by Paola Colagrande

GETTING OFF THE GROUND

Accurate weather information for ATC

An integrated solution that takes into account weather observation management and air traffic control activity provides invaluable support for take-off and landing

The best air traffic management (ATM) strategy, especially during severe weather conditions en route to and at airport areas, requires effective decision-making support tools capable of translating meteorological information into impact forecasts for air traffic. This will be used as feedback to refine the strategy itself. Providing accurate weather information to air traffic controllers is key in meeting safety and on-schedule requirements of airliner flights.

The first goal to be pursued for an effective ATM approach is the creation of a system for the collection and distribution of meteorological information, with a special focus on critical information for take-off and landing phases, by applying international standards (ICAO, WMO, EUMETNET, etc) to all data recorded from airport-installed meteo sensors or acquired from Earth-observing satellites.

The second goal is improvement of the system, by designing and developing a comprehensive and integrated interface and therefore getting the most user-friendly and effective data visualization tool for air traffic controllers and weather forecasters.

In this way, through weather data acquisition, collection, processing, and visualization processes, it is possible to develop a complete system offering a reliable platform for daily control tasks in the ATC environment.

SMS (Standard Meteorological Station), IMX (Interface for Meteo eXchange), and IWS (Integrated Weather System) may be regarded as components of this integrated system; their synergic teamwork ability represents an effective solution to a growing demand for higher-performing ability in handling weather information.

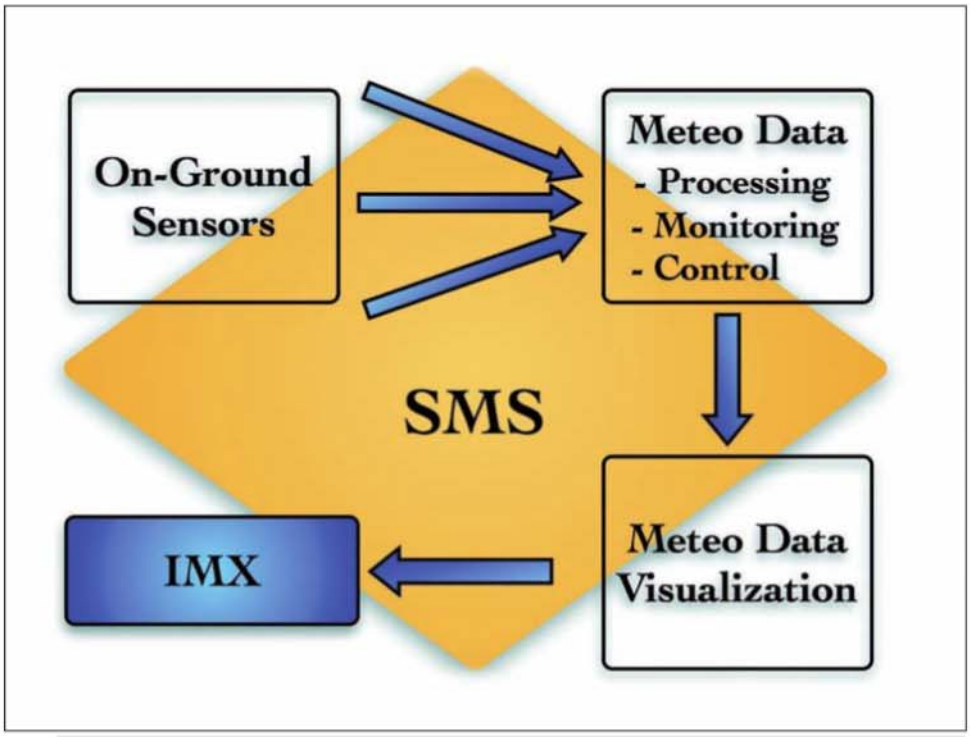


FIGURE 1: **SMS logical scheme**

Standard Meteorological Station

SMS is the system that is about to be developed by the Italian National Meteorological Service, in cooperation with the Vitrociset meteorological department, for modernizing and improving the national ground observation network.

Based on the EUMETNET AWS program requirements, the station may operate both manually and automatically.

The system is mainly defined by the following abilities: simplification of the interface with any digital sensor, by means of user-friendly configuration tables; automatic database generation including observed and derived variables; message and bulletin production in TAC and BUFR formats in compliance with WMO MTDCF (Migration to Table Driven Code Forms) requirements; transmission of collected data

to the central archive; and the possibility of local and remote controls.

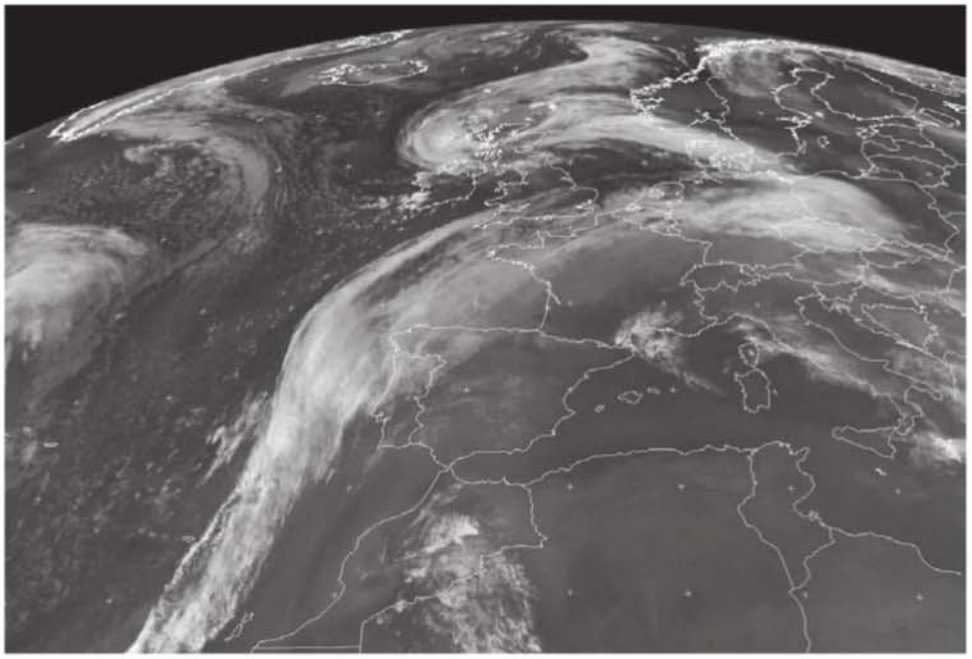
The entire system is a complete and flexible solution for managing leading-edge ground observation networks. The SMS system will be the standard reference for the Italian national meteorological network.

SMS has been developed to gather high-frequency physical atmospheric parameters from meteorological sensors; to generate suitable databases for observed and derived variables; to process and transmit data and meteorological messages; to operate manually and automatically; to meet WMO, ICAO and EUMETNET standards.

Simplicity, modularity, scalability and expandability, software portability, software flexibility, redundancy capability, Linux operational system and low maintenance requirements are only some of the prime distinguishing features of the SMS system.

SMS may be used with any commercial off-the-shelf sensors and fully automatic mode devices provided with a documented digital output string. The operational suite is based on the most popular software packages, including web interfaces. The SMS operating software package consists of three main modules (Ingest, GUI, and Sender) controlled by a 'supervisor' program, which guarantees high system reliability. A GPS clock gives the absolute reference time to the computer system. The Ingest module can gather, validate, process and archive atmospheric variables and also creates the following other variables: instantaneous db (individual sensor outputs, high sampling frequency), representative db (preliminary checks, data processing, mean values, etc), as well as the derived representative variables db (dew point temperature, QFE, and QNH).

The graphical user interface (GUI) enables users to manage and control the whole SMS, including: configuration tables, status of the station, data visualization, different users access, observations manual input by operator, message production in traditional alphanumeric codes (TAC) and WMO standard BUFR format, as defined by the MTDCF. The sender module is responsible for data and message transmission to remote central and local units.



IWS receives real-time data from meteorological sensors from satellite distribution systems

"One of the main tasks of IMX is to act as the bridge between two complementary systems"

The operating software is completely manageable by means of simple configuration tables accessible by a graphical interface. This includes: a site configuration table; sensor configuration table; data configuration tables (instantaneous variables, preliminary checks parameters, representative and derived representative variables); station services; meteorological message configuration table and networking parameter configuration table.

Integrated Weather System (IWS)

The Vitrociset-developed IWS system combines a wide range of weather forecasting tools, including forecaster's customized operational procedures, which support all scheduled activities, enhancing the coordination between the forecasters and ATC services. It is compliant to ICAO Annex 3 up to Amendment 74.

As the service requires that a forecaster be able to handle simultaneously a large and

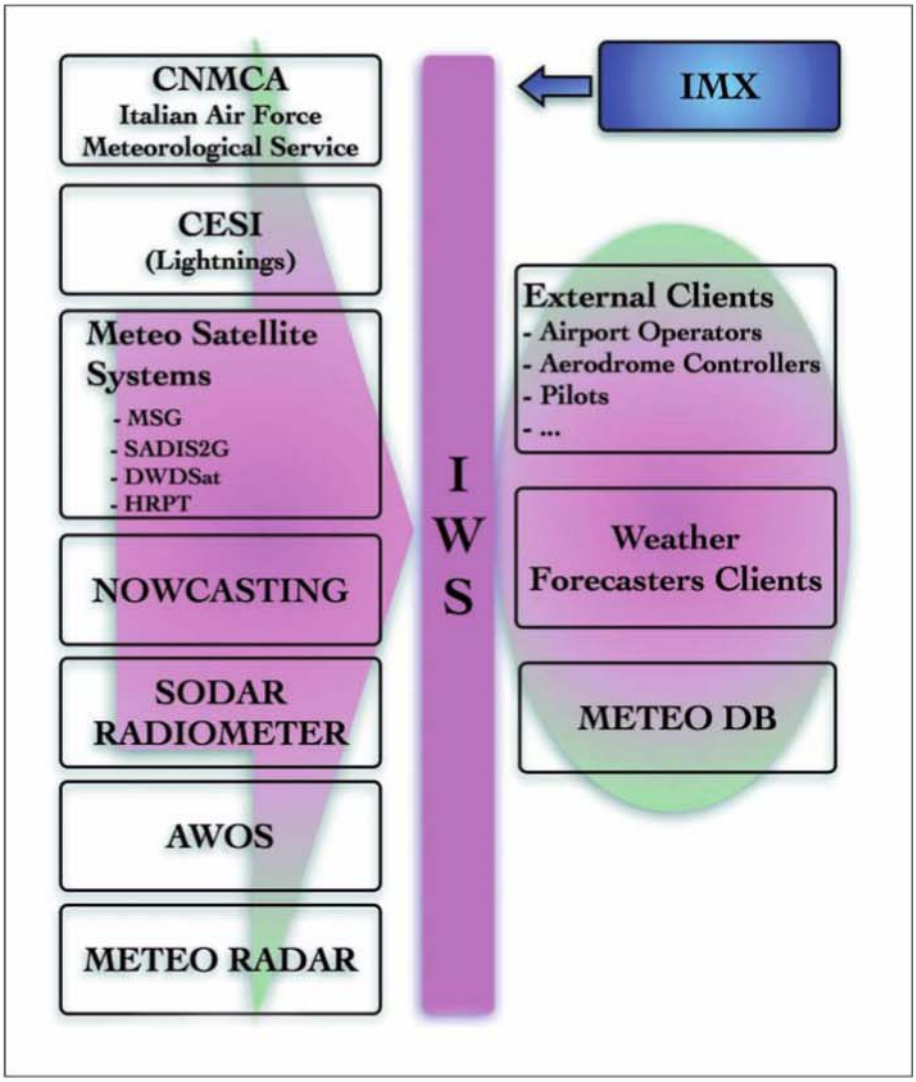


FIGURE 2: **IWS logical scheme**

wide variety of different-format meteorological information, IWS supports users with its processing, analysis and visualization functionalities.

Figure 2 gives a picture of the system's logical architecture. IWS receives real-time data from meteorological sensors (AWOS, WindShear, SODAR, Radiometer, Meteo RADAR, etc), from satellite distribution systems (SADIS2G, MSG, DWDSAT, HRPT, etc) as well as from official aeronautical services (CESI, Prometeo from Italian Air Force-CNMCA, etc), which constantly monitor the weather conditions at local and national levels.

After the data collection phase, the system processes and analyzes the available meteorological information, not only creating and displaying the results as images, satellite maps, bulletins and charts, but also making them ready for an ad hoc limitless grouping, re-processing, combination for users.

All data that is acquired from external systems and that is manually or automatically processed by the user is subsequently stored in databases in a configurable set of folders, based on file names, data types, data sources, etc, enabling different archiving duration periods.

The well-organized data management allows the system to support operators on daily duty, by automating their operational activities. For example, the automatic or manual compilations and their basic validity checks of bulletins, according to predefined rules, reduce errors and delays in their distribution to final users. Furthermore, the historical data archive enables the user to produce long-term analyses, based on its own weather expertise, by training and improving the user's forecasting ability so that a better service may be offered to flight operators.

Interface for Meteo eXchange (IMX)

Vitrociset's IMX system, already operating at the major civil Italian airports, plays a key role in the communication link between IWS and SMS systems. It manages all flows of data acquired from on-ground sensors and all the other systems installed in the airport area, and is responsible for correct data distribution, as well as harmonizing different formats and different communication protocols.

Since SMS and IWS each have their own formats and protocols, one of the main tasks of IMX is to act as the bridge between two complementary systems, both dedicated to the acquisition of ground and space meteorological information. By automatically adapting the source format to the final one, in accordance with predefined rules and criteria as required by the end system, in theory there is no limit to the number of systems IMX is able to connect to each another, unless the limit is caused by technological and physical constraints.

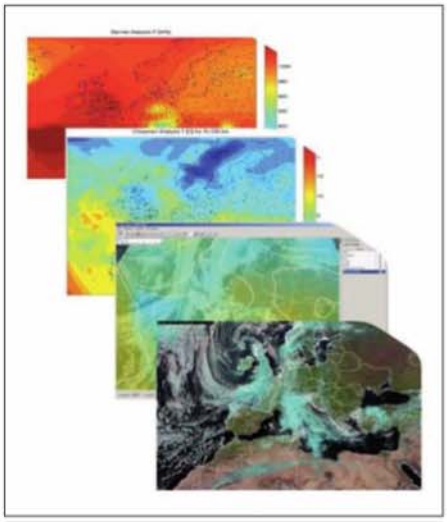


FIGURE 3: **Example of analysis reports generated by IWS**

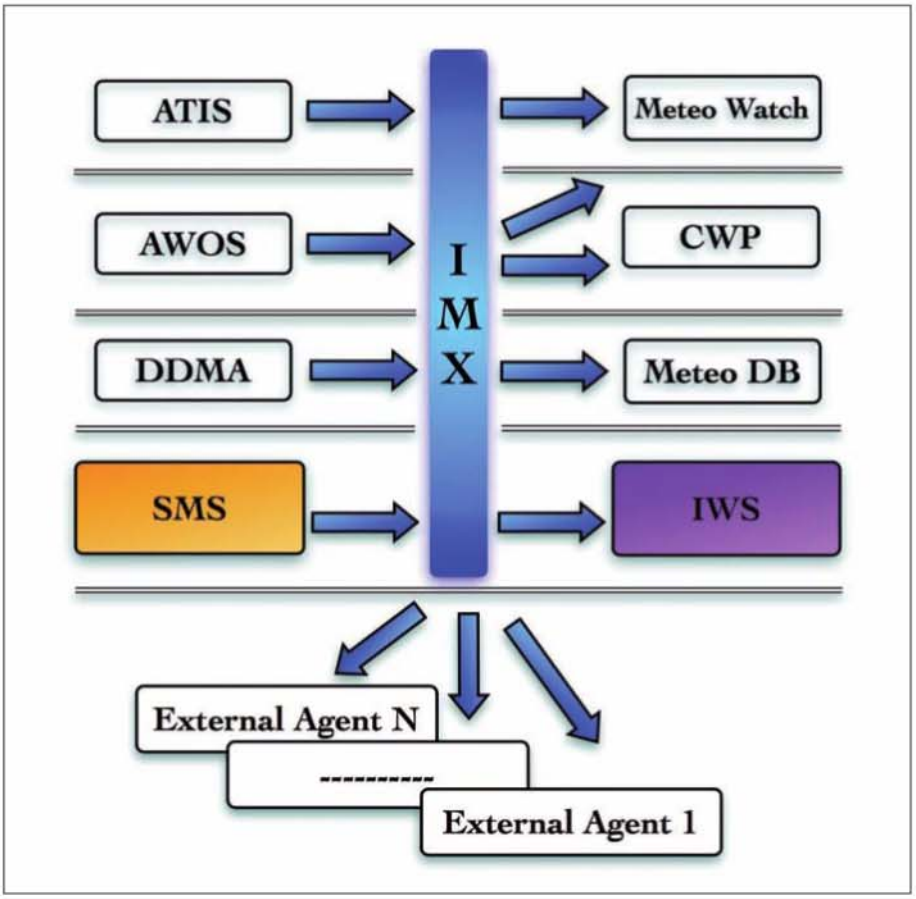


FIGURE 4: **IMX logical scheme**

The main activities carried out by IMX can be summarized as follows: it establishes connection with data collectors of the ground meteorological sensors; it acquires data and pre-processes it, reading and converting it if and/or when required; it broadcasts the acquired data to other systems or acts as a bridge among the other systems. In fact data distribution is executed forward and backward. In other words, the information can return to its origin enriched with the contributions from other systems. In practice all information regarding manual and automatic weather observations is sent to airport authorities, after being adapted into the required formats and contents; simultaneously the same information is sent to the regional air traffic control centers.

IMX is able to interface with the AFTN network, which means it can receive text messages to be transmitted, take care of their standardization and manage their queuing towards receiving systems.

In addition IMX operates as an interface with old-generation sensors. It performs a large number of conversions (type, format, unit, etc) for a wide range of meteorological sensors, by adapting old communication protocols to those of the new-generation sensors, which would otherwise be prevented from interfacing with obsolete systems. The same process takes place between more complex sensors/systems and the simple ones, with removal of differences and adaptation of the communication interface.

After acquisition and before distribution, all the information that passes through the IMX system can be visualized by the operator, who has the possibility to customize his own graphical interface by choosing from a predefined list of meteorological parameters and on-sight observations. This enables the correct running of the whole system to be monitored and controlled, from the acquisition stage of the ground sensors – thus guaranteeing reliability of measurements, and their correct decryption in addition to providing new coding when required – until their final distribution.

The solution proposed easily responds to new requirements arising from the continuous evolution process of the meteorological systems in support of all weather forecasting activities.

Starting from the acquisition of meteorological data up to its processing, distribution and visualization, by integrating and optimizing the three different systems mentioned above, with their own specific functionalities and tasks, it is possible to obtain a unique and complete tool that is able to support weather forecasting and the air traffic control activities. ◗

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