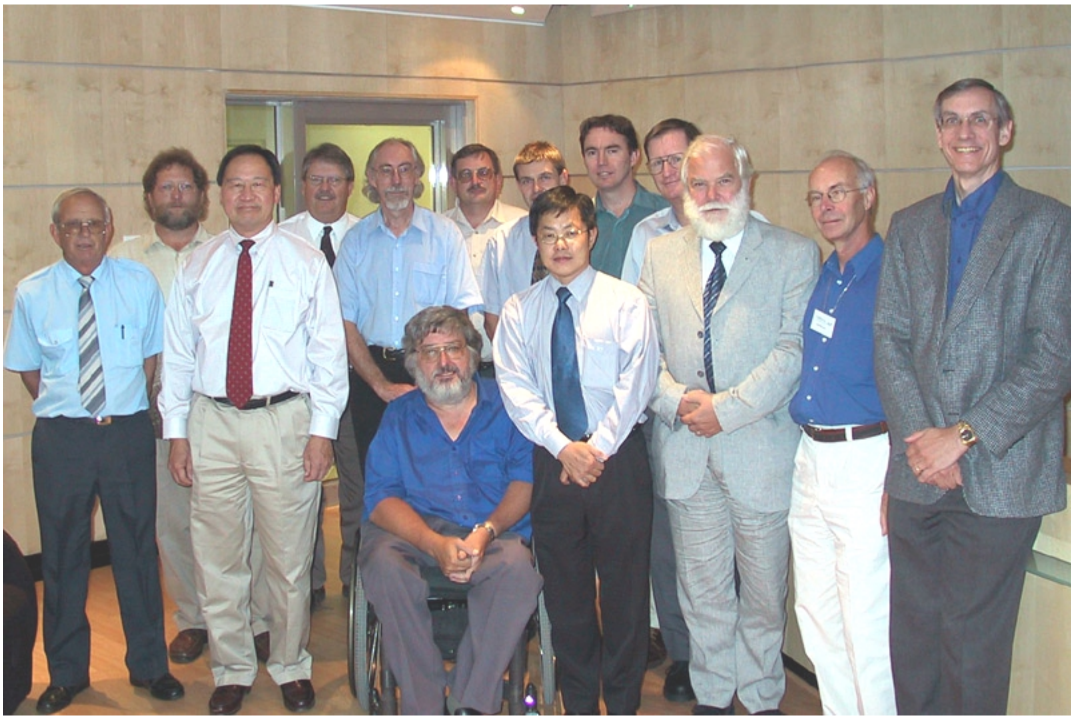
WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS

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

FINAL REPORT



JOHANNESBURG, SOUTH AFRICA, 23-27 SEPTEMBER 2002

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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 fourth meeting of the Inter-programme Task Team on Future WMO Information Systems was held 23-27 September 2002 in Johannesburg, South Africa.

The team reviewed current and emerging technologies that could have an impact on development of the Future WMO Information System (FWIS), including the proposed WMO Core Metadata Standard, Earth System GRID, the EUMETNET UNIDART project, satellite alternative dissemination methods, the Roshydromet CliWare project, the South African METGIS system, and the Unidata Internet Data Distribution (IDD) system. The team felt that all could contribute to FWIS.

The meeting considered reports on two pilot projects relevant to FWIS. The first was a preliminary trial of data distribution using IDD that was conducted by the Deutscher Wetterdienst (DWD). The test demonstrated that the IDD was very easy to install and operate and appeared to provide all of the capabilities that were expected. Given the limited nature of the test, it was not possible to verify all features but a more comprehensive test will be conducted in the near future. The second pilot involved the effort to establish a virtual (distributed) Global Information System Centre (VGISC) in RA VI. Data collection would be done by the participating RTHs, Bracknell, Offenbach and Toulouse, and their data would be stored at the three members of the VGISC. EUMETSAT and ECMWF would provide their data to the VGISC.

Taking into consideration the views of Executive Council, the CBS Implementation/Coordination Team on the ISS and others, the team reviewed the FWIS vision that had been developed at previous meetings. It agreed that, while no significant changes to the concept itself were required, much work was needed to clarify and improve the document that describes it. Consequently the team devoted considerable time to this effort. It developed a revised vision that included an introduction to clearly define the concept and the reasons for its development as well as an executive summary. It also expanded and improved the text to clarify the relationship with existing centres and improve the figures to ensure they more clearly illustrate the essential features of the concept.

The team felt that the success of FWIS would depends upon CBS actively supporting pilot projects that test and evaluate transitional technologies needed for implementation of the FWIS vision.

The revised vision is provided in the report of the meeting and is available at http://www.wmo.ch/web/www/WDM/reports/FWIS-vision-2002.html

1. ORGANIZATION OF THE MEETING

1.1 Opening remarks

1.1.1 The fourth meeting of the Inter-programme Task Team on Future WMO Information Systems (TT-FWIS) opened on Monday 23 September 2002 at the South African Weather Service (SAWS) in Johannesburg, South Africa. Prof. G-R. Hoffmann (Germany), chair of the team, opened the meeting and outlined the principal tasks facing the team. Mr D. Nadison Permanent Representative of South Africa to WMO welcomed the task team to South Africa and the SAWS. He noted that as a member of Executive Council he had participated in its discussions on FWIS. He pointed out that Council requested that CBS consider the challenges of implementing a new system from both the technical and policy-level perspectives. He noted that the upcoming CBS session in December and Congress in May were key milestones for the further refinement and development of FWIS.

1.1.2 Mr G. Schulze, Chief Operations Officer of SAWS wished the team members a memorable and enjoyable stay in South Africa and a successful meeting.

1.2 Adoption of the agenda

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

2. REVIEW OF TECHNOLOGIES AND PROJECTS APPLICABLE TO THE FUTURE WMO INFORMATION SYSTEM

2.1 During its review of current and emerging technologies that could have an impact on development of the Future WMO Information System (FWIS) the team considered the recommendations of the ET on Integrated Data Management (ET-IDM). The ET-IDM had finalized its proposal for a "WMO Core Metadata" profile within the context of the ISO Standard for Geographic Metadata (ISO 19115). This core provides a general definition for directory searches and exchange that should be applicable to a wide variety of WMO datasets. It does not specify how these metadata should be archived or presented to users and does not specify any particular implementation.

2.2 The TT-FWIS, noting that a catalogue was a key component of FWIS, agreed that the metadata standard recommended by the ET-IDM was a significant step forward. Although the standard was somewhat complex the team felt that it provided an optimum balance between completeness and complexity and should be used for development of pilot catalogue systems relevant to FWIS.

2.3 The team welcomed the participation of Mr A. Kellie, Director, Scientific Computing Division of the U.S. National Center for Atmospheric Research (NCAR). He made an informative presentation on the Earth System GRID activities and the team noted that there were many areas where FWIS and the Earth System GRID could benefit from collaboration, particularly in the areas of metadata, data discovery and catalogues.

2.4 Prof. Hoffmann briefed the meeting on the progress of the EUMETNET UNIDART Project. He noted that UNIDART would likely be the first project that would implement the WMO Core Metadata standard for its catalogue and would thus constitute an important pilot for FWIS.

2.5 The experts considered the report of the recent meeting on the Improved Main Telecommunications Network (IMTN). There was considerable discussion on the progress made to date and on the direction to be taken.

2.6 Mr Roesli briefed the task team on the results of the OPAG IOS Expert Team on Satellite System Utilization and Products (ET-SSUP). He noted that, considering the planned extensions of the operational meteorological satellite programmes and the recent inclusion of the environmental R&D satellites into the WMO satellite information concept, ET-SSUP expected a considerable increase in complexity and data volume when accessing satellite data and products by WMO Members. Whereas direct dissemination from operational satellites is the dominant means at present, in the future, access should be possible through a composite service comprised of both direct broadcast (DB) from satellite systems and alternative dissemination methods (ADM). ADM would be the baseline while direct broadcast reception would serve as back up as well as for those WMO Members unable to take advantage of ADM.

2.7 In this context DB means that a transponder aboard the meteorological spacecraft itself performs data broadcasting to the user whereas the ADM concept means that after downlink to a primary ground station (or Command and Data Acquisition station) the data distribution to the user community at large is performed through services available from telecommunication operators, which are not dedicated to meteorological data. ADM is understood to be essentially "near real time data distribution via commercial satellite telecommunication services".

2.8 Considerable effort has already gone into the development of the concept of ADM. Though still under investigation, it has reached a certain level of maturity. With the use of cost-efficient technology ADM would make more data available to a larger user community. ADM could also alleviate the difficulty of the reception/acquisition task by making data available via a telecommunication standard, and in a format adapted to the needs and constraints of the user community within the footprint, rather than requiring the user community to adapt to the specific format of each individual satellite system. This was particularly relevant for the access to multiple satellite systems with different data formats. In order to address the integration of ADM of satellite data and products into a wider vision of WMO information exchange, preliminary indications on temporal requirements and expected data volumes have been compiled.

2.9 Regarding NMHSs requirements for cost-optimized access to all necessary satellite data/products and based on the notion of three different types of satellites (geostationary, polar and R&D satellites), the present satellite information access concept will be extended by adding ADM to the direct broadcast (DB - retained as a back-up service).

2.10 Mr Besprozvannykh made a presentation on the CliWare project operated and being further developed by Roshydromet of the Russian Federation. The system is very technologically advanced and makes extensive use of international standard protocols, XML and ANSI SQL, and open source software and development tools. The project plans to add support for the proposed WMO Core Metadata standard. The task team was very impressed with the project and felt that once the support for the WMO Core Metadata had been added the project could be considered as a pilot to evaluate the catalogue and request/reply capabilities envisioned for FWIS.

2.11 Dr Robbins added that the task team evaluating the future Climate Data Base Management Systems (CDBMS) met in May 2002 and evaluated CliWare as well as CDBMSs developed by the Czech Republic, France, Zimbabwe, Jordan and Tunisia. It was noted that each CDBMS had been developed to meet the needs of different climate data centres and, thus, had different capabilities. Complete evaluations of each system are available on the WMO web site at http://www.wmo.ch/web/wcp/wcdmp/cdmsfuture/html/evaluation.html.

2.12 Mr Andrew van der Merwe made a presentation on the SAWS Meteorological Graphic Information System (METGIS). He explained that METGIS is a graphical display system for operational meteorological data that has been developed for Southern Africa over the last few years specifically to balance telecommunication capacity versus costs. The system has also been adapted for the Internet. The system works with a variety of protocols and optionally supports data compression.

2.13 The system consists of the following set of software, described below:

a. WOClient.exe – Weather Office Client Down Loader, which is responsible for downloading data from the relevant MSS.
b. EGRR.exe – Model Viewer, which is used to display and print GRIB and GRID NWP data. With little modification this software program can display data for any geographic position on the globe.
c. Bolug.exe – Upper Air Data Viewer, which is used to display and print upper air data and NWP data on pre-determined Pressure Levels.
d. Msynop.exe – Synoptic Plot, which is used to display and print synoptic data. There is a pre-determined set of maps available to choose from, as well as two specified maps where the user can set of the dimension of data.
e. Sat.exe – Satellite Viewer, which is used to display a set of satellite data from Meteosat. Loops and animation are also provided.
f. Radarviewer.exe – Radar Viewer, which is used to display composite radar images over Southern Africa. These images can be animated to track the movement of storms.

g. FaxDisp.exe – Fax Display, which is used to display and print International Significant Weather Charts as distributed by WAFC.
h. Intldlg.exe – International Winds, which is used to print International Aviation Winds from the WAFC NWP GRIB data.

2.14 The system currently only runs on Windows PCs, but it will be available for Linux in 2003. The minimum requirement of the PC used is an entry level PC (Celeron or Pentium II/III, 64-128 MB Ram and 10 GB Hard drive).

2.15 The task team requested that a description of METGIS be submitted to the WMO Secretariat for inclusion in the CBS Software Registry and that the software be made available to Members that request it, particularly in developing countries.

3. REVIEW OF RELEVANT DECISIONS OF EC-LIV

3.1 The task team considered the additional guidance on FWIS provided by Executive Council (EC) at its fifty-fourth session. The team noted that EC was pleased with the progress that had been made to date and that the Council agreed that a window of opportunity existed now to arrive at an agreed standard for the FWIS and that any delay in necessary coordination could result in multiple incompatible systems.

3.2 The TT-FWIS noted that EC, recognizing that the proposed system would likely require changes in operational and institutional arrangements, agreed that there were several technical and policy level issues that needed further consideration. EC had requested CBS to further refine the concept and to develop more detailed technical information on specific requirements for FWIS and how the proposed system would function and address these requirements. It had also asked CBS to specify how the existing WWW system and centres would evolve into the new structure, ensuring a smooth transition with no interruption in essential services.

3.3 The Council had also recalled the policy issues raised at its fifty-third session, namely:

- The possible impact of the introduction of a future WMO information system on Members' responsibilities and resources;

- The extent to which the functions and responsibilities of existing infrastructure and centres should be used or revised.

3.4 EC requested that a study be undertaken to explore these and other policy-level implications of the FWIS, based on the outcome of CBS at its extraordinary session in 2002. The Council requested the EC Advisory Group on the Role and Operation of NMHSs to consider the results of the study, analyze the relevant policy issues and report its findings to fourteenth Congress.

3.5 EC-LIV also discussed alternative telecommunications services In particular, it noted the matter of Alternative Dissemination Methods (ADM) for the distribution of satellite data and products from the operational meteorological satellites. The Council urged the CBS to review the ADM concept, as a matter of urgency, to include data and products from Research and Development satellites in order to provide WMO Members with guidance on how the valuable satellite information could be made available in an optimized distribution system. Candidates for ADM included Internet and commercial telecommunication satellites. The Council was pleased to learn that CBS had made significant progress in reviewing ADM with the expectation that the Commission would finalize a distribution concept at its next session.

3.6 The team kept these considerations in mind as it worked to refine its vision for FWIS.

4. REPORTS ON PILOT PROJECTS

4.1 The meeting considered a report on a preliminary trial of data distribution using Internet Data Distribution software (IDD) conducted by the Deutscher Wetterdienst (DWD). It was originally planned at the TT-FWIS-3 to test IDD with satellite data sent by the UK Met Office. Due to non-technical problems there, it was not possible to set up the test so far. Therefore, DWD decided to conduct a limited test to see if the Internet could be used to transmit WMO data with IDD.

4.2 The test demonstrated that the IDD was very easy to install and operate and appeared to provide all of the capabilities that were expected. A daily feed of nearly 200 MB was received. However, given the limited nature of the test, it was not possible to check if all data that was sent was really received, since it was not known precisely what was actually sent. Furthermore, many of the functions of the IDD (such as automatic monitoring of system performance) were not tested.

4.3 The TT-FWIS noted that it is planned in the near future to carry out the IDD test as originally planned and to gain some operational experience with 'real' data. It looked forward to being informed of the results of this test.

4.4 Prof. Hoffmann informed the team on the effort to establish a virtual (distributed) GISC in RA VI. He described the roles for participants of the Virtual GISC (VGISC) and presented some ideas on data acquisition and products, data distribution, and data distribution policy. Data collection would be done by the National Centres (NC's) and their data be stored at the three members of the VGISC. The DCPCs (EUMETSAT and ECMWF) would provide their data to the VGISC by feeding them into the communications ring. Where the data will be stored physically will be decided at a later stage.

4.5 The future work plan for the VGISC has been assigned to four Working Groups:

- Working Group on Policy
- Working Group on Data
- Working Group on Communications
- Working Group on Data Acquisition / Dissemination

4.6 The team was impressed with the scope of the activity that had been proposed and looked forward to further reports on this project.

5. REVIEW OF THE VISION OF THE FUTURE WMO INFORMATION SYSTEM

5.1 The task team considered the report of the recent meeting of the Implementation/Coordination Team on the ISS (ICT-ISS), paying particular attention to its conclusions and recommendations concerning FWIS. The team noted that the ICT-ISS had underlined that one essential characteristic of the FWIS was that the concept was developed with a view to meeting the data exchange and data management requirements of all programmes of WMO, in addition to the requirements of the WWW system, taking due account of the different levels of service required (real-time, near real-time, non real-time, etc.). The team noted that the ICT-ISS had recommended that the respective requirements in the concept of the FWIS should be developed and clarified to reflect the respective specific needs and constraints of each Programme.

5.2 The task team also noted that the ICT-ISS felt that the FWIS concept was not currently providing a clear description of the integration of the current functions of the WWW system, and how they could be integrated into the FWIS concept. The ICT-ISS had suggested that the current functions and responsibilities of the WWW system components should be matched to the functions and responsibilities of the FWIS components, taking into account that they were expanded to meet other programmes' requirements and stressed the importance of developing a study clarifying the evolution from the current WWW information systems into the FWIS.

5.3 Taking into consideration these views, as well as views expressed by Executive Council and others, the team reviewed the FWIS vision that had been developed at previous meetings. It agreed that, while no significant changes to the concept itself were required, much work was needed to clarify and improve the document that describes it. Consequently the team devoted considerable time to this effort. It recognized that the document need to be amended to:

- Include an introduction to clearly define the concept and the reasons for its development
- Expand and improve the text to clarify the relationship with existing centres
- Include a new diagram illustrating the relationship of FWIS to existing WMO Programmes
- Improve existing diagrams to ensure they clearly illustrate the concept and are less subject to misinterpretation
- Develop an executive summary

5.4 With these considerations in mind the team developed the revised "Vision for the Future WMO Information System" as given in the annex to this paragraph.

6. TRANSITION FROM THE CURRENT INFORMATION SYSTEM AND FURTHER DEVELOPMENT

6.1 The implementation and operation of FWIS requires the participation of many Programmes and centres. Since all WMO Programmes stand to benefit, each must actively participate and contribute its own expertise and resources. The support of many members of the WMO community, including regional associations and technical commissions will be required.

6.2 The team devoted significant effort in examining how the transition from the current information systems to FWIS could be undertaken, including how existing WWW systems and centres could evolve. It noted that the smooth transition to FWIS with no interruption in essential services is a fundamental requirement for the successful implementation and operation of FWIS. A number of alternative approaches for this transition were considered:

(a) Global implementation on a given cut-over date with a period of parallel operations

(b) Phased implementation through introduction of FWIS on a regional basis (use of dual, or interface systems on the boundaries between the new and old)

(c) Gradual introduction of new capabilities and evolution of existing systems.

The advantages and disadvantages of the various approaches depend upon the needs and capabilities of Members, the nature of the changes and the hardware and software to be used.

6.3 Option (a), world-wide implementation on a cut-over date, is not considered to be feasible. Option (b) would suffer from some of the same problems as option (a) albeit on a smaller scale. While careful consideration and design of the interfaces between the existing and new systems might make such an approach possible, the team felt that this would not be the preferred strategy.

6.4 Option (c) would be most likely to ensure a continuity of existing services and the most practical to implement. While such an evolutionary transition is, in fact, occurring today it is being pursued in an uncoordinated fashion. Requirements that are not addressed by existing systems are being met through implementation of new systems in an ad hoc manner. However, there is still a window of opportunity to influence these developments and guide them towards common coordinated solutions.

6.5 Consequently, the team recommended that the further development and implementation of FWIS be pursued through a gradual introduction and evaluation of enabling technologies through pilots and prototypes. Successful prototypes could then be expanded to serve additional communities and/or distributed to other Members and centres for wider implementation. In this way, the enhanced functions provided by FWIS would be gradually introduced and expanded.

6.6 The TT-FWIS stressed the importance of the general acceptance and implementation of the proposed Core WMO Metadata Standard. The team noted that the ICT-ISS had recognized that several further actions were required before WMO could adopt the metadata standard for operational use. Key among these was to apply the draft standard to data held by several Programmes, so that practical problems with using the standard could be identified. This would allow the problems to be corrected before the standard is finalised.

6.7 The team agreed that future development of FWIS catalogues is vital. While CliWare and UNIDART will test implementation of the proposed metadata standard, TT-FWIS recognized that commonality of discovery-level metadata needs to be tested more widely.

6.8 The team felt that the success of FWIS would depends upon CBS actively supporting pilot projects that test and evaluate transitional technologies needed for implementation of the FWIS vision. The following pilot projects are proposed to ensure that the proposed technologies provide the services required.

- Evaluation of Automatic File Distribution (AFD) and IDD capabilities and deficiencies in providing alternative solutions to GTS message switching capabilities, considering assurance of reliability and timely delivery of WMO products.

- Evaluation of network data security provided by Virtual Private Networks (VPN) and Internet Protocol Security (IPSec) systems.
- Evaluation of existing and planned request/reply systems, such as UNIDART and CliWare to provide delivery of data and products that are not provided by the current GTS.
- Evaluation of a distributed GISC, i.e. the VGISC project in RA VI.

Evaluations of additional technologies that show potential for FWIS, such as METGIS, peer to peer file sharing systems and Web Services, should also be conducted.

6.9 Centres considering participation in FWIS may be concerned that this would entail additional costs and replacement of equipment. However, FWIS will be built upon existing systems and these systems can continue to carry out their current tasks without modification. Additional equipment will likely be required if centres choose to provide the enhanced services offered by FWIS but, overall, cost savings will probably be realized since FWIS will not require maintenance of equipment once it becomes obsolete.

6.10 One RTH on the MTN, RTH Beijing, examined the functions to be performed by a GISC in comparison with its existing capabilities. As can be seen from the table below no major difficulties were foreseen. Most of the GISC functions could be easily accommodated within the existing infrastructure. The functions that are not currently supported could be provided without an excessive development effort.

Responsibilities of a GISC	RTH Beijing current status or plan
Receive observational data and products that are intended for global exchange from NCs and DCPCs within their area of responsibility, reformat as necessary and aggregate into products that cover their responsible area	Implemented
Exchange information intended for global dissemination with other GISCs	Implemented
Disseminate, within its area of responsibility, the entire set of data and products agreed by WMO for routine global exchange	Implemented
Hold the entire set of data and products agreed by WMO for routine global exchange and make it available via WMO request/reply ("Pull") mechanisms	To be implemented in 2003
Describe its products according to an agreed WMO standard and provide access to this catalogue of products	Bulletin catalogue and routing directory was implemented; new product catalogue to be implemented when WMO standard is adopted
Provide around-the-clock connectivity to the public and private networks at a bandwidth that is sufficient to meet its global and regional responsibilities.	Permanent connection (through firewall) to Internet at 10Mb/s, to be upgraded to higher speed when needed; 128Kbps access line to RMDCN to be implemented in 2002, and to RTH Tokyo in 2003, to be upgraded to higher speed when needed;
Provide facilities to collect observations from and deliver products to all NMHS within its area of responsibility	To be enhanced.
Ensure that they have procedures and arrangements in place to provide swift recovery or backup of their essential services in the event of an outage (due to, for example, fire or a natural disaster).	To be enhanced.

Participate in monitoring the performance of the system, including monitoring the collection and distribution of data and products intended for global exchange.	Enhancement required

7. CLOSURE OF THE MEETING

7.1 The meeting closed on Friday 27 September 2002.

Annex to Paragraph 5.2

Revised Vision for the Future WMO Information System

1 October 2002

EXECUTIVE SUMMARY

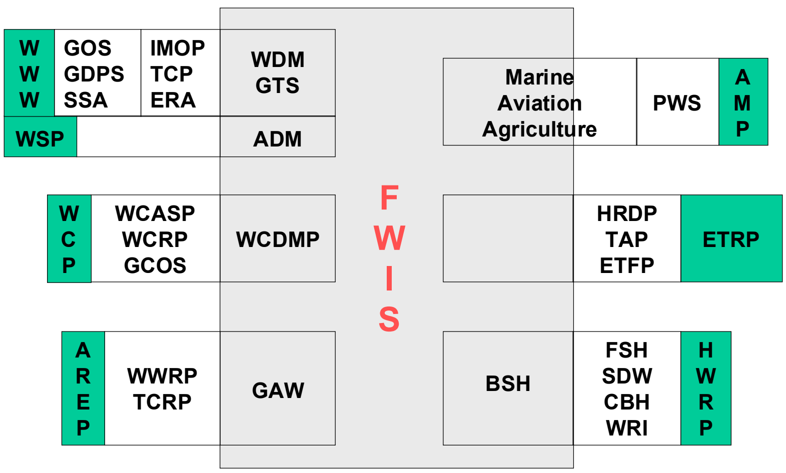
The current WMO information systems have been developed to meet a diverse set of requirements. The principal system is the GTS along with the related data processing and management functions that have been developed to serve the World Weather Watch (WWW). The GTS has a number of significant strengths: it is an operational private network that mainly provides for the exchange of real-time high-priority data, it is mature, well tested and operated according to well-defined procedures and shared responsibilities.

Other information systems that have been developed to meet the needs of other programmes and Commissions have their own advantages. Given the diversity of these systems it is difficult to provide a concise summary. However, most share a common strength: they have been developed by individual programmes to meet their specific requirements. Thus, the systems are generally focused in their approach and do not suffer from compromises and inefficiencies that can sometimes result from development of generalised systems.

The multiplicity of systems operated for different Programmes has, however, resulted in incompatibilities, inefficiencies, duplication of effort and higher overall costs for Members. Continuing to develop systems in this uncoordinated manner will exacerbate these problems and will further isolate the WMO Programmes from each other and from the wider environmental community. It will increase the difficulty in sharing information between programmes, which is essential for them to fulfil their requirements. As a consequence, other organizations, environmental programmes or commercial concerns might assume responsibility for providing essential data and services and WMO would thus lose its leadership role.

One option to address these problems might be to enhance the GTS in such a way as to generalize the services to all Programmes. However, the GTS would still suffer from well known inherent deficiencies that prevent it from meeting all of the requirements of WMO Programmes.

Therefore, an alternative approach is proposed: a single coordinated global infrastructure, the Future WMO Information System (FWIS). It is envisioned that FWIS would be used for the collection and sharing of information for all WMO and related international programmes. The relationship between functions performed by FWIS and similar functions performed by current WMO Programmes is illustrated in the figure. The FWIS vision provides a common roadmap to guide the orderly evolution of these systems into an integrated system that efficiently meets all of the international environmental information requirements of Members.



FWIS relationship to WMO Programmes

FWIS should provide an integrated approach to meeting the requirements of:

- Routine collection and automated dissemination of observed data and products ("push").

- Timely delivery of data and products (appropriate to requirements)
- Ad-hoc requests for data and products ("pull")

FWIS 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 and extensible - able to adjust to changing requirements and allow dissemination of products from diverse data sources and allow participants to collaborate at levels appropriate to their responsibilities and budgetary resources

FWIS should also support:

- Different user groups and access policies, such as WMO Resolutions 40/25
- Data as well as network security
- Integration of diverse datasets

Taking into account that information systems technology is evolving rapidly, FWIS should utilize industry standards for protocols, hardware and software. Use of these standards will reduce costs and allow exploitation of the ubiquitous Internet and web services.

The ultimate implementation of FWIS would build upon the most successful components of existing WMO information systems. It would continue to rely upon the WMO communication system (initially the GTS) to provide highly reliable delivery of time-critical data and products.

To clarify the concept of FWIS, three functional components are defined: National Centres (NC), Data Collection or Product Centres (DCPC) and Global Information System Centres (GISC). The information and communication responsibilities of existing WWW and other WMO Programme centres can be mapped into the corresponding functions within FWIS as illustrated in the table below. It should be noted that the FWIS functions will be added to the existing functions and responsibilities of the participating centres, which will continue.

Current WWW Centres	**FWIS Functions**
NMHS	NC
RSMC	DCPC and/or GISC
WMC	DCPC and/or GISC
RTH	DCPC
RTH on MTN	DCPC and/or GISC
Other Programme Centres	NC and/or DCPC

NMHSs span a range of responsibilities and capabilities. FWIS provides a flexible and extensible structure that would allow NMHSs to enhance their capabilities as their national and international responsibilities grow.

Centres considering participation in FWIS may be concerned that this would entail additional costs and replacement of equipment. However, FWIS will be built upon existing systems and these systems can continue to carry out their current tasks without modification. Additional equipment will probably be required if centres choose to provide the enhanced services offered by FWIS but, overall, cost savings will likely be realized since FWIS will not require maintenance of equipment once it becomes obsolete.

Further development and implementation of FWIS should be pursued through a gradual introduction and evaluation of enabling technologies through pilots and prototypes. Successful prototypes could then be expanded to serve additional communities and/or distributed to other Members and centres for wider implementation. In this way, the enhanced functions provided by FWIS would be gradually introduced and expanded.

1. INTRODUCTION

1.1 The current WMO information systems have been developed to meet a diverse set of requirements. The principal system is the GTS along with the related data processing and management functions that have been developed to serve the World Weather Watch (WWW). The GTS has a number of significant strengths: it is an operational private network that mainly provides for the exchange of real-time high-priority data, it is mature, well tested and operated according to well-defined procedures and shared responsibilities.

1.2 Other information systems that have been developed to meet the needs of other programmes and Commissions have their own advantages. Given the diversity of these systems it is difficult to provide a concise summary. However, most share a common strength: they have been developed by individual programmes to meet their specific requirements. Thus, the systems are generally focused in their approach and do not suffer from compromises and inefficiencies that can sometimes result from development of generalised systems.

1.3 Considering the current state of the WMO Information System and the overall vision of a future system Figure 1 highlights some of the key points:

- There is now limited utilisation of the Internet for operational store and forward applications
- There is limited connectivity between applications developed to serve the needs of the different Commissions
- There are a large number of different applications whose development has not been coordinated making integration of data sets technically challenging
- Multidisciplinary application of meteorological, hydrological and oceanographic data is hampered by lack of agreed standards needed to effectively identify, acquire and use all of the relevant data

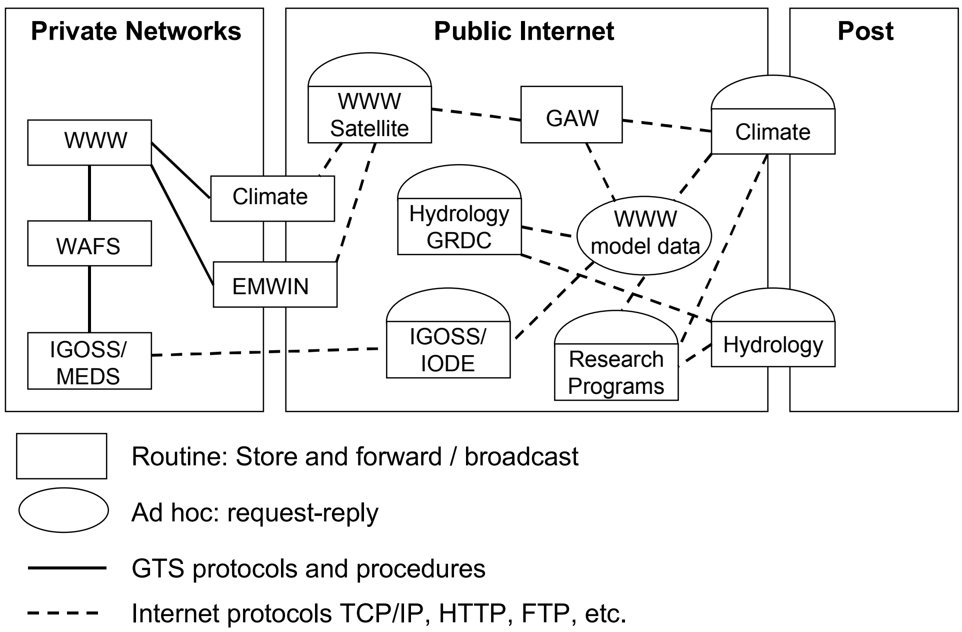


Figure 1. Current WMO Information Systems

1.4 The multiplicity of systems operated for different Programmes has resulted in incompatibilities, inefficiencies, duplication of effort and higher overall costs for Members. Continuing to develop systems in this uncoordinated manner will exacerbate these problems and will further isolate the WMO Programmes from each other and from the wider environmental community. It will increase the difficulty in sharing information between programmes, which is essential for them to fulfil their requirements. As a consequence, other organizations, environmental programmes or commercial concerns might assume responsibility for providing essential data and services and WMO would thus lose its leadership role.

1.5 One option to address these problems might be to enhance the GTS in such a way as to generalize the services to all Programmes. However, the GTS would still suffer from inherent deficiencies, some of which are listed below:

- Use of proprietary high level protocols that are not supported by the marketplace.
- Volume restrictions preclude the transmission of satellite imagery, as well as video and other high volume data sets (in the order of gigabytes or terabytes).
- Lack of support for a request/reply system providing ad-hoc access to the data and products available for international exchange.
- Inability to facilitate information insertion and distribution to programmes and public and other clients beyond the meteorological community.
- Inability to rapidly (i.e. routinely near-real-time) identify where data losses are occurring and undertake remedial action.
- Inability to easily accommodate requirements that include short periods of high volume traffic followed by lengthy periods of low or no traffic.
- Inadequate product identification and metadata leading to duplication and uncertainty of content.

1.6 Therefore, an alternative approach is proposed: a single coordinated global infrastructure, the Future WMO Information System (FWIS). It is envisioned that FWIS would be used for the collection and sharing of information for all WMO and related international programmes. The relationship between functions performed by FWIS and similar functions performed by current WMO Programmes is illustrated in Figure 2 below. The FWIS vision provides a common roadmap to guide the orderly evolution of these systems into an integrated system that efficiently meets all of the international environmental information requirements of Members.

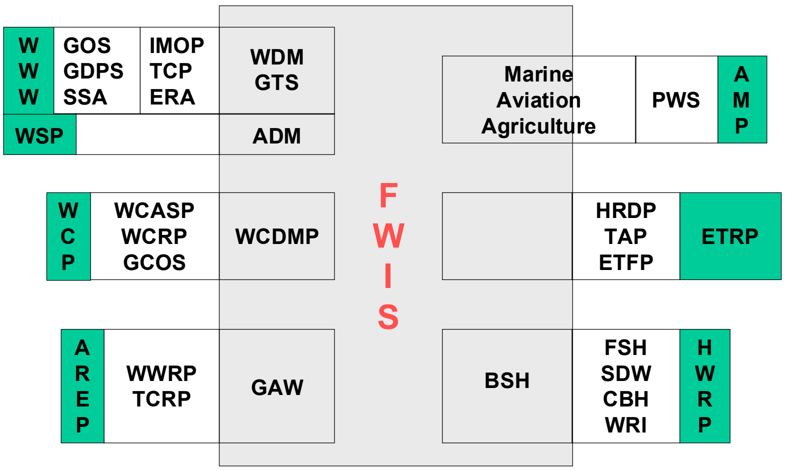


Figure 2. FWIS relationship to WMO Programmes

1.7 FWIS should provide an integrated approach to meeting the requirements of:

- Routine collection and automated dissemination of observed data and products (“push”).
- Timely delivery of data and products (appropriate to requirements)
- Ad-hoc requests for data and products (“pull”)

FWIS 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 and extensible - able to adjust to changing requirements and allow dissemination of products from diverse data sources and allow participants to collaborate at levels appropriate to their responsibilities and budgetary resources

FWIS should also support:

- Different user groups and access policies, such as WMO Resolutions 40/25
- Data as well as network security
- Integration of diverse datasets

1.8 Taking into account that information systems technology is evolving rapidly, FWIS should utilize industry standards for protocols, hardware and software. Use of these standards will reduce costs and allow exploitation of the ubiquitous Internet and web services.

1.9 The ultimate implementation of FWIS would build upon the most successful components of existing WMO information systems. It would continue to rely upon the WMO communication system (initially the GTS) to provide highly reliable delivery of time-critical data and products. Currently, this requires a private network but this is likely to change as public communications services evolve.

1.10 Executive Council has noted that a window of opportunity exists now to arrive at an agreed standard for FWIS.

2. FUNCTIONS AND RESPONSIBILITIES

2.1 To clarify the concept of FWIS, three functional components are defined: National Centres (NC), Data Collection or Product Centres (DCPC) and Global Information System Centres (GISC). It should be noted that this is a functional description defining responsibilities for data and product exchange. One physical centre could perform the functions of one or more of these components. Likewise, several physical centres could cooperate to perform the functions of a single functional centre.

National Centres

2.2 FWIS NCs would serve data and product needs of their country. Most NCs would be part of an NMHS. However, there might be others within the same country having 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. NCs would:

a. Collect observational data from within their country
b. Provide observations and products intended for global dissemination to their responsible GISC
c. Provide observations and products intended for regional distribution to the responsible DCPC
d. Collect, generate and disseminate products for national use.
e. Participate in monitoring the performance of the system.

Data Collection or Product Centres

2.3 Several dozen centres would serve as DCPCs. An existing RSMC would fulfil the function of a DCPC but many additional centres would also serve as DCPCs. This would include suppliers of special observations (e.g. ARGOS, ARINC, field experiments) and centres producing products related to a specific discipline (e.g. ECMWF, NESDIS). As appropriate, DCPCs would:

a. Collect information intended for dissemination to NCs within its area of responsibility (i.e. regional collections)
b. Collect special programme-related data and products
c. Produce regional or specialized data and products
d. Provide information intended for global exchange to their responsible GISC
e. Disseminate information not intended for global exchange
f. Support access to their products via WMO request/reply ("Pull") mechanisms in an appropriate manner
g. Describe their products according to an agreed WMO standard and provide access to this catalogue of products or provide this information to another centre with this responsibility (e.g. a GISC)
h. Ensure that they have procedures and arrangements in place to provide swift recovery or backup of their essential services in the event of an outage (due to, for example, fire or a natural disaster).
i. Participate in monitoring the performance of the system.

Global Information System Centres

2.4 Several (perhaps 4 to 10) centres would serve as GISCs. Each GISC would have a defined area of responsibility. GISCs would usually be located within or closely associated with a centre running a global data assimilation system or having some other global commitment, such as a WMC. However, the proposed architecture does not dictate that this be a requirement. The responsibilities of a GISC can be summarised as follows. Each GISC would:

a. Receive observational data and products that are intended for global exchange from NCs and DCPCs within their area of responsibility, reformat as necessary and aggregate into products that cover their responsible area
b. Exchange information intended for global dissemination with other GISCs
c. Disseminate, within its area of responsibility, 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)
d. Hold the entire set of data and products agreed by WMO for routine global exchange and make it available via WMO request/reply ("Pull") mechanisms
e. Describe its products according to an agreed WMO standard and provide access to this catalogue of products
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. Ensure that they have procedures and arrangements in place to provide swift recovery or backup of their essential services in the event of an outage (due to, for example, fire or a natural disaster).
h. Participate in monitoring the performance of the system, including monitoring the collection and distribution of data and products intended for global exchange.

2.5 The flow of information between these centres is illustrated in figures 3 through 5. Figure 3 outlines the collection of observations and products. It is not considered necessary to standardise the physical links to be used between all of the suppliers and collectors. These could instead be decided by bilateral agreement to best match the requirements and capabilities of the parties involved. However, Members would be encouraged to use standard protocols recommended by WMO.

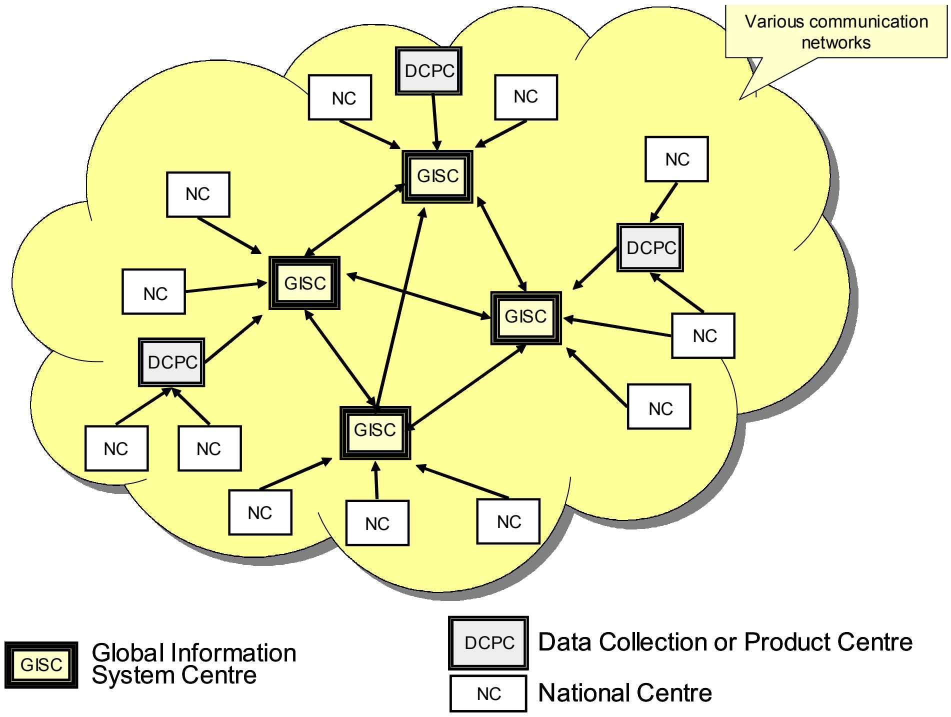


Figure 3. Information collection data flow
(Arrows indicate data flows; no physical links are implied)

2.6 Figure 4 illustrates the dissemination of products (both routine and non-routine). Routine (i.e. scheduled) dissemination of observed data and products would be accomplished through an automatic broadcast or "push" system that could be implemented via a variety of technologies, including the existing GTS. Ad-hoc (non-scheduled) and special requests for data and products would be satisfied by a request/reply ("pull") system. The "push" and "pull" systems, operating in parallel, should be available to all users of WMO data and products.

2.7 Figure 5 provides a simplified view of the various categories of information flow.

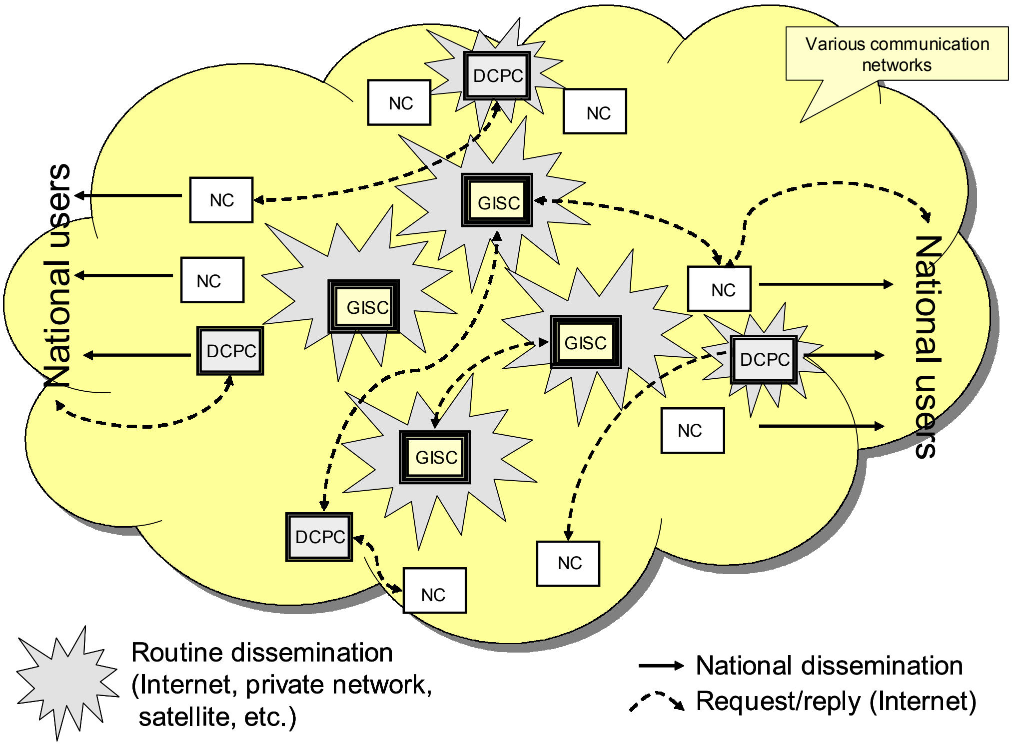


Figure 4. Information distribution
(Arrows indicate data flows; no physical links are implied)

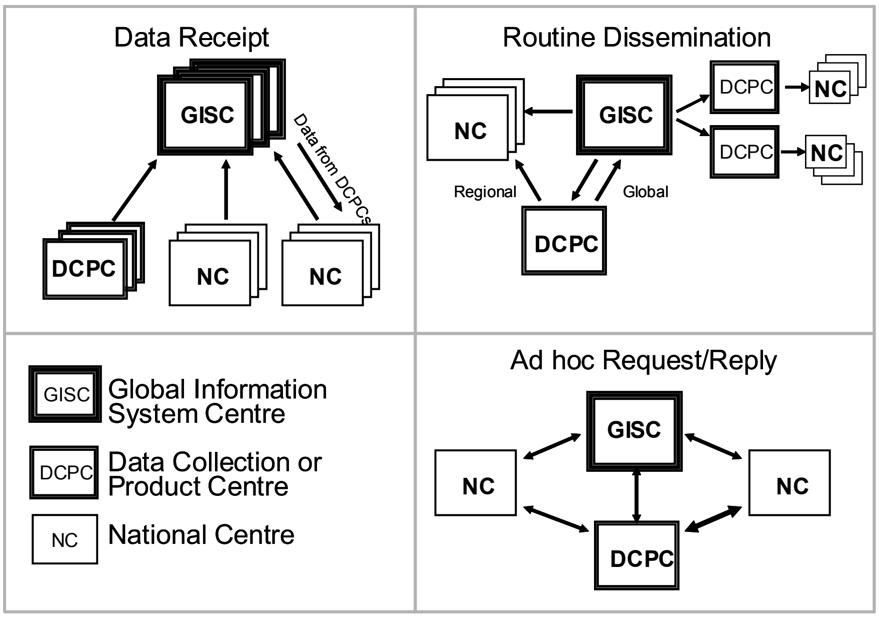


Figure 5. Overview of communication topologies

3. RELATIONSHIP TO EXISTING CENTRES

3.1 The information and communication responsibilities of existing WWW and other WMO Programme centres can be mapped into the corresponding functions within FWIS as illustrated in the table below. It should be noted that the FWIS functions will be added to the existing functions and responsibilities of the participating centres, which will continue.

Current WWW Centres	**FWIS Functions**
NMHS	NC

RSMC	DCPC and/or GISC
WMC	DCPC and/or GISC
RTH	DCPC
RTH on MTN	DCPC and/or GISC
Other Programme Centres	NC and/or DCPC

4. ENHANCED CAPABILITIES IN RESPONSE TO INCREASING RESPONSIBILITIES

4.1 NMHSs span a range of responsibilities and capabilities. FWIS provides a flexible and extensible structure that would allow NMHSs to enhance their capabilities as their national and international responsibilities grow. FWIS services of less developed NMHSs with less demanding requirements could be successfully implemented with Personal Computers and dial-up Internet connections, provided they receive basic products via satellite broadcast (e.g. EMWIN, MDD, RETIM2000, etc.). As resources and requirements increase, NMHSs could be equipped with increased capabilities as illustrated in Figure 6. It should be noted that there is not a direct relation between the functional FWIS components and the centres illustrated in the figure.

4.2 Increased capabilities at an affordable cost could be provided using one or more PCs, a permanent connection to the Internet and, possibly, satellite communications for assured and timely receipt of WMO products. Centres with these facilities would have the capabilities to function as a NC or small DCPC.

4.3 Further capacity would be provided by PCs, workstations or servers, a broadband Internet connection, and connection to the WMO communication system (GTS with a dedicated message switch, UNIDART, and/or Internet Data Distribution (IDD)). A centre with this infrastructure could serve as a fully functional NC or DCPC.

4.4 A full capacity centre would be equipped with a large computer system (mainframe, multiple interconnected servers, workstations and PCs), a very broadband Internet connection, and a high-speed connection (or multiple connections) to the WMO communication system. A fully equipped centre with these capabilities could provide the services of a sophisticated NC, DCPC, GISC or any combination of these three centres.

5. TECHNICAL CONSIDERATIONS

5.1 For the near future, transmission of the current suite of global products will continue to be distributed to WMO Centres via the existing GTS infrastructure. However, implementation of request/reply systems and exchange of high volume datasets (e.g. radar data, satellite imagery, and high resolution model output) cannot be supported by the existing GTS. Realization of the FWIS vision requires that the existing GTS dedicated communication links and message switches be augmented by additional communications capabilities such as those provided by the commercial Internet and other communication options.

5.2 The current GTS can be extremely costly to WMO Members and inhibit participation in WMO data exchange due to high costs associated with dedicated lines, acquisition of message switches, and ongoing costs of maintaining message switch routing tables. Consequently, the Internet is likely to become the default communication carrier for WMO FWIS data exchange and only where it does not meet the requirements of WMO Programmes would use of private, dedicated circuits and message switches be justified. However, the current capabilities of the Internet raise concerns for Members’ requirements for:

- reliable and continuous connectivity,
- sufficient bandwidth to handle peak-period data transmission,
- responsive delivery of time-critical information,
- a secure networking environment

These concerns must be addressed through long-term testing of Internet capabilities and advanced methodologies (e.g. IPv6, QoS) that promise to provide a secure network environment and predictable performance.

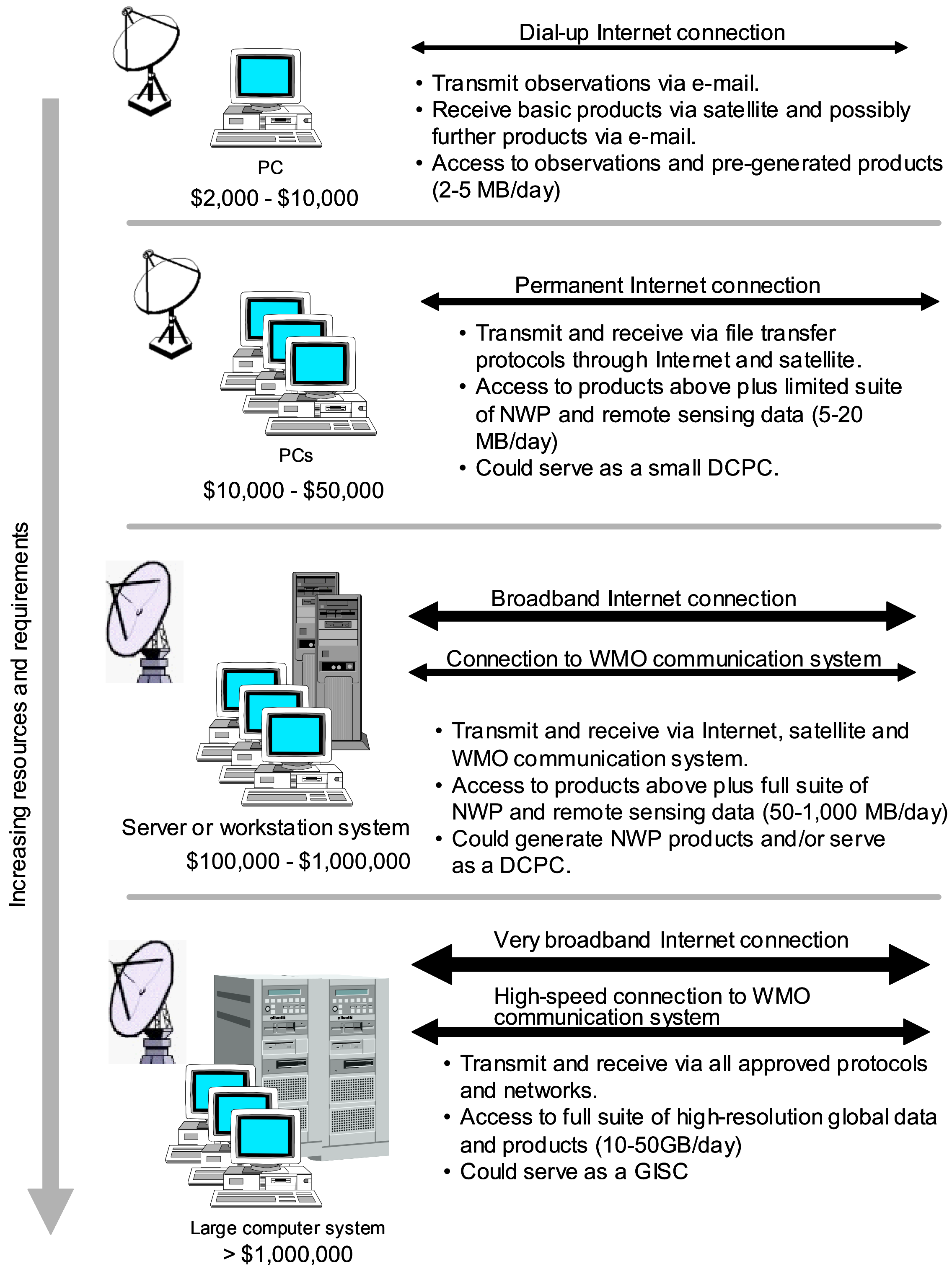


Figure 6. Capabilities of centres in response to increasing requirements
The approximate value of computer hardware and software performing FWIS functions is provided for each level in US dollars.

5.3 Use of alternative communications pathways and software to facilitate data exchange can lower costs and simplify operational management of basic data exchange between Members and can provide flexible and scalable solutions to meet changing data exchange requirements. Alternative methodologies to communicate messages include the Automatic File Distribution (AFD) system developed by the DWD and the IDD developed by the UNIDATA Program Center. While these systems take different approaches to the transmission of data products, they both have a proven history of operation and offer cost-effective alternatives to message switches. Additionally, these methodologies can coexist on dedicated or public communication pathways to provide maximum flexibility for data exchange in a store and forward (push) environment.

5.4 In environments where dedicated communication lines are prohibitively expensive or unreliable, receipt of basic data and pre-generated products can be accomplished by relatively low cost satellite communication. However, the sending of observations via two-way satellite transmission may be too expensive so use of dial-up communications would be necessary.

5.5 To reduce costs for Members FWIS should:

- Use cost-effective communication systems whenever practicable. Cost-effective communication choices will vary between Regions and between Centres with differing responsibilities and local communications infrastructure but compatibility should be a paramount consideration.
- Use commercial off the shelf or open source software where it is available to meet requirements at reasonable cost.
- Employ well-supported open-source software as the foundation for system development when new software is required. System costs will be lowered and continued development of systems will not rely on proprietary system components. Software code will be readily available for modification to meet evolving needs.
- Foster development of open-source projects. Parallel system development is on-going at many Member organizations. Organized open-source projects, focussed on common needs, will result in improved systems benefiting all Members.

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ANNEX

LIST OF ACRONYMS

ADM	Alternative dissemination methods
AFD	Automatic file distribution
AMP	Applications of Meteorology Programme
ANSI	American National Standards Institute
BSH	Basic Systems in Hydrology
CAeM	Commission for Aeronautical Meteorology
CAgM	Commission for Agricultural Meteorology
CBH	Capacity Building in Hydrology and Water Resources
CBS	Commission for Basic Systems
CCl	Commission for Climatology
CHy	Commission for Hydrology
CIMO	Commission for Instruments and Methods of Observation
DB	Direct broadcast
DCPC	Data collection or product centre
DWD	Deutscher Wetterdienst (German Weather Office)
EC	Executive Council of WMO
ECMWF	European Centre for Medium Range Weather Forecasts
EMWIN	Emergency Managers Weather Information Network
ERA	Emergency Response Activities
ET	Expert team
ETFP	Education Training and Fellowships programme
ETRP	Education and Training Programme
FAH	Forecasting and Application in Hydrology
FTP	File transfer protocol
FWIS	Future WMO Information System
GAW	Global Atmosphere Watch
GCOS	Global Climate Observing System
GDPS	Global Data Processing System
GISC	Global information system centre
GOS	Global Observing System
GRDC	Global run-off data centre
GTS	Global Telecommunications System
HRDP	Human Resources Development programme
IDD	Internet data distribution system
ICT	Implementation/coordination team (of CBS)
IMOP	Instruments and Methods of Observations programme
IOS	Integrated Observing System
ISO	International Standards Organization
ISS	Information Systems and Services
JCOMM	Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
LDM	Unidata's local data manager
MB	Megabyte
METGIS	Meteorological Graphic Information System
MSS	Message Switch System
MTN	Main Telecommunications Network (of the GTS)
NMHS	National Meteorological or Hydrological Service
NWP	Numerical Weather Prediction
OPAG	Open Programme Area Group (of CBS)
OPAG-ISS	Open Programme Area Group on Information Systems and Services
PC	Personal computer
PWS	Public Weather Services
RMDCN	Regional meteorological data communications network

RTH	Regional telecommunications hub
SAWS	South African Weather Service
SDW	Sustainable Development of Water Resources
SQL	Standard Query Language
SSA	System Support Activities
SSUP	Satellite Systems Utilization and Products
TAP	Training Activities programme
TCP	Tropical Cyclone programme
TCP/IP	Transport control protocol, internet protocol
TCRP	Tropical Cyclone Research Programme
UNIDART	Uniform Data Request Interface
VGISC	Virtual Global information system centre
WAFC	World Area Forecast Centre
WAFS	World Area Forecast System
WDM	World Weather Watch Data Management
WCASP	World Climate Applications and Services Programme
WCDMP	World Climate Data and Monitoring Programme
WCRP	World Climate Research Programme
WHYCOS	World Hydrological Cycle Observing System
WMO	World Meteorological Organization
WRI	Water-related Issues
WSP	WMO Space Programme (proposed)
WWRP	World Weather Research Programme
WWW	World Weather Watch
XML	Extensible mark-up language