SwissMetNet: Renewal of the Swiss Meteorological Networks

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Abstract

The Swiss Federal Office for Meteorology and Climatology (MeteoSwiss) has launched the SwissMetNet-project for the renewal of its presently operational meteorological networks (subproject SDM) consisting of ANETZ (72 stations), ENET (44 stations) and KLIMA (25 stations). The main goals may be summarized as following:

1) *to better fulfil the requirements of the clients,*
2) *to standardize the different networks and their operation and*
3) *to lower the maintenance and operating costs.*

Furthermore, a new camera network (subproject CAM) is presently being installed consisting of 25 stations distributed around Switzerland to provide on-line information for now-casting information as well as for increasing the information potential concerning the aeronautical flight corridors over the Alps. Independently, an upgrade of the visual observation network (subproject OBS: 70 stations) is presently being performed by making use of modern computer techniques in order to increase the user-friendliness and therefore the quality of the observations. Finally, the EUMETNET/SWS project is now concluded and the results have been presented during TECO-2003 in Bratislava.

1. History

The first automatic station of the ANETZ network was installed in Switzerland in 1975 and the last one in 1989. This means that the oldest station reaches today an operational period of about 30 years.

For various reasons such as the difficulties in guaranteeing the renewal of the spare parts, a increasingly old technology (field stations and central data acquisition station), a wear of the material, the lack of flexibility, an aging system of transmission of the data on the technical level, etc., it was decided in 1998 to carry out an inquiry on the future requirements of the data users on one side and of the operators responsible for maintenance and correct operation of these networks on the other side. The need for a general concept became progressively obvious to work out a global strategy for MeteoSwiss concerning all the ground-based measurements for terrestrial and atmospheric meteorological information. This analysis was called “Messkonzept 2010” and was performed in parallel to the project dealing with the renewal of the meteorological networks. Very quickly, it was recognized that:

- in the long term, all the networks of MeteoSwiss were to be renewed together with a total cleansing of the sites;
- only an integral and standardized renewal of the networks would make it possible to optimize the operational aspects, and to decrease the operational costs;

- MeteoSwiss could build-up its capacity in this field and offer its competences to other institutions in charge of meteorological networks.

The direct consequence of these findings was an extension of the preliminary project (which took then the name of SwissMetNet) to all the existing meteorological networks operated by MeteoSwiss. Therefore, the following decisions were made concerning the specifications of the SwissMetNet project:

- Task 1: Renewal of the automatic and conventional meteorological networks in Switzerland that are run by MeteoSwiss (automatic backbone network ANETZ: 72 stations, automatic extended network ENET: 44 stations, “manual” climatic network KLIMA: 25 stations). In the future, and when suitable, take in charge other meteorological networks of the Confederation, Cantons, Communes and other partners to ensure their maintenance and operation (“Service provider”).
- Task 2: Develop a new network of 25 cameras (either fixed or mobile) for monitoring the atmospheric state and increase the competences of the forecasters (sub-project CAM).
- Task 3: Separate physically the visual observations from the weather stations and develop a new stand alone network for visual observations (sub-project OBS: 70 stations) making use of the most modern technologies.
- Task 4: Participate together with Finland and France to the EUMETNET/SWS "Severe Weather Sensors" project to gather the necessary bases to proceed to the choice of the weather instruments installed on sites under very harsh conditions (sub-project SWS).

2. Initial conditions

2.1 General

The initial requirements for the project SwissMetNet were defined as following:

- Take into account the requirements of all the existing and potential users such as they were defined within the framework of Concept MK2010 ("Messkonzept 2010").
- Take into account the needs for modernization of the infrastructures and the operational processes according to requirements of the operators while carrying out the following objectives:
    - eliminate the recognized problems;
    - adapt the networks to modern technologies of the XXI century;
    - reduce the operational costs.

2.2 Configuration of the network

Considering the recommendations contained in the Concept MK2010, the following configuration of SwissMetNet was defined:

Stations

- 45 stations of type WEeather STAtion WESTA B (basic climate stations, high quality standards),

- 45 stations complementary stations of type WESTA S1 (identical WESTA B with reduced instruments' configuration),
- 40 complementary stations of type WESTA S2 (simplified stations, reduced instrumentation),
- 70 visual observation stations of type WESTA O,
- 25 camera stations of type WESTA K.

Instruments

According to the Concept MK2010, the following criteria have to be applied:

- Preserve the instruments that give satisfaction.
- Replace the problematic instruments while preserving the quality of the existing long series of measurements by performing parallel measurements as far as possible.
- Prepare as far as possible the extension to new types of sensors in the future.

With regards to these requirements, the decision was made to partially renew the weather sensors outfitting the automatic weather stations.

Data Acquisition Systems

Concerning the data acquisition systems, the following requirements of performances were selected, such as:

- Record and digitalize the signals produced by the instruments.
- Format and transmit the data to the Central station.
- Perform the needed computation to deliver physical values for local use.
- Store locally the measurements (in the event of breakdown of transmission).
- Perform measurements concerning the state of the sensors and the station .
- Provide an electrical backup system for 7 days "low mode" operation (battery and solar panels)
- Initialize and transmit meteorological or technical alarms.
- Guarantee the flexibility of the system and its user friendliness

With regards to these requirements, the decision was made to completely renew the data acquisition systems of the automatic weather stations. In view of the volume of the task, the immediate consequence was that an international Call for Tenders following the rules of the World Trade Organization WTO became mandatory.

Measurement fields

Concerning the stations' field facilities, the following recommendations were defined:

- The local data acquisition systems have to be installed on the field (unlike the setup of the old ANETZ where the loggers were installed in a nearby building).
- The infrastructure for the installation of the instruments has to be renewed (masts, towers, measurement bridges, etc.).
- A complete renewal of the cables and wirings is mandatory.
- An enhancement of the maintenance procedures is to be planed.

With regards to these requirements, the decision was made to proceed to the general cleansing of all the measurement fields of the automatic weather stations.

Transmission of the data

From the 1.1.2001, the Federal Office for Informatic and Telecommunications (FOITT) is responsible for all the transmissions within the Swiss Confederation. This new situation makes it possible to make use of the advanced technologies established and operationally used by the FOITT. For SwissMetNet, the following conditions were defined:

- Use of the BVnet ("BundesVerwaltungs Netz") network of the Confederation (FOITT).
- Installation of Cisco "routers" located in appropriate buildings as near as possible from the field facility.
- TCP/IP Sessions between the measuring site and the Central station
- Availability and reliability of about 100%.

Central Server

The basic requirements for a standardization of the meteorological networks lead to the conclusion that the WTO Call for Tenders should include the delivery of the central server, which would fulfill the existing requirements and make full use of the major improvements in the field of software and telecommunications.

Data must be logged from each weather station every 10 minutes and undergo a first set of quality tests within the Central Server (quasi on-line plausibility tests). Bulletins are then edited and automatically transmitted through a Message Handling System MHS to the new Data Warehouse DWH of MeteoSwiss and to other potential clients.

Technical Quality Assurance

A restricted set of data (e.g. all the surface networks' data for the last 3 months) is automatically updated every night (Data Mart). In this way, off-line quality assurance tests (or diagnostics) can be performed on a daily basis, based on the set of data of the last 3 months. Procedures adapted to single instruments, single stations or to the complete network are applied to monitor the overall technical state of the network, allowing for preventive maintenance (early recognition of erroneous data or system degradation) avoiding time consuming and expensive breakdown repairs and data corrections.

Data Warehouse and meteorological Quality Assurance

In 2001 MeteoSwiss has started a project to consolidate its various databases, data processing and quality control systems in a unified conceptual architecture. As far as quality control is concerned a new generation of tools was implemented which has been developed over the last few years. The checking logic follows the recommendations of WMO. Additional tests were added to take into account the particularities of Alpine weather (e.g. Föhn, strong cold air pools). Station specific percentiles for each month are used as threshold values for limit checks which were recalculated from long time series of high temporal resolved data (usually 10 minute data).

The quality control tools are distributed in several modules in order to check data as close as possible to the data source and to provide checked data to the users as quickly as possible. Some of the modules in the chain are performed without user interaction, flagging suspicious data and attempting to correct obvious errors automatically. Others allow interactive checking and correction of actual as well as historical data. This concept allows different levels of quality according to the customers needs. All modules use a unified flagging procedure consisting of the 'plausibility information' (a bitmap indicating the test violations), a 'treatment

information' (indicating the correction if one was applied) and the 'time series state' (indicating the quality level of the data) to guarantee transparency about a value's status.

3. Current State of the SwissMetNet project

3.1 New automatic meteorological network (SDM)

A preliminary analysis phase was first launched in order to analyze the prevailing situation and to submit the different possibilities for the future network. A tentative budget and human resources planning was performed. This preliminary phase ended in December 2000.

This action was followed by a Concept phase where the specifications and requirements for the new network were defined. An international WTO Call for Tenders (4.2.2002) for the selection of the basis infrastructure of the network was then launched and its results evaluated: the final decision was made on the 27.5.2002 with the selection of Almos Systems as supplier for the SwissMetNet.

The Realization phase was then initialized to test the selected hardware and software. This was achieved by proceeding to the installation of two pilot stations in the plain (types WESTA B & S2 at Payerne) and in the mountains (Guetsch, altitude 2300 m a.s.l.). This test period gave enough positive information to launch the Introduction phase in July 2003.

Fig. 1 displays the installation of the Guetsch pilot station. As this site has to be used in the future as a MeteoSwiss test station for harsh environment, the design has been extended in comparison with a "standard" B station. This may be seen with the installation of up to 4 potential measurement bridges to allow for the testing of numerous instruments and their references. The new SwissMetNet type of mast, which can be kipped for the anemometer installation, can be spotted at the back of the picture. Furthermore, a new model of enclosure has been selected, which contains in separate compartments the power supplies and the data acquisition system (double units for the test station). A dedicated heating and ventilation system has also been designed to protect the latter sensitive elements. Finally, a full set of "house-keeping" measurement has been integrated in the system, allowing for an advanced remote diagnostic capacity.

Fig. 1: Pilot station on the Guetsch, 2300 m a.s.l.

As the effective construction of the network has to be performed by the "owner" of the network (Federal Office for Constructions and Logistics), two companies for the civil engineering and electrical tasks were selected again through a public publication procedure. In order to train this new manpower and tune the numerous project interfaces, it was then decided to proceed with the construction of two model stations in the plain (station Aigle) and in the mountains (station Guetsch). At the same time, the former pilot stations at Payerne and on the Guetsch (see Fig. 1) were upgraded to the newest level and refurbished as test stations, while a laboratory test stations was installed in Payerne.

In parallel, the new Central Server was installed at Zurich (standard version), so that the final Acceptance Test procedures for the pilot network (2 pilot/test and 2 model stations with a complete set of measurements connected through the BVnet to the central server) could be performed in 2003 and 2004 with full success.

3.2 New network of camera (CAM)

A preliminary analysis was concluded in January 2002, based on the evaluation by the clients (MeteoSwiss forecasters) of the pictures yielded by a test station installed at the International airport of Geneva and equipped with 3 types of cameras (fix, mobile and a "Total Sky Imager"). It was followed by a Concept phase where the definitive layout of the future network was defined as well as the procedures to be applied for the installation of totally new techniques for the MeteoSwiss staff. It was then decided that the Realization (pilot) phase had to deal with the following tasks:

- Installation of a reduced set of pilot stations.
- Tests of the use of mobile cameras for the reconstruction of panoramic sights.
- Tests of the quality of transmission of multiple pictures through the BVnet.
- Dissemination / Storing of the pictures (Internet, Data Base).

The installation of 3 and later 8 pilot sites has been performed in 2004 with good results. From the available test sites, the following preliminary conclusions could be drawn:

- The use of mobile cameras is possible even under harsh conditions. The problem concerning the degradation of the pictures' quality due to rain or snow can be avoided by integrating the cameras in a dedicated heated enclosure which can be positioned towards the ground between each panorama picture acquisition. This preventive measure gave very good results.
- The use of mobile cameras for reconstructing panorama views gives good results.
- The use of the BVnet for the data transmission has proved very reliable.

However, for different reasons, it was decided mid-2004 to out-source (through a new WTO Call for Tenders) the installation as well as the operation/maintenance of the complete network which will be operational in summer 2005.

3.3 Visual observations (OBS)

A Preliminary Phase was conducted in November 2001 based on the evaluation by the clients and the experiences with the current system, followed by a Concept phase ending in July 2002 which emphasized the physical separation of the visual observations from the automatic weather stations together with the development of a user friendly tool for the observers.

Based on these requirements the following tasks have been achieved during the ongoing Realization phase:

- The OBS-Clients are developed based on the browser technology without a local intelligence. All the intelligence is on the central system (which is part of the Data Warehouse system: measuring program, plausibility checks, context-data, etc.). Locally there is only some information like pictures of clouds stored.
- The GUIs for the observers are set up dynamically, based on information provided by the central system.
- Data transmission is based on a Remote Access Server (via modem and ISDN-terminal) to perform a high security standard.
- The observations are collected on-line. Tests on limits are done immediately while tests on consistency and variability are performed at the end of each session.
- The Software development is done in-house.
- The Realization phase is split into a "Proof of Concept" (detail-specification, performance, user guidance, security aspects, availability, etc.) and a pilot phase to implement the new tool at several pilot-sites.

The pilot phase ended at the end of 2004 and the upgrade of the whole network will start in March 2005.

3.4 EUMETNET/Severe Weather Sensors (SWS)

The EUMETNET[1] project "Specification of Severe Weather Sensors 1997-1998" summarized the icing effects on different types of meteorological sensors. Following the first SWS project, the SWS II project was started by the EUMETNET in July 2000 in order to test a number of ice-free sensors, as well as other measurement arrangements designed for cold climate conditions. Three different sites in Finland, France, and Switzerland were selected for this purpose. The final full report was published in 2002 and a reduced version in 2003. For more details see proceeding of the TECO-2003 Conference.

Fig. 2: Test platforms with different sensors at Mont Aigoual (left) and Säntis (right)

[1] EUMETNET is a network of 18 National Meteorological Services: those of the EU plus Iceland, Norway and Switzerland; www.eumetnet.eu.or

4. Perspectives

The intensive installation phase of the single stations of the new meteorological network is due to start on April 1st 2005. From that moment onward, the station will be upgraded following a very tight schedule so that the first 70 stations should be operational at the end of 2007.

In parallel to those activities, there are two other projects which are worth mentioning in relation with SwissMetNet.

4.1 CN-MET

The meteorological components linked to the security of the nuclear power plants (NPP) in Switzerland are integrated within SwissMetNet. Among others, 100 meter towers are operational at each NPP and should be also upgraded at the installation time. However, new concepts are today emerging, with the combination of remote sensing measurements and high spatial resolution models. This is why a new project named CN-MET has been launched to analyse the solution best fitted to the Swiss topography (more details are presented by B. Calpini: “Meteorology and Security around the Nuclear Power Plants in Switzerland”, Paper 2(7)).

4.2 Airports

One of the basic philosophical arguments sustaining the SwissMetNet project is the attempt to standardize all the measurement activities operated by MeteoSwiss. This includes also the 2 international airports located at Geneva and Kloten near Zurich, where SwissMetNet stations are anyhow planed. As the organization of the maintenance of the airports installations is also being presently reviewed, it is obvious that the SwissMetNet project will have to be extended to the complete infrastructure of the 2 airports. Discussions are presently underway to define a general maintenance concept for these 2 sites and the consequences on the installations’ configuration.