TAWES - The New Austrian Meteorological Measuring Network

Dipl.-Ing. Gerhard Pevny, Logotronic GmbH, Phorusgasse 8, 1040 Vienna, Austria
Tel: +43/1/5872971-14, Fax: +43/1/5872971-41, E-mail: gerhard.pevny@logotronic.co.at

Dr. Martin Mair, ZAMG - Zentralanstalt für Meteorologie und Geodynamik,
Hohe Warte 38, 1191 Vienna, Austria,
Tel: +43/1/36026-2706, Fax: +43/1/36026-2720, E-mail: martin.mair@zamg.ac.at

ABSTRACT

The Austrian Central Institute of Meteorology and Geodynamics is actually installing the new meteorological measuring network. More than 200 automatic weather stations will be installed until the end of the year 2008. The stations are located all around the Austrian territory in different climatic regions, also in high alpine environment. The company Logotronic GmbH from Vienna supplied the complete measuring equipment to ZAMG. The TAWES measuring station design has many very novel features which influence heavenly the operation of the network. This presentation gives an detailed overview about these new features.

- Strong modular design of the TAWES station, based on the new station manager Gealog SG, bus oriented station architecture and intelligent sensor specific measuring interfaces;
- Improvement of the data quality status by using "Integrated Quality Control" functionalities which means high level diagnostics implemented both in station hardware and software;
- Improvement of data availability by using multiple data transfer paths (leased telephone line, GSM/GPRS, METEOSAT satellite, WEB-interface);
- Improvements in the maintainability using extra data transfer paths for maintenance purposes, full access to all station parameters using Web-based communication, etc.

The presentation also gives an overview about possible future extensions of the measuring network, i.e. integration of image information, new data transfer protocol standards, etc.
The presentation describes briefly the project organization of the TAWES project and gives also the workplan for the installation of the measuring stations.
The presentation closes with some pictures of new TAWES stations.

Starting Point

After 20 years of operation the need for updating the old TAWES network of the Austrian Central Institut of Meteorology and Geodynamics, the Austrian national weather service, becomes urgent because of problems with maintainability and servicability of the old components. A public tender was launched in the year 2005 and the contract for the turnkey supply went to an Austrian consortium where Logotronic was responsible for the delivery of all measuring equipment, Fleck Energietechnik for the installation of the new equipmnent. The project includes the upgrade of 106 already existing TAWES stations and the supply of 94 new stations.

Specific requirements:

- Use of existing station infrastructure;
- No introduction of new sensor system in order to avoid system induced influence on long term time series of measurement data;
- Modular design (bus oriented data collection and power supply system);
- Battery buffered power supply for 6 days of autonomy in case of loss of mains electricity (operation without sensor heating);
- Compatibility to the existing data transfer protocols;
- Extension possibilities for sensors and communication.

General Station Layout

The standard TAWES station consists of a so called "Central Station", which means an electronic enclosure with the station manager "Gealog SG", the power supply module and the different communication modules. Additionally the Central Station includes a high precision barometer (Meteolabor GB1 or BM35). The Central Station is located inside a nearby building.

There are normally two Sensor Stations, Sensor Station A and Sensor Station B.

Sensor Station A:

- Stephenson´s screen with forced ventilation, inside:
  - Air temperature (Linearized thermistor Fenwall)
  - Relative humidity (Lambrecht hair hygrometer Pernix)
  - Some stations with Dew Point sensor (Vaisala HMP243)
- 4 Soil temperature sensors (Linearized thermistor Fenwall)
- Precipitation (Paar AP23 or Meteoservis MR3H-F (C))
- Precipitation detector (Thies Opical detector)
- GPS module for getting precise time information

Sensor Station B:

- Tiltable Wind Mast 10 m
- Wind speed and direction
- Global radiation (Schenk 8101)
- Sunshine duration (Haenni/Lufft/Kroneis Solar 111)

Of course there are also stations with a different set of sensors.

One of the main features of the new TAWES stations is, that the substations are connected by bus - orientated structures:

- Gealog RS485 Fieldbus
  All data is transferred from the Sensor Station via a serial fieldbus based on the RS485 standard. No analog signals are used. Beside the possible long distances between Central Station and Sensor Stations it opens the possibility to use "Short Distance Radio" for wireless data transfer between Sensor Stations and Central Station as well as between Sensor Stations. Some TAWES stations are in fact equipped with short distance radio.
- Energy Bus
  There are two Energy Bus lines for the power supply of the electronic components, called 12 V DC Energy Bus and the power supply for sensor heaters, called 48 V AC Energy Bus. No mains voltages are present at the sensor stations.

Beside this standard layout there are also stations possible with up to four Sensor Stations. Because of the basic bus-structure it is no problem to have different station structures.

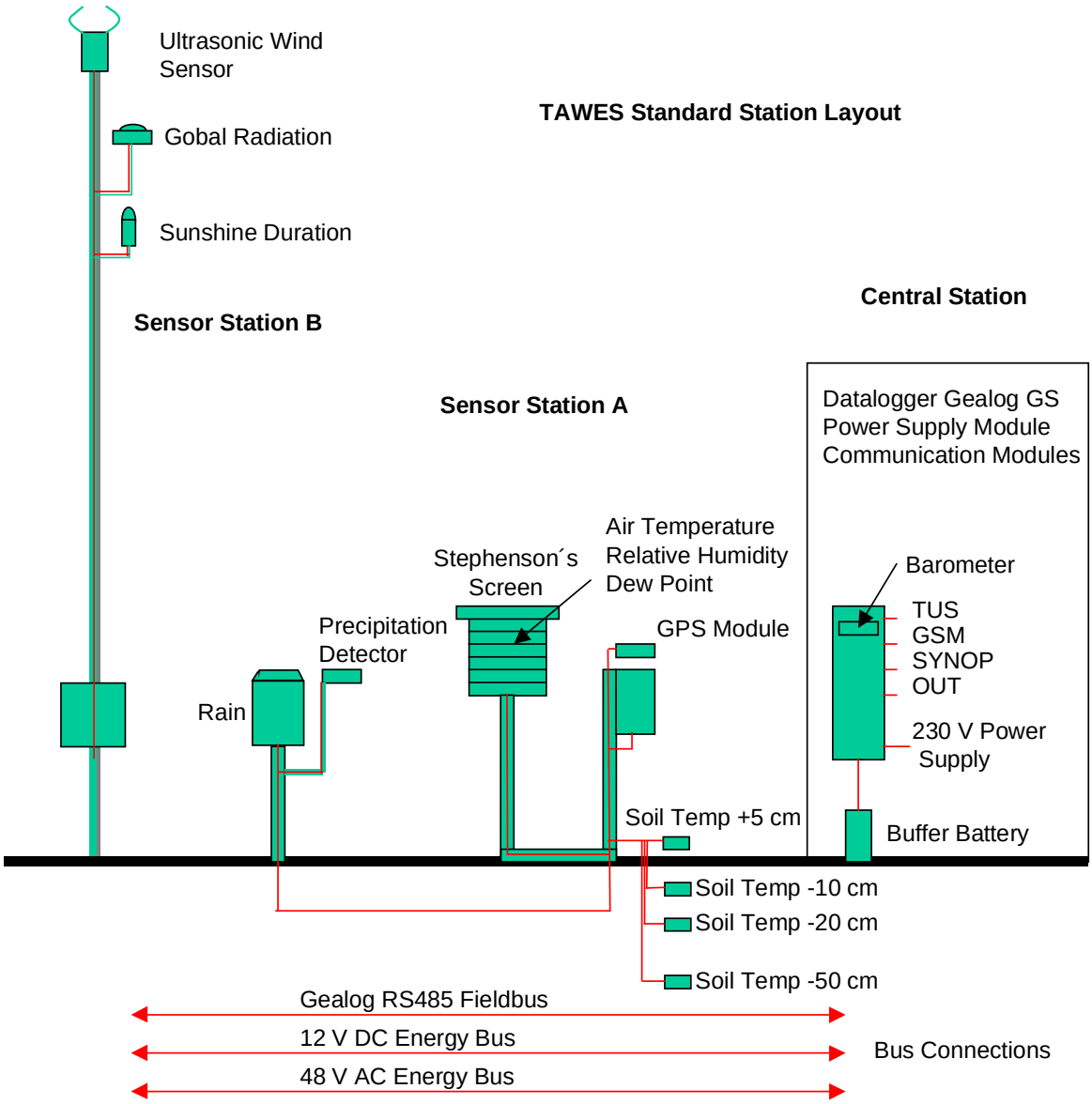

Fig.1.: TAWES Station Standard Layout

Station Manager "Gealog SG"

Fig. 2.: Station Manager Gealog SG

The heart of the TAWES station is the new station manager Gealog SG. It is a high sophisticated datalogging system especially developed for the application in environmental measuring stations. Many novel features allow the design of powerful and flexible measuring stations:

- Powerful operating system
  The system is based on the LINUX operating system. The firmware can be adapted easily because of the standard programming environment and many software modules which can be downloaded from the Web, normally free of cost.

- High number of hardware interfaces, high communication power
  - Sensor interfaces:
    - 2 x Gealog RS485-Fieldbus
      Connection of Gealog Measuring Interfaces, GPS Module or other sensors with RS485 interface
    - SDI-12 interface
      Standard sensor interface (see SDI-12 Support Group http://www.sdi-12.org)
  - Communication interfaces
    - 3 Serial interfaces RS232 for connection of any type of modem. All ports can work in parallel. (direct connection of PC, telephone modem, GSM modem, GPRS modem, radio modem, satellite transmitter)
    - Ethernet interface
      Can be used to create measurement networks based on Ethernet and to connect a camera for taking pictures in regular time intervals.
  - USB interface
    Use of USB Memory Sticks for readout of stored data, download of new parameter sets or firmware updates

- Integrated Quality Control - IQC:
  As a new concept the IQC provides highest quality standards regarding measuring values and system functionality. All possibilities for monitoring of error sources are used to recognise errors in advance before they affect the measuring values. If errors occur, the system provides possibilities to avoid the influence of the errors on the system. These IQC functionalities are an integral part of the system's hardware and operating software.
  Some examples for IQC:
  - Extensive plausibility tests (validity range check, variability test, non-variability test, monitoring channel);
  - Use of mathematical formulas for the definition of specific quality criterias;
  - Monitoring of sensors (sensor status, sensor protocol check);
  - Hardware orientated monitoring: monitoring of the rotation speed of fans of the sensor ventilation, monitoring of the sensor heaters, monitoring of the ambient temperature, monitoring of station battery voltage, voltage of the external power supply and voltage of backup battery.

All of this testing and analyzing leads finally to the Quality Tag. A quality tag is a quality status information, assigned to each single measuring value. TAWES is using the letters A, B, C, D, W, K, P

Rule: No single measuring value without quality status information

Highly Modular Station Layout

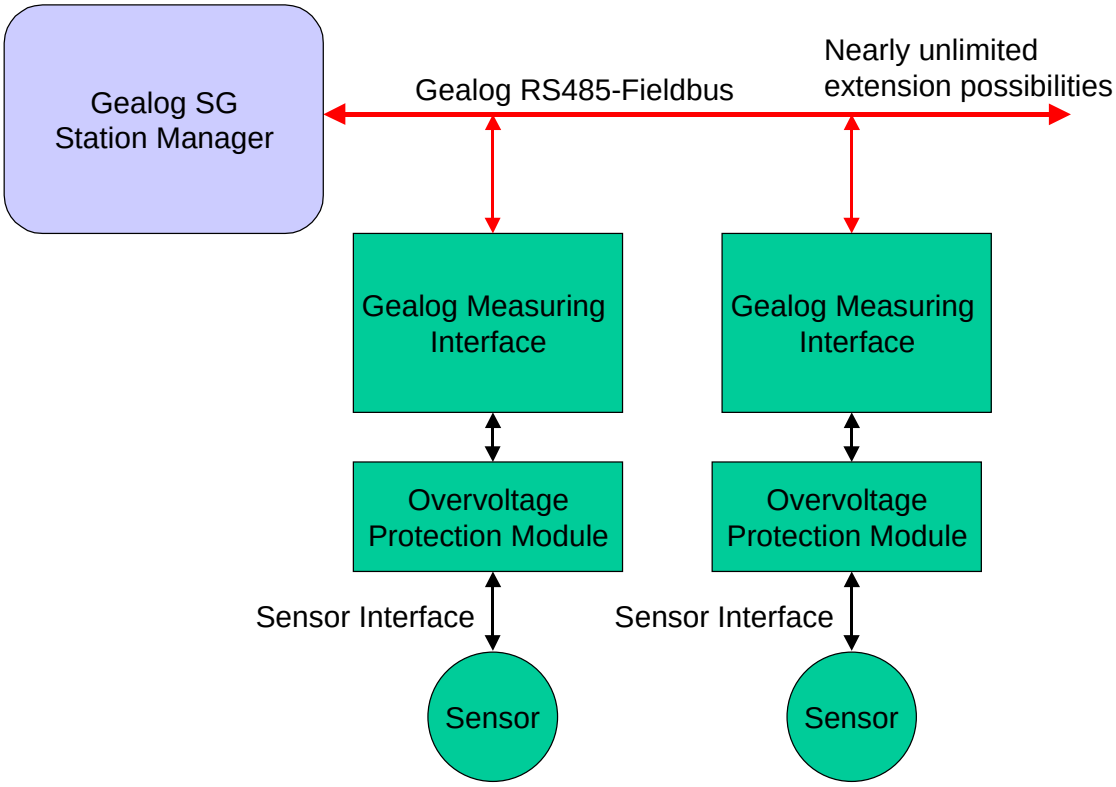

Fig. 3.: Gealog Measuring Interfaces

Unlike "classical" dataloggers Gealog SG don´t have direct measuring inputs for sensors. It only has it´s two RS485-Fieldbus interfaces and the SDI-12 bus to connect Gealog Measuring Interfaces or intelligent sensors. Gealog Measuring Interfaces are intelligent, sensor specific modules, which convert the specific sensor interface into the "Gealog RS485 Fieldbus" format. Additionally they are doing different sensor specific preprocessings and deliver more or less "Ready" data to the station manager Gealog SG. This concept brings many advantages.

- Nearly unlimited capacity regarding the number of sensors connected. The measuring interfaces together with the sensors are switched simply in parallel onto the RS485-bus. The measuring interfaces can be installed directly beside the datalogger, which results in a "classical datalogger structure" or also remote in external sensor stations.

- Flexibility
  Easy extension of the system by adding sensors together with the appropriate measuring interfaces. Same for exchanging of sensors.

- High computing power
  Each measuring interface operates with one or more microcontrollers and makes locally some preprocessing of the sensor data. The datalogger by itself gets ready preprocessed data without any need for "high speed computation". (e.g. the "Gealog Measuring Interface Wind" performs locally all statistical computations on a two second sample rate - vectorial average, standard deviation, arithmetical average)

- Remote sensor locations
  The Gealog RS485 Fieldbus is specified up to some hundred meters length. That means, that Gealog Measuring Interfaces together with the sensor can be installed far away from the datalogger. No distortion of the measuring value can happen because of the fully digital data transfer. The fieldbus can be perfectly protected against overvoltages on both datalogger and sensor side. This structure can be used advantageously for e.g. a weather station with a remote precipitation sensor or additional remote water level sensor.

- Perfect overvoltage protection by sensor specific overvoltage protection modules

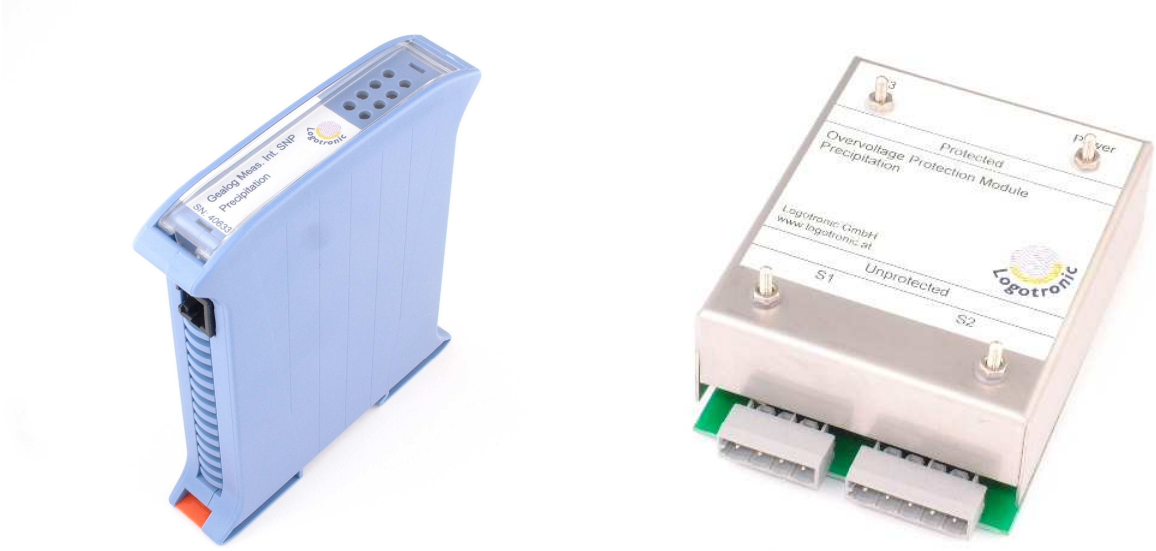

Fig. 4.: Measuring Module and Overvoltage Protection Module

TAWES Communication

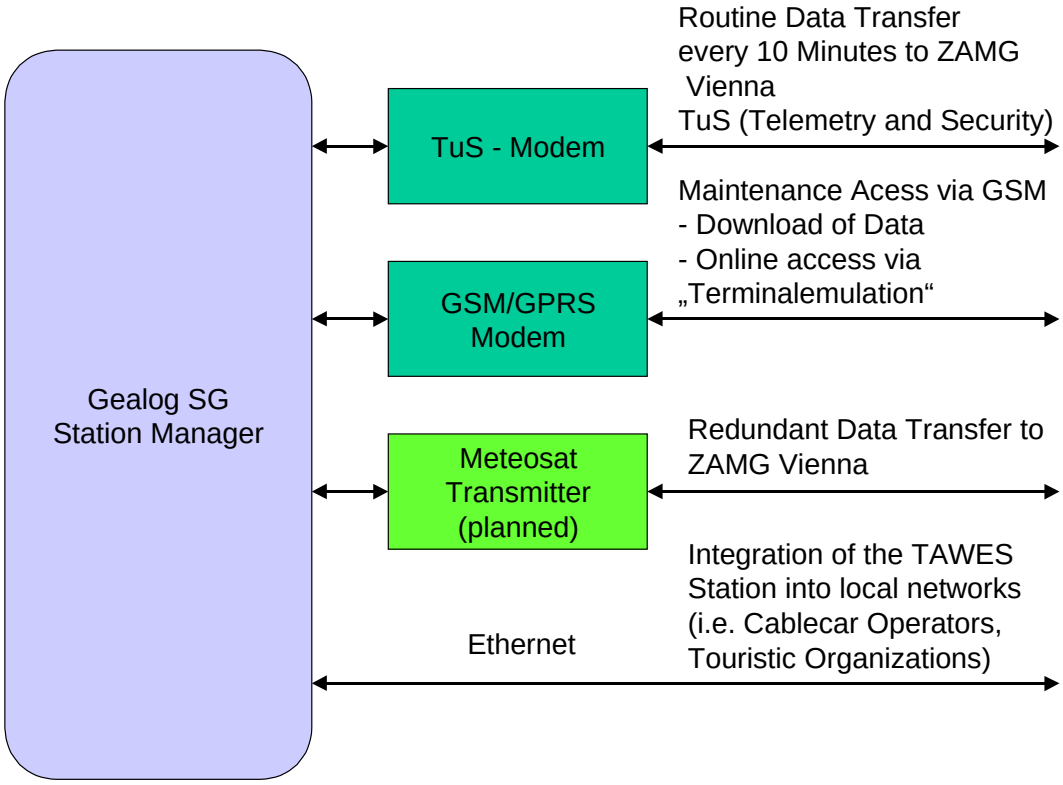

Fig. 5.: TAWES Communication Paths

The above picture shows the communication paths used by the TAWES network.

- TuS
  As standard for the routine data messages TAWES uses the TuS network (Telemetry and Security) which offers a high reliable leased line connection. Data transfer takes place every 10 minutes. The existing data transfer protocols were updated and implemented in the Gealog SG station manager.

- GSM/GPRS
  A GSM/GPRS modem is used for the direct access to the TAWES station. The maintenance personal can dial the station and can download the stored data, can check the actual measured values and the system status. Also station parameters can be changed via GSM connection. It can be used also as a redundant data transfer path in emergency situations. Gealog SG manages a high sophisticated access control system to avoid misuse of this powerful interface.

- Planned is the use of Meteosat satellite transmitters for important TAWES stations as redundant data transfer path. The data transfer can be done 1 time per hour and it is in most cases free of cost for meteorological institutes.

- The Ethernet interface is used for the integration of the TAWES station into local networks to give other users direct access to measured data. Gealog SG offers for this purpose an integrated Web-server. The access to the data can be done using any Web-browser software.

Possible Future Extensions

The field of automatic weatherstations, sensors and data communication is actually highly dynamic. Therefore TAWES offers much room for future extensions. Here are some examples.

- Integration of visual information
  Gealog SG offers the possibility to connect cameras via the Ethernet port and to store and transport this image-data in the same way as measuring values. This information can be used probably for meteorological applications or for surveilance.

- Continous integration of new sensor technologies
  One of Logotronic´s jobs is to continously extend the number of specific types of measuring interfaces for new sensors on the market. A new sensor can be easily integrated into the Gealog system by the design of a specific Gealog Measuring Interface which is normally done within a few days. With the new measuring interface ready all features of the TAWES station are available also for the new sensor. The integration into existing measuring networks is possible without any changes of the existing structures, not depending on the specific sensor´s hardware and software interface.

- New data transfer protocols
  Much work is ongoing in the specification of more general data transfer protocols using Internet standards. i.e. XML based protocols. Gealog SG as LINUX based system can adopt these standards quite easily.

Installation of the new TAWES system

In 2006 the network of the Austrian Meteorological Service (ZAMG) consisted of 106 Automatic Weather Stations. The upgrade to a number of 200 AWS should be concluded by the end of 2008. The installation of the first prototype station was in June 2006. After the finalization the main work started in April 2007. A strict time schedule was given for installation or replacement of the stations. In a 14 day schedule 10 stations were installed or replaced. Between April and November 2007 a total of 141 AWS were installed (57 new installations and 84 upgrades).

As a pre-installation work the actual status of the infrastructure (steel constructions, cable ducts, wind mast etc) of all existing AWS had to be validated by ZAMG. For the new stations local construction companies were commissioned for the installation of infrastructure.

All new AWS systems were set up in with their individual configuration in the Technical Laboratory of ZAMG (Fig. 6). Each station was running with simulated measurement signals in a longterm test lasting at least 10 days.

Fig. 6.: Test of new AWS in ZAMG laboratory

The main installation at the station site was done by an external installation company (Fleck Energietechnik) accompanied by one member of ZAMG staff for commissioning of the new AWS.

In order to avoid an interruption of long term time series of measurement data during the installation of the new AWS a temporary mobile station for the most significant meteorological parameters was installed (Fig. 7). Data transmission using GPRS every 30-180 minutes.

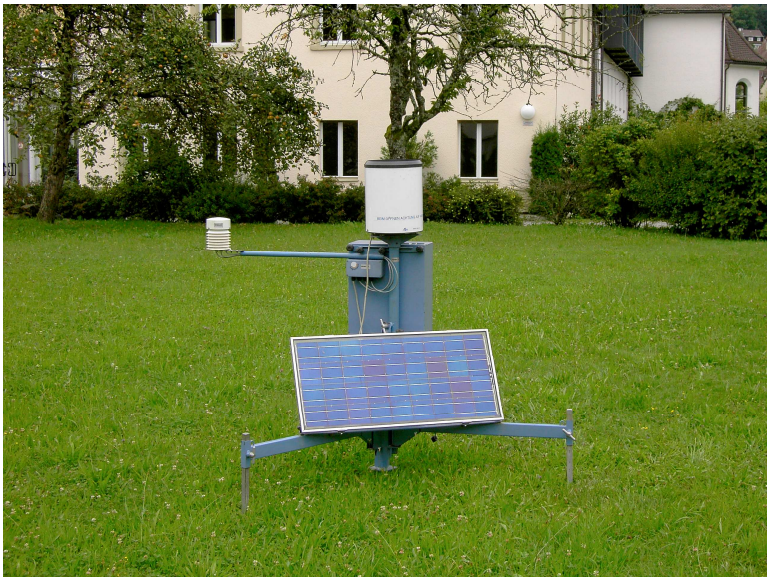

Fig. 7.: Temporary mobile AWS

Delivery of data acquisition and measurement systems for new AWS

Longterm test of each AWS with specific configuration in ZAMG Test Laboratory (Fig. 6)

Calibration of all sensors in ZAMG Calibration Laboratory

Installation at the AWS site

(normally 1-2 working days)

- Installation of mobile AWS for the most significant parameters (temperature, humidity and precipitation) (Fig. 7)
- Dismantling of the existing AWS
- Replacement of cable installation
- Replacement of measurement system including sensors
- Startup of new AWS
- Dismantling of mobile AWS

Recycling of re-usable sensors and components from old AWS by ZAMG

Fig. 8. Workplan for the installation of the AWS

Pictures of TAWES Stations

Fig. 9.: TAWES Station Amstetten - Sensor Station A

This picture shows the Sensor Station A of TAWES station Amstetten. A special pedestal for the Stephenson´s Screen and the sensors was developed for the TAWES project. Directly attached to the pedestal is the electronic enclosure which contains the Gealog Measuring Interfaces, the overvoltage protection modules and some voltage converters for the sensor heaters.

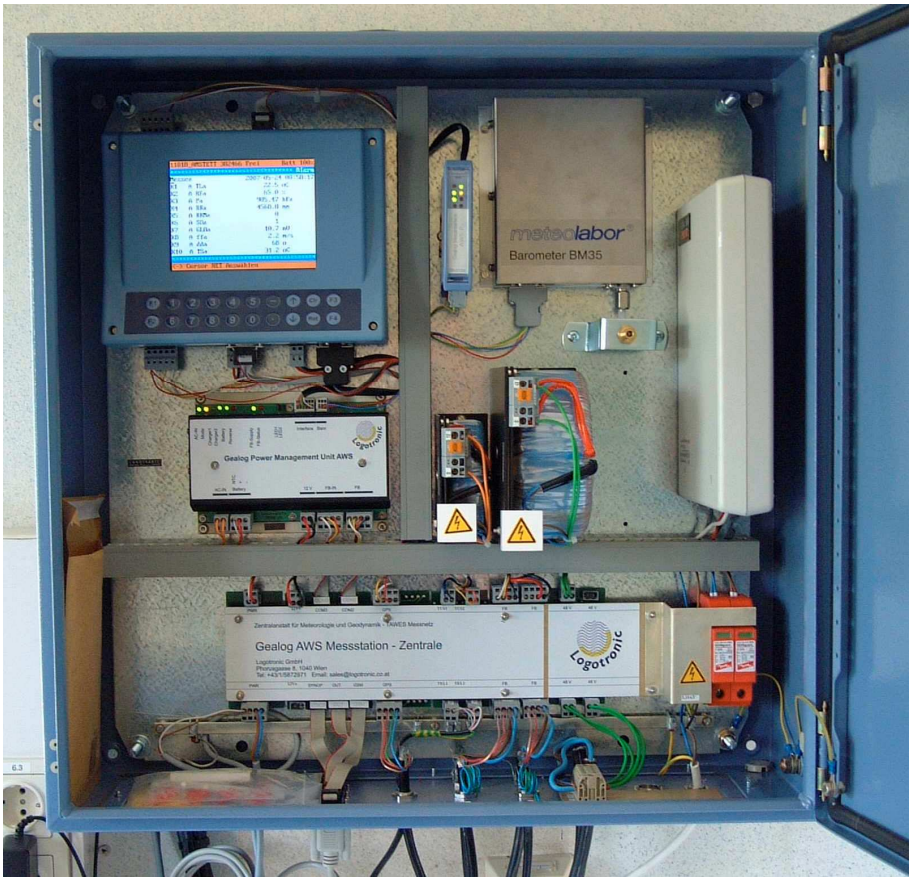

Fig. 10.: TAWES Central Station

This picture shows the enclosure of the Central Station. Left on the top there is the station manager Gealog SG, right the high precision barometer.
In the middle there is the intelligent battery charging unit "Gealog Power Management Unit", mains transformers and the TuS modem. On the bottom there are different types of overvoltage protection modules.

Fig. 11.: TAWES Station Enns - Sensor Station B - Wind Mast

The above picture shows the wind mast of the TAWES station In Enns. On the top the Ultrasonic wind sensor, below a Pyranometer sensor for solar radiation and a sunshine duration sensor. The wind mast was especially developed for the TAWES project. For sensor maintenance it can be tilted by one person only using a special hydraulic pump.

Fig. 12.: TAWES Station Galzig, St. Anton

This station is used beside it´s TAWES functionality as test station for special sensors in high alpine environment.

Fig, 13.: TAWES Station Pitztal Glacier - Sensor Station A in a High Alpine Environment