

FUTURE WMO INFORMATION SYSTEM

(Submitted by WMO)

Summary and purpose of document

This working paper discusses the development of the Future WMO Information System, including the outcome of the recent meeting of the CBS/Inter-programme Task Team on FWIS (Kuala Lumpur, 20-24 October 2003).

ACTION PROPOSED

- Appendices:**
- A. Questionnaire to Technical Commissions/WMO Programmes
 - B. The Future WMO Information System Concept
-

DISCUSSION

1. The ITT-FWIS noted with particular attention the decisions and directives of the XIV WMO Congress and EC LV relevant to FWIS. Congress supported the views and conclusions of CBS on the FWIS vision, and requested CBS to pursue the further development of the FWIS towards the refinement and consolidation of the concept and then the design and implementation planning phases. The ITT-FWIS took note of the directives of Cg and EC, and in particular the following:

- Comprehensive requirements of all WMO Programmes as regards information types and volumes, timeliness, sources and users, security, etc., needed to be taken into account to consolidate the FWIS concept, and to develop design and implementation plans;
- All WMO Programmes should actively participate and contribute their own expertise and resources in all phases of the development of the FWIS. The support and involvement of many members of the WMO community, including especially regional associations and technical commissions, was needed, as early as possible, in all phases of the FWIS development in order to ensure a full and shared ownership of the project, and its effective implementation;
- The implementation of FWIS should build upon the most successful components of existing WMO information systems in an evolutionary process. In particular, the FWIS would build upon the GTS with respect to the requirements for highly reliable delivery of time-critical data and products, and the Improved MTN would be the basis for the core communication network;
- The FWIS development should pay special attention to a smooth and coordinated transition.

2. The team agreed that the ITT-FWIS should promote an active interaction with all WMO Programmes in the further development of FWIS. In order to assess the data exchange requirements of WMO Programmes and their integration into a common system, the team developed a questionnaire, (see Appendix A) containing the description of the FWIS concept and seeking information from WMO Technical Commissions about their respective WMO Programmes requirements and systems, at present and for the foreseeable future. The team requested the WMO Secretariat to arrange for the distribution of the questionnaire to the WMO Technical Commissions, and to request replies within four months.

3. The team considered two contributions on the current status and trends for the development of the GTS and the Improved Main Telecommunications Network (IMTN). The team noted the rapid introduction in the GTS, and in particular on the IMTN, of advanced data-communication services, such as managed data-communication networks and Frame Relay that provided efficient and cost-effective means, with a very high reliability and full security, a guaranteed quality of service and an easy scalability of capacity. The capacity of the links is selected to meet peak traffic requirements (i.e. NWP models output, satellite data), and a large spare capacity remains. The team also noted the GTS data-distribution systems via satellite, and the introduction of highly cost-effective digital video broadcasting (DVB-S) and digital audio broadcasting (DAB) data-communication techniques (e.g. VSAT in Region IV, DVB-S in Regions VI and I, DAB in Region II). In particular, EUMETSAT had implemented a DVB-S satellite-based system (EUMETCAST) for distributing MSG data and products over Europe, Africa and part of Asia, which should also support the distribution of WWW data and products.

REFINEMENT AND CONSOLIDATION OF THE FWIS CONCEPT

4. The task team noted that CBS-Ext.(02) had agreed that the FWIS should identify and acknowledge the national level of the WMO Information System, that were currently included in the GTS structure and were of crucial importance for the national data collection. It agreed that the role of data and products cataloguing, which is crucial for the whole FWIS operation, should be

explicitly addressed. Each GISC should maintain and operate a comprehensive catalogue of data for routine global exchange; it should also maintain, as part of the catalogue, the necessary metadata information required to locate the NC, DCPC or other GISC providing other data made available for exchange, on the understanding that the full detailed catalogue of these data are maintained and operated by the responsible provider centre (NC, DCPC or GISC).

5. The team also refined the functions of NCs, DCPCs and GISCs, in particular with respect to data collection and storage, as well as users' access. It agreed that, in accordance with NCs' responsibilities to serve data and product needs of their country, NCs should provide for the authorization of their respective national users to access FWIS, as required. Appropriate identification, authentication and authorization procedures will be exercised through relevant standard techniques that are developed for a number of Internet applications. The team emphasized that data quality control and monitoring as well as data archiving was not an FWIS responsibility, and would remain under the control of the respective programmes and relevant centres. The FWIS would ensure the data access and delivery services, including the monitoring of these activities.

6. The team agreed that, in the further development and design of the core-communication network of the FWIS, particular attention should be given to traffic management to ensure the adequate prioritisation of different categories of exchange. It noted in this respect that WWW centres had been highly reluctant to use spare capacity of the GTS for other lower priority traffic to safeguard the effective WWW exchange. The team agreed that, to ensure a smooth transition, new request-reply and client-server services provided by FWIS should be supported via the Internet, while the GTS would continue to support high-priority "routine" traffic. However, current request-reply in the framework of routine exchange would continue to be routed on the GTS.

7. The team reviewed the FWIS vision that had been developed at the previous meeting and, with the above considerations in mind, it developed the consolidated "Future WMO Information System concept" as given in Annex B.

QUESTIONNAIRE TO TECHNICAL COMMISSIONS/WMO Programmes

Preamble of Questionnaire

- Background including Congress statement on FWIS
- FWIS Vision
- Purpose of Questionnaire
- There will be follow-up to this questionnaire as the FWIS concept develops.
- List of members and additional experts in the ITT-FWIS
- Please nominate a contact point within your Commission.

Questions

1. Do you feel that your data management and exchange requirements within your programmes or with other programmes can be met by the FWIS? What specific issues can you identify?
2. What are the sources (providers) of data within your programmes? Who are the users of these data?
3. What are the entities (organisations) that need to be provided with your data within each WMO Member country?
4. Please map your current and future data exchange structure into the FWIS structure (see diagrams) with respect to GISCs, DCPCs and NCs, and corresponding data flows. Are there any specific issues related to this mapping?
5. Roughly how much volume in total needs to be exchanged by your programmes at present and in the foreseeable future?
6. What proportion of your data is required to be exchanged within the following timeframes:
 - up to 15 minutes?
 - 15 to 60 minutes?
 - 1 to 3 hours?
 - 3 hours to one day?
 - longer than one day?
7. What proportion of your data is exchanged by:
 - the WWW GTS?
 - the Internet?
 - other mechanisms? Please specify.
8. What proportion of your data is exchanged by:
 - routine dissemination (push)?
 - request-reply?
 - other mechanisms? Please specify
9. Please specify the general formats of your data with respect to:
 - WMO standards?
 - other international standards?
 - proprietary or other formats?

10. Please describe the existing or planned metadata and catalogue standards within your programmes.
 11. Is there any other information about the data management and exchange requirements of your programmes you think FWIS needs to be aware of?
-

THE FUTURE WMO INFORMATION SYSTEM CONCEPT

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, some of the key points are:

- 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.

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 1 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.

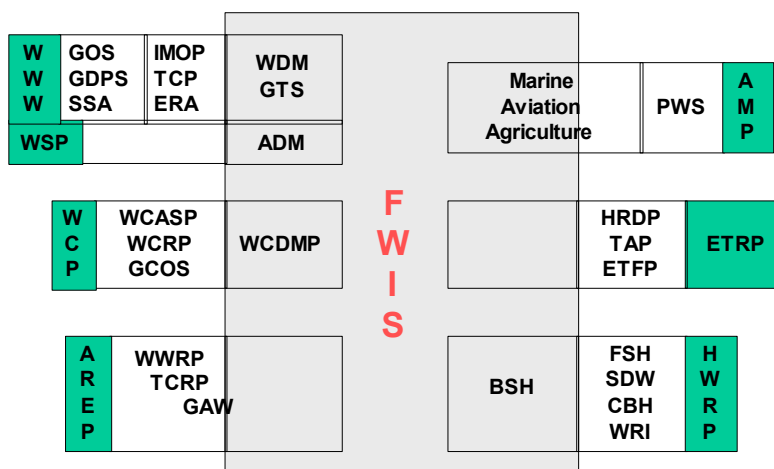


Figure 1. FWIS relationship to WMO Programmes

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. For this purpose, each country will implement and maintain an appropriate infrastructure, being the national component of FWIS. 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 (possibly via a DCPC);
- (c) Provide observations and products intended for regional or specialised 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 and provide this information as appropriate to other centres, in particular 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 for at least 24 hours and make it available via WMO request/reply ("Pull") mechanisms;
- (e) Maintain, in accordance to the WMO standards, a catalogue of all data and products for global exchange and provide access to this catalogue to locate the relevant centre;
- (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.

Security and authorization

2.5 In accordance with NCs' responsibilities to serve data and product needs of their country, NCs would provide for the authorization of their respective national users to access FWIS, as required. Appropriate identification, authentication and authorization procedures will be exercised through relevant standards.

Data archives

2.6 FWIS would not control data archiving, which remains the responsibility of the respective WMO programmes and relevant centres.

Data flow

2.7 The flow of information between these centres is illustrated in figures 2 through 4. Figure 2 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.

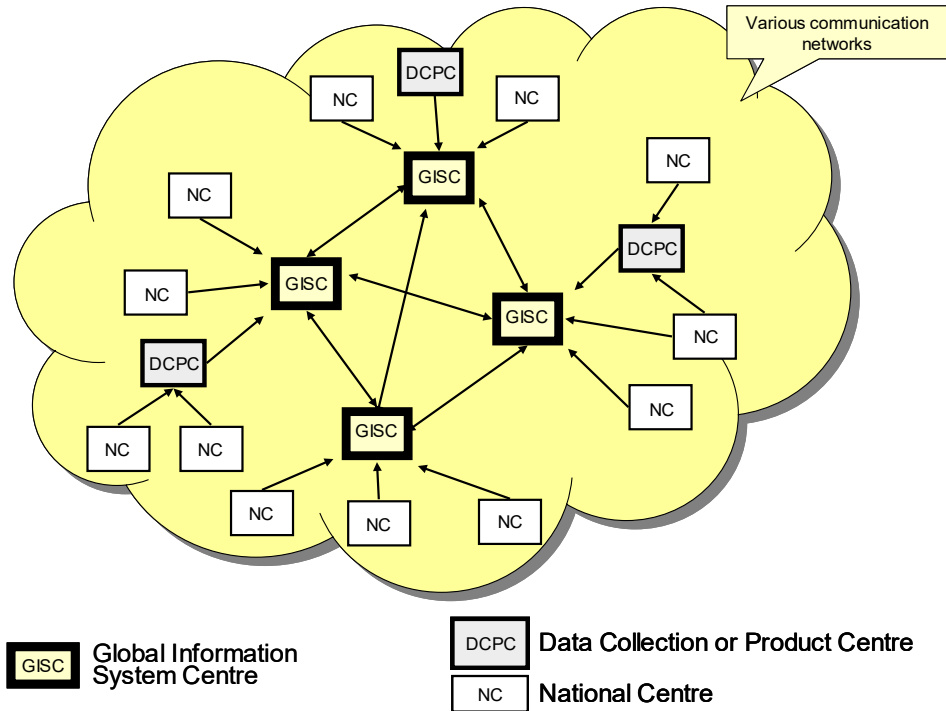


Figure 2. Information collection data flow
 (Arrows indicate data flows; no physical links are implied)

2.8 Figure 3 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.

2.9 Figure 4 provides a simplified view of the various categories of information flow.

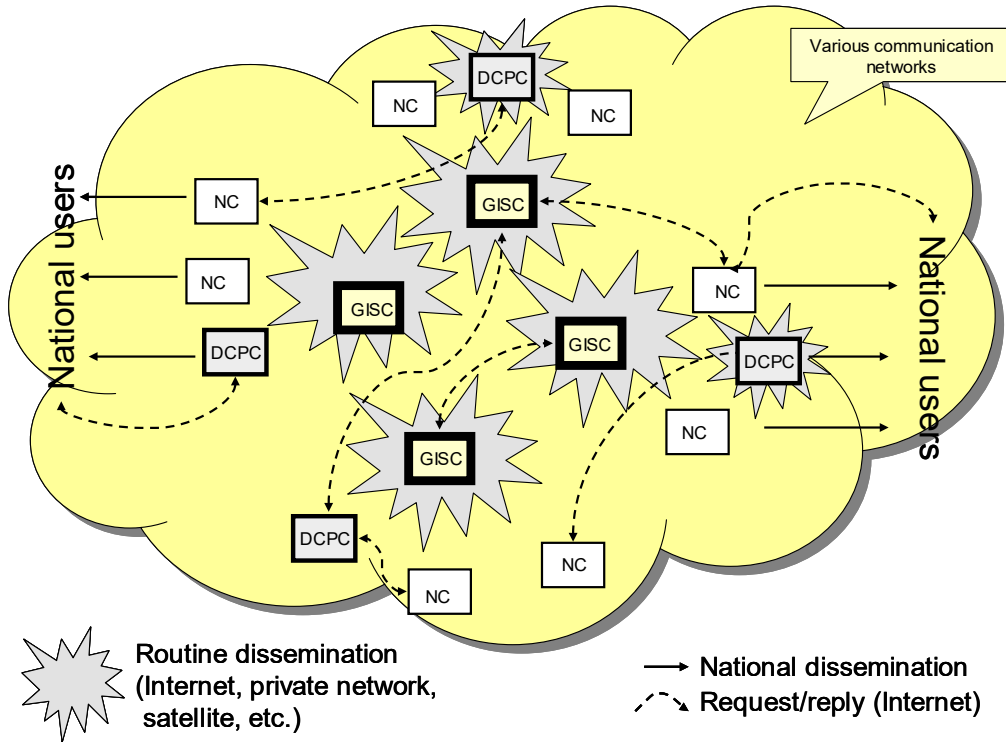


Figure 3. Information distribution
 (Arrows indicate data flows; no physical links are implied)

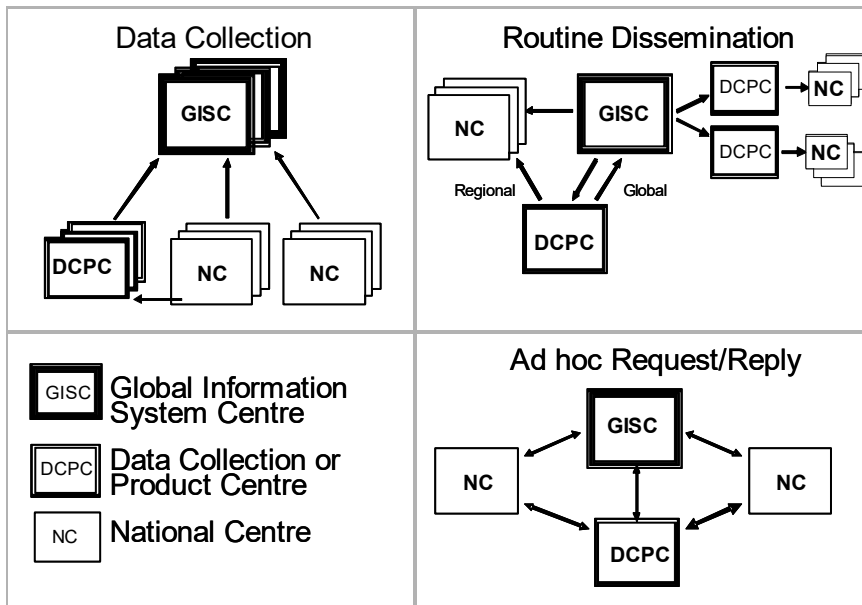


Figure 4. Overview of communication topologies

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
NMC (as regards information and communication)	NC
RSMC (as regards information and communication)	DCPC and/or GISC
WMC (as regards information and communication)	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 5. 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, 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 network services 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.

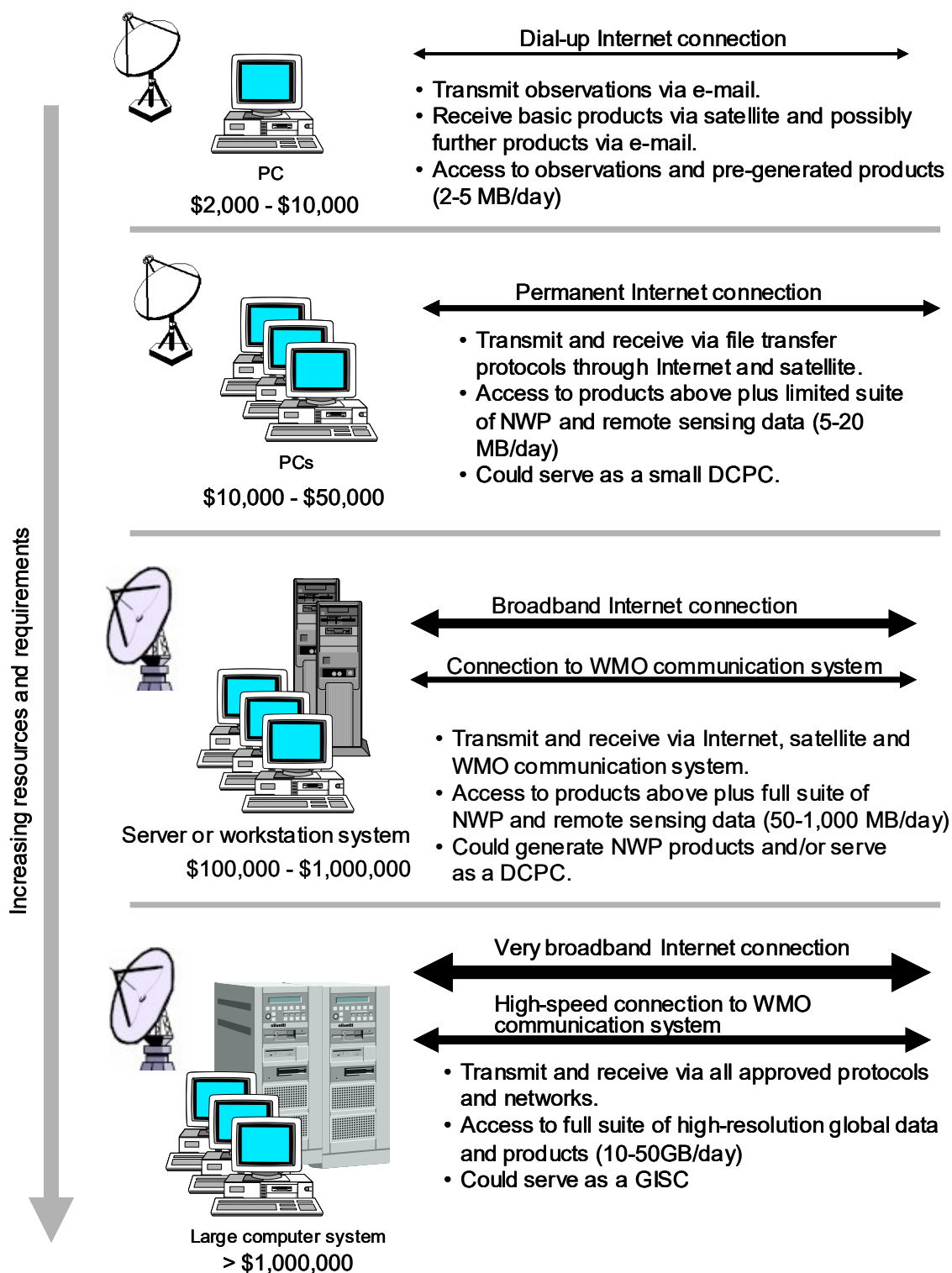


Figure 5. Capabilities of centres in response to increasing requirements
 The approximate value of computer hardware and software performing FWIS functions is provided for each level in US dollars.

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, e.g. Data-Grid-services, OPeNDAP, etc. 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 For the request/reply mechanism and catalogue enquiries Web-services and Web portals should be considered, e.g., as in the UNIDART project.

5.5 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.

5.6 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 ongoing at many Member organizations. Organized open-source projects, focussed on common needs, will result in improved systems benefiting all Members.
-