the functions of a National Centre

National Centres

5.20 National Centres would form the foundation of the future WMO information system. Many National Centres would be part of an NMHS but others would have national responsibility for functions falling within WMO Programmes but located outside of the NMHS. The participation of the centres would be coordinated through the national Permanent Representative to WMO. National Centres would:

a. Collect observational data
b. Provide observations and products to their responsible Global Information System Centre
c. Collect and generate products for national use

6. FURTHER DEVELOPMENT OF FUTURE WMO INFORMATION SYSTEMS

6.1 The experts agreed that although design, development and implementation of the envisioned future WMO information system would be a formidable task it would not face any serious technical difficulties. It could be successfully implemented with existing technology. However, its development would require a substantial commitment of staff representing Members and participating WMO Programmes. Therefore, the team suggested that the proposed conceptual vision be evaluated and approved by CBS before substantial resources are invested in pursuing its development.

6.2 The meeting discussed steps that could be taken to further develop future WMO information systems consistent with the vision outlined above. The team felt that further work should focus around two key aspects:

a. re-developing the current store and forward GTS to take best advantage of the new technologies;
b. coordinating the development of the request-reply capability of the WMO's information systems.

6.3 The team agreed that the most straightforward way to test the feasibility of the proposed vision would be to examine successful implementations of promising new technologies by those outside of the WMO community and by undertaking pilot projects which utilise critical aspects of these new technologies. It recommended that volunteers be sought to participate in these pilot projects.

Inter alia the following technologies and projects should be evaluated through pilot projects. a. Unidata IDD b. Internet broadcast (as used by EMWIN) c. EUMIN projects

6.4 With regard to the further development of the request-reply capability the team agreed that the most pressing requirement is the development of a catalogue of products that could be searched on-line via the Internet. They noted that while satellite-based broadcast systems are generally regional in scope, request-reply systems implemented over the Internet are intrinsically global in scope. Therefore, the interface to this system (including the product catalogue) must be globally uniform. They also noted that a number of major WMO centres already have on-line catalogues in place and the harmonisation of these systems to a common standard will be a challenging task. As additional centres develop catalogue systems and bring them on line it will become increasingly difficult and expensive to implement a global standard. Therefore, there is an urgent need for this standard to be developed as quickly as possible.

Development of a WMO catalogue of products should be a high priority task for the OPAG-ISS, noting that the talents of an interdisciplinary group of experts will be required.

6.5 Technology is constantly evolving and new technologies that could improve WMO information systems could emerge. A group with representation from many WMO and related international programmes should be tasked to stay abreast of developments and assess possible applicability of new technologies to WMO requirements.

An inter-programme expert team should keep abreast of technological developments relevant to WMO information system requirements.

6.6 While noting that the conceptual vision developed by the team could be implemented with existing technology, the experts also felt that to do so satisfactorily may require changes in responsibilities between Members, and between centres as they are currently configured. It considered that this matter should be further investigated. It agreed that it was important to ensure that all of the WMO Programmes be represented in this investigation.

The inter-programme expert team should investigate possible organizational responsibilities for the envisioned future WMO information system.

7. CLOSURE OF THE MEETING

7.1 The meeting closed on Friday 1 September 2000.

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ANNEX

LIST OF ACRONYMS

AMDAR	Aircraft Meteorological Data Acquisition and Relay
AWG	CBS Advisory Working Group
AWS	Automatic Weather Station
BUFR	Binary Universal Form for data Representation
CAeM	Commission for Aeronautical Meteorology
CAgM	Commission for Agricultural Meteorology
CBS	Commission for Basic Systems
CBS-Ext.(98)	Extraordinary session of CBS held in 1998
CCI	Commission for Climatology
CEOS	Committee on Earth Observation Satellites
CHy	Commission for Hydrology
CIMO	Commission for Instruments and Methods of Observation
CLIPS	Climate Information and Predictions Services
CREX	Character Representation form for data Exchange
DCP	Data Collection Platform
EC	Executive Council of the WMO
EMWIN	Emergency Managers Weather Information Network
EUMIN	European Meteorological Information Network
FTP	File Transfer Protocol
GCOS	Global Climate Observing System
GDPS	Global Data Processing System
GIS	Geographic Information System
GISC	Global Information System Centre
GOS	Global Observing System
GTS	Global Telecommunications System
IDD	Internet Data Distribution system
ICT	Implementation/Coordination Team (of CBS)
ISO	International Standards Organization
JCOMM	Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
LDM	Unidata's Local Data Manager
MTN	Main Telecommunications Network (of the GTS)
NMHS	National Meteorological or Hydrological Service
NMS	National Meteorological Service
NWP	Numerical Weather Prediction
OPAG	Open Programme Area Group (of CBS)
OPAG-ISS	Open Programme Area Group on Information Systems and Services
SPC	Specialized Product Centre
TCP/IP	Transport Control Protocol, Internet Protocol
UCAN	Unified Climate Access Network
UNIDART	Uniform Data Request Interface
WCRP	World Climate Research Programme
WDC	World Data Centre
WMO	World Meteorological Organization
WWW	World Weather Watch
XML	Extensible Markup Language