WMO Information System 2.0 Strategy

2017 edition

WEATHER CLIMATE WATER

WORLD
METEOROLOGICAL
ORGANIZATION

WMO-No. 1213

WMO Information System 2.0 Strategy

2017 edition

WORLD
METEOROLOGICAL
ORGANIZATION

WMO-No. 1213

EDITORIAL NOTE

METEOTERM, the WMO terminology database, may be consulted at http://public.wmo.int/en/resources/meteoterm.

Readers who copy hyperlinks by selecting them in the text should be aware that additional spaces may appear immediately following http://, https://, ftp://, mailto:, and after slashes (/), dashes (-), periods (.) and unbroken sequences of characters (letters and numbers). These spaces should be removed from the pasted URL. The correct URL is displayed when hovering over the link or when clicking on the link and then copying it from the browser.

WMO-No. 1213

Chairperson, Publications Board
World Meteorological Organization (WMO)
7 bis, avenue de la Paix
P.O. Box 2300
CH-1211 Geneva 2, Switzerland

Tel.: +41 (0) 22 730 84 03
Fax: +41 (0) 22 730 81 17
Email: publications@wmo.int

ISBN 978-92-63-11213-2

PUBLICATION REVISION TRACK RECORD

Date	*Part/ chapter/ section*	*Purpose of amendment*	*Proposed by*	*Approved by*

CONTENTS

1. INTRODUCTION

1.1 The WMO Information System (WIS) was established to provide high-performance and reliable information sharing and management services for all WMO Programmes and related activities. After a decade of implementation, WIS became operational in 2012 and must evolve to meet the ever growing requirements of its users. The status of WIS in August 2016 is described in Annex I.

1.2 The 2014 extraordinary session of the Commission for Basic Systems (CBS), held in Asuncion, Paraguay, requested the Implementation Coordination Team on Information Systems and Services (ICT-ISS) to elaborate and maintain a strategic plan for developing WIS over a ten year period. The sixty-eighth session of the WMO Executive Council requested that CBS present a proposal for a governance structure and a strategy for the evolution of WIS to the sixty-ninth session of the Council. This document outlines the strategic activities for the evolution of WIS toward its next generation, WIS 2.0, with an enhanced focus on supporting global agendas, such as the Global Framework for Climate Services (GFCS), Disaster Risk Reduction (DRR), the United Nations Sustainable Development Goals (SDGs) and the United Nations Framework Convention on Climate Change (UNFCCC), as well as on reducing costs, facilitating the activities of National Meteorological and Hydrological Services (NMHSs) and improving efficiency and processes. Further effort will be required to define how services will be delivered and supported to help WMO Members achieve maximum advantage from WIS.

1.3 Note that the terms “cloud computing” and “open ecosystem”, as used in this document, are defined in the Glossary.

2. VISION

WIS 2.0 will provide users with seamless access to diverse information from a wide range of sources and will enable weather, water and climate information to be related to socioeconomic and other contexts. Through an open ecosystem of tools, applications and services, WIS 2.0 will allow all information providers to manage, publish and share their data, products and services, and will allow all users to develop value-added services and new products.

3. DRIVERS AND CHALLENGES FOR WIS 2.0

3.1 User expectations

3.1.1 Effective use of information, including combining data from multiple areas of benefit to society, such as biology, earth sciences and disaster-risk management, is a factor of economic growth. It is increasingly important that information becomes available in a way that maximizes uptake and business opportunities.

3.1.2 Users expect to access weather, water and climate information and services through the same mechanisms that they use for other types of information, with familiar interfaces and applications. Users will expect more social interaction and mobile delivery. They will also expect services that are built on more creative use of information, such as those that derive insight from analysis of Big Data.

3.1.3 Key changes in the world of information technology (IT) are taking place which require the traditional approach of pushing the information to be amended. It is anticipated that WIS 2.0 users will combine mobile, cloud computing and social technologies to access a much wider range of information sources and to collaborate in new and different ways. In the current design, NMHSs are, in general, pushing predefined static sets of information to the end-user communities. In WIS 2.0, this will evolve into a model where end users are pulling selected information into environments and collaboration areas of their choice.

3.1.4 WMO Members find it increasingly challenging to deliver the services necessary to meet such needs in a rapidly evolving environment. These challenges result from the increasing volumes and variety of information required. WIS has to evolve to provide the foundation to support these services.

3.1.5 User expectations are driven by the services provided by global companies with the financial resources to invest in innovative solutions. Public sector organizations typically cannot access funding on the same scale. As a consequence, they may need to work in close partnership to develop common components and deliver services.

3.2 Data volume and complexity

3.2.1 Satellites, radars and numerical models are producing information in greater volumes than ever before. For example, the current generation of satellites produces about 50 times more data than its predecessor. Furthermore, improvements in weather science will drive demand for the exchange of weather radar data at much higher frequency and on a global scale.

3.2.2 In addition to information traditionally used by NMHSs, increasing use will be made of information from sources not previously considered, both private and public.

3.2.3 Other sources of information are becoming available that may have data volumes exceeding those of traditional data sources, such as social networks and crowd sourcing. Some of these sources may contain quantitative information but will not be formatted in traditional ways using WMO code forms, and will require processing before they can be utilized.

3.2.4 Data volumes created by Earth observing and numerical prediction systems continue to grow considerably faster than the performance of telecommunications networks. This ever increasing flow of information poses significant challenges for processing, distribution and storage.

3.2.5 It will therefore be ever-more challenging to manage and share the increasing volume of data by sending it all to end users. Instead, users may want to select the subsets that meet their needs, or execute their queries and algorithms in close proximity with the data in order to reduce the volume of information to be transferred. This is described as “bringing the user to the data”. For some services, however, timely provision of the underpinning data to the user will remain critical, “taking the data to the user”.

3.3 Costs

3.3.1 National Meteorological and Hydrological Services (NMHSs) face continuing pressure on budgets. It is important to remove duplication of effort, to facilitate the use of existing solutions (such as commercial, open source or off-the-shelf systems) and to make the infrastructure more cost-effective through simplification.

3.3.2 Collaboration needs to be enhanced to reduce the number and variety of local solutions across WIS, with NMHSs working in close partnership to develop common components and deliver services, rather than being solely responsible for those services.

3.3.3 WIS 2.0 will offer mechanisms to increase collaborative development, maintenance and support of services, promote the exchange of best practices and enable the uptake of new technologies.

3.4 Policy environment

3.4.1 Many policymakers and funders place requirements on public sector organizations to provide their information as "open data". This has led to a number of global and regional initiatives that place obligations on Members.

3.4.2 Publishers of information are being increasingly required to describe, explain and justify the workflows and methods they have used to create that information. As a consequence, WIS 2.0 will need to define an information assurance framework. This will, in particular, include a data life-cycle management that demonstrates compliance with these policy requirements.

3.5 Technology trends

3.5.1 Technology in recent years, in responding to user needs and expectations, has moved towards a service-centric approach. WIS 2.0 needs to take these changes into account when developing services and infrastructure. Cloud computing, Web services, data analytics and other technologies are expected to offer opportunities through new paradigms and concepts that will enable users to exploit data with much lower barriers.

3.5.2 Among technical and policy changes, those in Annex II are considered as being the most relevant for WIS 2.0.

4. WIS 2.0 STRATEGY

4.1 Strategy

4.1.1 Changes in data supply patterns and user expectations over the past decade present new challenges that the current WIS struggles to meet. At the same time, changes in technology (e.g. cloud computing infrastructure, messaging, search engines, web services) present new opportunities.

4.1.2 WIS 2.0 will facilitate exchange of the right information at the right time with the right people. It will be built on redundant, resilient, efficient and scalable infrastructure. It will use applications and services based on standard interfaces for data exchange ready for Social, Mobile, Analytics (Big Data) and Cloud (SMAC) and Internet of Things.

4.1.3 WIS 2.0 will be operated by the WMO community, and will be built on industry standards, incorporating existing services and solutions provided by the public and private sectors. It aims to establish a global information management, processing and sharing platform that will provide the following benefits:

(a) Accessibility: a platform enhancing the collection of data and allowing applications and services to be developed, capable of working with high-volume and archived data, and operated and managed without the complexity of building and maintaining infrastructure or managing local repositories of data;

(b) Interoperability: software components interact with the platform using industry-accepted approaches and open standards;

(c) Visibility: authoritative data from NMHSs are visible to government, commerce and citizens;

(d) Utility: a focus on meeting the needs of users to exploit meteorological data in context with data from other domains, enabled through services offered by the WMO community;

(e) Reliability: data and services are safe and accessible with guaranteed performance at any time;

(f) Cost-effectiveness: avoidance of duplication through use of shared components built on the infrastructure of organizations that can leverage economies of scale; the system uses standard technology, avoiding the need for WIS-specific skills;

(g) Capacity-building: training to enable all NMHSs, particularly from least developed countries and small island developing States, to use the infrastructure and services of the WIS 2.0 platform to build services that meet the needs of their domestic stakeholders.

4.1.4 A core principle of the WIS 2.0 strategy is the recognition that advances in technology make it feasible for organizations to provide services and components that serve a global audience. The WIS 2.0 platform will support the provision of such shared components, reducing the need for duplication and the overhead of associated data synchronization.

4.1.5 WIS 2.0 encourages Members to coordinate delivery and operation of the shared components that comprise the WIS 2.0 platform. Fundamentally, the WIS 2.0 platform is intended to support the needs of the WMO community, providing the foundation that makes it simple for the WMO community to provide information and services and simple for users to find them.

4.1.6 The WIS 2.0 platform will support a change in user behaviour from downloading a copy of information for local processing to using services that process the information at its source. The WIS 2.0 platform will be complemented by a set of principles to encourage best-practice information assurance (data life-cycle management) by the WMO community. This will support the emergence of common approaches designed to give users confidence in the quality of information, utilizing user feedback mechanisms, in order to support continuous improvement and to present a seamless user experience across Members' services.

4.1.7 WIS 2.0 will continue to provide data collection and distribution at national, regional and global scales.

4.1.8 Technical aspects of WIS 2.0 are anticipated to include:

(a) Use of cloud computing infrastructure to host shared components (such as data repositories and applications) in order to provide low-latency global data sharing that enables the WMO community to 'plug' their components into shared infrastructure and easily deliver value-added services to their users, and provide facilities that enable users to work with high-volume data in-situ rather than require download for local use;

(b) Use of Web standards, Web services and well-defined Application Programming Interfaces (APIs) to enable WIS 2.0 to become 'machine interoperable' - i.e. enabling software systems to find and use the meteorological data and services hosted on the WIS 2.0 platform without requiring routine human intervention;

(c) Use of common open data formats (e.g. JSON, CSV, XML, netCDF, HDF) complementing Table-driven Code Forms (GRIB, BUFR) to simplify data provision and use by a broader community;

(d) Use of analytics and user feedback to drive continued improvement of user experience;

(e) Integration with global search engines (such as Google, Bing or Yahoo) to improve visibility of the authoritative information provided by NMHSs while retaining data sovereignty;

(f) Integration with third-party identity management services (such as eduGAIN) to simplify authentication of users;

(g) Retirement of traditional Global Telecommunication System (GTS) message switching as the basis for operational, real-time data exchange in favour of industry standard data distribution methods and protocols such as secure file transfer and publish-subscribe messaging;

(h) Fault-tolerant design of WIS 2.0 components and applications to deliver high quality of service even where underlying infrastructure cannot guarantee a level of service.

4.1.9 Implementation of this strategy must be based on the most cost-effective way to provide shared components, comparing the benefits of managed cloud computing services that are operated on behalf of the WMO community with a federated solution that takes advantage of the competencies and strengths of organizations within the community.

4.2 Governance

4.2.1 A governance regime supporting a financially sustainable WIS 2.0 platform will be developed alongside the technical aspects. National Centres and Data Collection or Production Centres remain the primary centres within WIS 2.0 as these collect data, generate content and deliver services. WIS 2.0 will continue relying on the contribution of the Global Information System Centres (GISCs), including their associated collaboration and capacity development activities. Their role will evolve from infrastructure provision to focus on providing more effective support to centres in their area of responsibility.

4.2.2 WIS 2.0 governance will need to address issues such as:

(a) Data life-cycle management;

(b) Data licensing and access;

(c) Information security;

(d) Cost sharing and contract management with commercial infrastructure suppliers;

(e) Resource allocation (e.g. computing, storage) within shared components;

(f) Private sector participation.

4.3 Incremental change

4.3.1 Considering the operational aspects of WIS and the risks involved in a "big-bang" approach, WIS 2.0 will be implemented step by step with defined and manageable incremental phases.

4.3.2 Activities within the Open Programme Area Group on Information Systems and Services (OPAG-ISS) are providing insight into the first incremental steps to transition to WIS 2.0. For example, evaluation of the "cache in and through the cloud" is a step in this direction.

4.3.3 The Open Programme Area Group on Information Systems and Services, in collaboration with other technical commissions and programmes, will prepare an implementation plan describing the transition to WIS 2.0 that takes into account priorities based on management of risks and benefits.

5. RISK IDENTIFICATION

5.1 The overall strategy is ambitious, involving many contributors, new technologies and standards. Hardware, systems, development and ongoing support have to be integrated into strategic planning and system replacement processes.

5.2 Each contributor's solution has to interface with other contributors' solutions, whilst meeting local, national and regional requirements. WIS 2.0 will also entail extensive alterations to current business processes. There is also a critical requirement for the evolution of existing

information systems to WIS 2.0: the evolution must not disrupt the present systems, which have established very high availability, robustness and performance. These qualities are also required in WIS 2.0.

5.3 The successful implementation of the WIS 2.0 strategy will require the participation of experts from around the world. Many of them are not allocated full-time to the task and already face pressing operational issues as they also support critical operational systems and procedures. The WIS 2.0 implementation team will have to work as a virtual team.

5.4 WMO systems support many high-profile or critical activities in Member countries such as the preparation and distribution of warnings. Failures in the new system could lead to critical information not reaching the right place at the right time, a risk that must be addressed in the implementation plan.

5.5 WIS 2.0 will provide new capabilities that could create opportunities for Members to run their operations more efficiently. Some components of WIS 2.0 such as data policy and data access via the Internet have raised concerns that will need to be addressed.

5.6 To reduce the exposure to the above risks and to ensure prompt delivery of WIS 2.0, it is recommended that a full-time project manager is appointed to guide implementation of the strategy, to maintain a comprehensive risk assessment and to act as the focal point for all significant issues.

ANNEX I. WIS STATUS

1. WIS AND WMO PROGRAMMES

1.1 WIS is the single coordinated global infrastructure responsible for telecommunications and data management functions. It is the pillar of the WMO strategy for managing and moving weather, climate and water information in the twenty-first century. WIS provides an integrated approach suitable for all WMO Programmes to meet the requirements for routine collection and automated dissemination of observed data and products, as well as data discovery, access and retrieval services for all weather, climate, water and related data produced by centres and Members within the framework of any WMO Programme.

1.2 In its current form, WIS (and the Global Telecommunication System (GTS)) is a niche infrastructure that supports the expert meteorological community. WIS intended to support all WMO Programmes; however, the reality is that the majority of products and services registered in WIS relate to real-time information, primarily associated with the World Weather Watch Programme.

2. WIS ARCHITECTURE

2.1 The infrastructure used for operational exchange among WIS centres is a combination of private Multiprotocol Label Switching (MPLS) networks (such as the Regional Meteorological Data Communication Network (RMDCN)), the public network (Internet) and satellite broadcasts (such as Eumetcast). Services rely largely on well-known applications (File Transfer Protocol (FTP) and Secure File Transfer Protocol (SFTP)). Although operational and workable, dedicated MPLS networking is complex and has increasing Information Technology (IT) security challenges and contractual complexities. Further, MPLS networks can offer a Service Level Agreement, but at a very high cost for limited bandwidth, so the resulting operational costs can constrain bandwidth, limiting the amount and types of data exchanged through traditional GTS processes.

2.2 Continued evolution of the GTS as a component of WIS, though providing an efficient operational service and allowing a smooth transition to WIS, now hinders both real-time and delayed mode information exchange through WIS by imposing "old" technologies. The mapping of the TTAAii[1] bulletin header to metadata creates problems and imposes two rather different solutions: TTAAii on the one hand, Discovery, Access and Retrieval (DAR) on the other hand. Both components should be merged while preserving the operational quality of the GTS and ensuring that information arrives when and where it is needed.

2.3 The functional architecture document (see *Guide to the WMO Information System* (WMO-No. 1061) Part III) has been the baseline used to design the WIS as we know it today. A large majority of the requirements have not changed and the obligations that the WIS has to fulfil are still the same. However, the current topology of WIS is largely inherited from the pre-existing GTS[2] and the technical solutions available twenty years ago.

2.4 Due to their collaboration and networking, Global Information System Centres (GISCs) have played a central role in building the WIS. In addition to hosting the discovery metadata services and new functionality of WIS, they have significantly contributed to capacity

---

[1] TTAAii is a code (4 characters and 2 digits) used by the GTS to define a message type.

[2] The GTS combines technical and procedural elements involving NMHSs and RTH. The term GTS covers many different technical, functional, administrative and operational aspects. In most cases, the decommissioning of the GTS will only address the technical part of the *Manual on the Global Telecommunication System* (WMO-No. 386).

development within their area of responsibility. Global Information System Centres and other WIS centres will evaluate and test new technologies in the evolution process to the future WIS 2.0.

3. STRENGTHS AND WEAKNESSES OF WIS

3.1 WIS provides access to diverse information for a broad range of users in both public and private sectors. Data, information and knowledge enable stakeholders to improve decision-making processes.

3.2 WIS is very reliable. It has been established as the common communication infrastructure to support all WMO Programmes and related organizations. World Weather Watch data and products have been circulated through the GTS only for WMO Members. Today, the information intended for global exchange is also available to WMO Members and the meteorological communities through the WIS DAR service over the Internet.

3.3 WIS facilitates the sharing of weather and climate data and information collected and processed by WIS centres. It ensures that those data are discoverable and accessible to support the development of products and the delivery of information services.

3.4 WIS provides a reliable service through redundant systems such as Disaster Recovery Centres and backup arrangement with partner GISCs. Area Meteorological Data Communication Networks (AMDCN) with their Areas of Responsibility (AoR) are being used not only for network infrastructure but also as a framework for capacity development with the WIS competency and training guidance.

4. METADATA

4.1 The WIS DAR Catalogue comprises around 150 000 metadata records, which makes it significantly larger than many catalogues.

4.2 Metadata records conform to ISO 19115:2003, Geographic Information – Metadata, and are encoded in XML format complying with WMO Core Metadata Profile. The quality of metadata is mixed and impacts the discovery service offered to WIS users. For example, when a user is searching for temperature products, they are deluged with search results of bulletins, as the catalogue contains very fine-grained metadata dominated by GTS bulletins.

4.3 With the retirement of Weather Reporting (WMO-No. 9), Volume C1, the primary function of WIS appears to have become management of operational bulletins (e.g. notification of changes between operational centres).

ANNEX II. INFORMATION AND TECHNOLOGY TRENDS

1. BIG DATA

Big Data is a term widely used and usually refers to new technical solutions to deal with massive amounts of data (volume).Additionally velocity (the data are being created frequently), variety (the nature of data can be very different) and veracity (can the data be trusted?) are also covered. These aspects are often referred to as the 4 Vs of Big Data. In the context of WIS, we have to address these 4 Vs, and this can have operational consequences. For example, transferring huge amounts of data to users might no longer be possible. In the current system, the data is usually sent to the process. In the future, the opposite should be possible, where the process is sent to the data.

2. THE CLOUD

2.1 The big players on the Internet (e.g. Google, Amazon) and other providers are making available to users applications, computing and storage resources to host and process data in a shared environment called the Cloud. Instead of using internal resources, in certain situations, it may be much more cost-effective for an organization to use a Cloud service for processing, storing and exchanging data.

2.2 Considering Big Data as described above, the Cloud and the associated services (applications, processing and storage) are likely to be a very cost-effective way for the WIS to deliver services and data to the users.

2.3 The Implementation Coordination Team on Information Systems and Services (ICT-ISS) is investigating the applicability and potential of cloud computing services and data exchange based on cloud computing in support of WIS.

3. SEARCH ENGINES

The current WIS is based on a catalogue of metadata. In order to find a particular dataset, users have to connect to the portal of a Global Information System Centre (GISC) and use its search tools. This means that the “gates” to the WIS are the GISCs. However, nowadays, the “gates” for all content on the Internet are search engines such as Google and Bing. Therefore, making data available to users will require WIS to use the de facto standards and common practice of the Internet. The catalogue should therefore be searchable and accessible via the common “gates” of the Internet, the search engines.

4. MESSAGING AND SOCIAL NETWORKING

Sharing notifications, messages and alerts through the social media has become common place. Services such as Twitter are built using industry standard messaging protocols and quickly scaled to support many millions of concurrent users sharing information in real time. Social media messages often include images, whose size easily exceeds that of a typical GTS message. These technologies offer new opportunities for sharing meteorological data in real time using common industry practices.

5. INTERNET OF THINGS

Along with available network connectivity almost everywhere (Wi-Fi, fourth- and fifth-generation mobile networks (4G and 5G), Bluetooth, very low speed networks, etc.) and very cheap sensors of all kinds, the Internet of Things is developing rapidly. Whether it takes the form of windscreen wipers connected on cars, or weather stations for homes, the Internet of Things is creating and will continue to create a vast ecosystem of companies, which are not WIS users, but which will be nevertheless interested in exchanging data with WIS users to develop their business and in return provide an incredibly large amount of observation data. WIS should facilitate these interactions with weather-related Internet of Things.

6. APPLICATION PROGRAMMING INTERFACES AND WEB SERVICES

Application Programming Interfaces (APIs) and Web services are now very common solutions for machine to machine interaction. By offering standard interfaces and by allowing the exchange of data using official or de facto standards (JSON, XML, CSV), WIS should offer, in addition to the human interface it currently has, solutions to facilitate machine to machine communication. The Open Geospatial Consortium (OGC) is developing several standards to facilitate such interactions. Along with these solutions, WIS should provide lightweight interfaces to allow users to interact with it. As such interactions often require users to be authenticated, WIS Members should be encouraged to accept validated third-party authentication services, such as those provided by research network GEANT (eduGAIN) or by commercial entities such as Google or Facebook.

7. OPEN DATA

Open data are data that anyone can access, use or share and whose licence allows users to do what they need to do with the data without additional constraints. Many governments have decided to release data in this way, aiming to foster the development of applications and services that will benefit citizens. Sometimes these data must be presented using standard protocols and formats.

GLOSSARY

Cloud computing: Network- or Internet-based services, computing, storage or processing that provides shared resources to WIS centres to support flexible levels of demand.

Open ecosystem: Interoperable virtualized digital services focusing on maximizing reuse, agility of operations and scalability built on open standards.

For more information, please contact:

World Meteorological Organization

7 bis, avenue de la Paix – P.O. Box 2300 – CH 1211 Geneva 2 – Switzerland

Communication and Public Affairs Office

Tel.: +41 (0) 22 730 83 14/15 – Fax: +41 (0) 22 730 80 27

Email: cpa@wmo.int

public.wmo.int

JN 18428