REMOTE MONITORING OF WEATHER AT NORWEGIAN AIRPORTS

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ABSTRACT

The paper presents a meteorological parameter display and storing system that is developed to reduce workload in connection with meteorological observations at Norwegian airports. Based on use of license free software (LINUX and PostGre SQL database) all instrument-measured meteorological variables at the airports are displayed in near real-time at forecasting centrals. The parameters are displayed both as time-series and as digital actuals. Sensors are connected to LAN, thus allowing for data processing both locally at the airport and at any chosen forecasting central. All data that are stored and displayed comes from already exsisting sensors at the various airports without any restraint on type of sensor in use at a specific airport. By use of video-technique, the weather around the airport can also be monitored at any chosen forecasting site. Video cameras allows for 360 degree survey of the weather by transmitting JPG-images every 1 minute form each camera. The developed system is very flexibel both with regard to setup of the displaying function, storing of data and inclusions of new sensors as well as to enable users at any site connected to the network to view data from any sensor at any airport they might wish to monitor. At the moment the main use of the system is to add TREND to METARs by meteorologists serving different airports from their workplace at forecasting centrals.

Background.

It was decided that Meteorological personal working at Norwegian airports should be removed from the airports. Meteorological observations, i.e. METAR, should be made by CAA personal at the airport while the TREND addition to METAR should be added by well trained and skilled meteorological personal working at forecasting centrals. To be able to do this it was necessary to present airport meteorological instrument information as near true time time-series at the forecasting centrals. In addition to the measurements from the traditional batch of sensors, video images presenting the sky conditions around the airport had to be included in the information necessary to perform TREND forecasting.

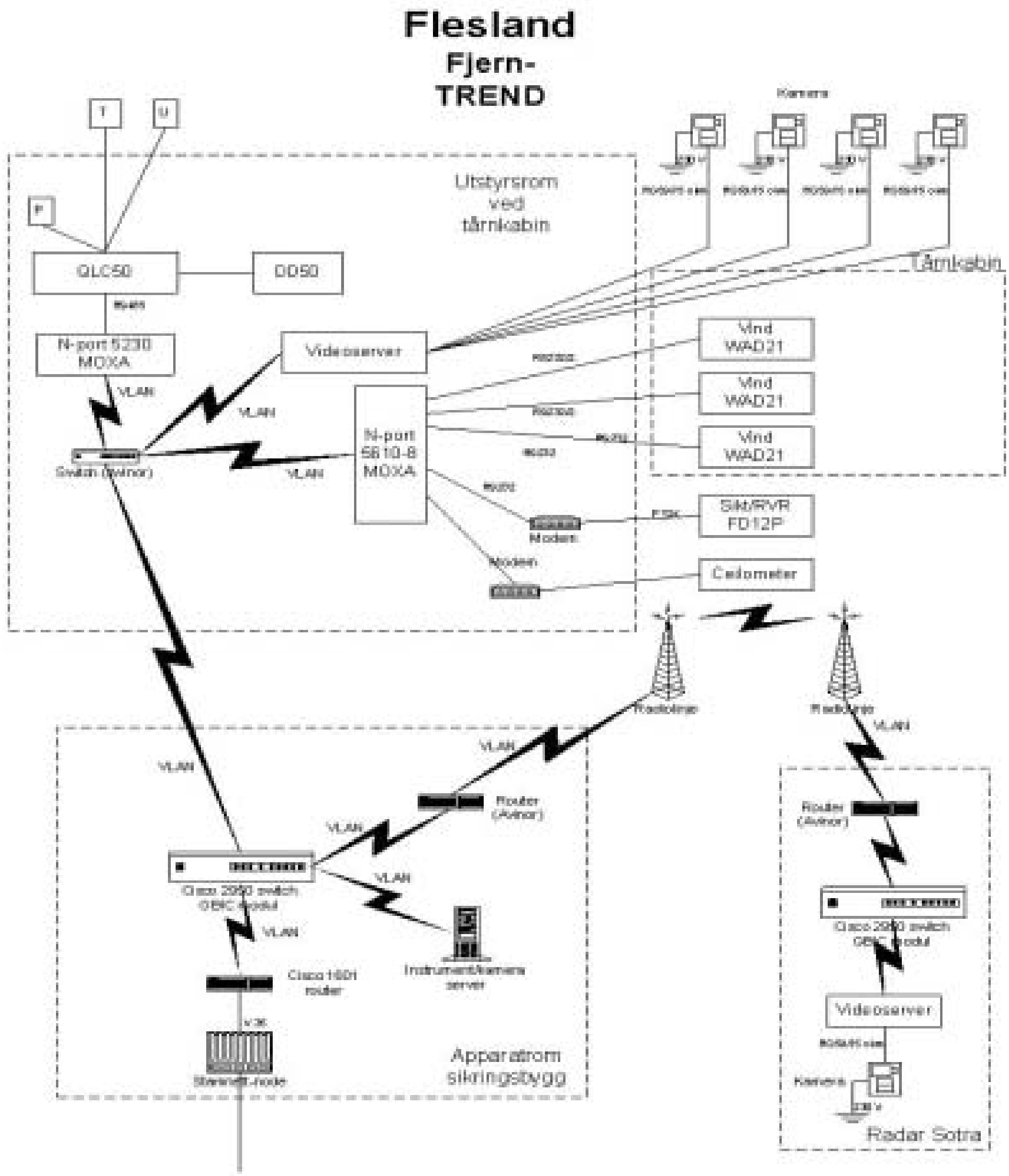
Instrumentation.

In addition to sensors for measurement of air temperature, humidity, air pressure, cloud base and vertical visibility, wind speed and wind direction, the airports were also equipped with forward scatter instrumentation to give information on RVR and present weather. Some of the airports have, in addition to wind measurement along the runway, wind information from nearby mountain sites to help estimation on wind shear in the airport area. All relevant parameters from all meteorological sensors are stored in a database.

System design at the airports.

Serial output from existing sensors at the airport are converted to LAN by means of terminal servers (MOXA). Serial lines from wind sensors are directly connected to the terminal servers. Information from ceilometers and visibility instrumentation goes into the terminal server via modems. Temperature, humidity and pressure measurements are taken from a local logger. Video images are created by a video server. That means that all data are available on net communication. A net connected LINUX server is installed locally at each airport. Figure 1 below shows the design at one of the airports, Flesland outside Bergen. From the airport there is a net connection to the forecasting central that have the responsibility to do the TREND forecasting for that particular airport. Altogether 3 forecasting centrals are included in the net, i.e. Oslo, Bergen and Tromsoe.

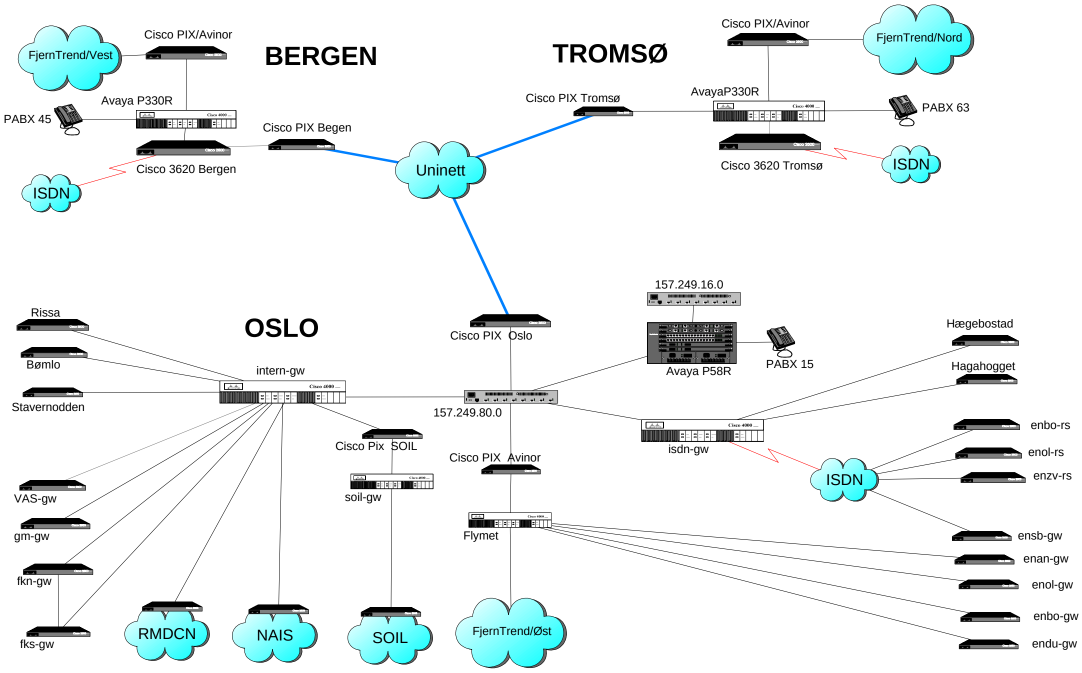
Figure 1. System design at Flesland airport.



At each forecasting central a LINUX server is directly connected to all sensors at all airports that are served by that central. Storing of data in the database is done independently and simultaneously at the central server and at the local server at the airport.

The centrals themselves is further connected via uninet, see figure 2 below.

Figure 2. Net connection



Maintenance of the system is provided by the Observation division which is located in Oslo.

Software development.

All software is developed to run on licence free platforms, i.e. LINUX and PostGreSQL.
As developing tools are used Kylix and Java.

Following software modules are developed:

- Sensor data collector
- Video image collector
- Database
- Sensor data presentation
- Video image presentation

The **Sensor data collector** reads digital parameters from the sensors and store new readings in the database every minute.
The **Video image collector** store new pictures from all video cameras attached once every minute.
The **Database** structure is developed based on **PostGre SQL** database. The structure includes different tables for configuration used to tailor the database to each individual airport, to tailor the data presentation to end users wishes and tables containing meteorological parameter names to enable flexible input of different parameters into the database.
The **Sensor data presentation** is software developed to create the machine/man interface. Since the presentation setup is determined by a configuration table included in the database, it is very simple to change the visual presentation.

The **Video image presentation** is software developed to present the pictures from all cameras to the user. The presentation of video images is available to the user as last picture from each camera as well as an animation showing a sequence of pictures.

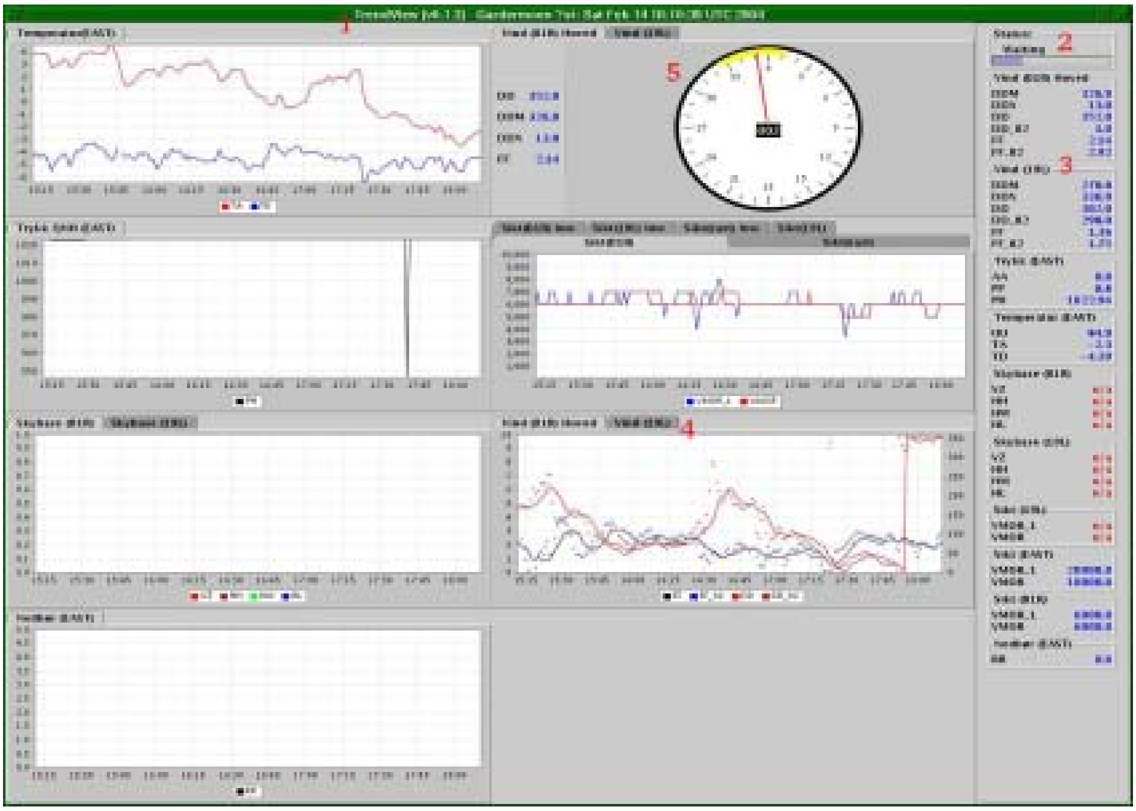
User interface/Data presentation.

All information is shown to the user on two screens, one for information from standard meteorological sensors and one separate screen for video images. For presentation both of sensor measurements and video images we have used 19” flat screens.

Information from standard meteorological sensors

The screen image consists of 7 graphical fields, a field presenting the last measured data as numerical values, a field giving information on the program status and a top field where location and time is given. An example of the screen picture is shown in Figure 4 below.

Figure 4: Data presentation screen.



The Status field (2) consists of a text field and a program progress indicator. The text field tells what goes on at the moment, i.e. Sleeping/Reading/Distributing data. The program progress indicator shows how far the program has come on the ongoing task.

The numerical values field (3) on the right hand side of the screen contains all last values for all wind sensors at the airport, the air pressure values, temperature and humidity values, cloud information from ceilometers and visibility information from forward scatter instruments or transmissometers whichever are mounted at the actual site. When using the mouse to point on an actual value the user will get information about exact time for that measurement. The colour of the numbers also give information regarding the updating of the measurements. A dark blue colour indicates that a valid value, i.e. new value received last minute, a light blue number indicates that the value was not updated last minute and a red number tells the user that the value shown no longer is valid. In some cases n/a is shown in red instead of a numerical value. This is the case if the sensor providing the information is not available for instance due to servicing or sensor breakdown.

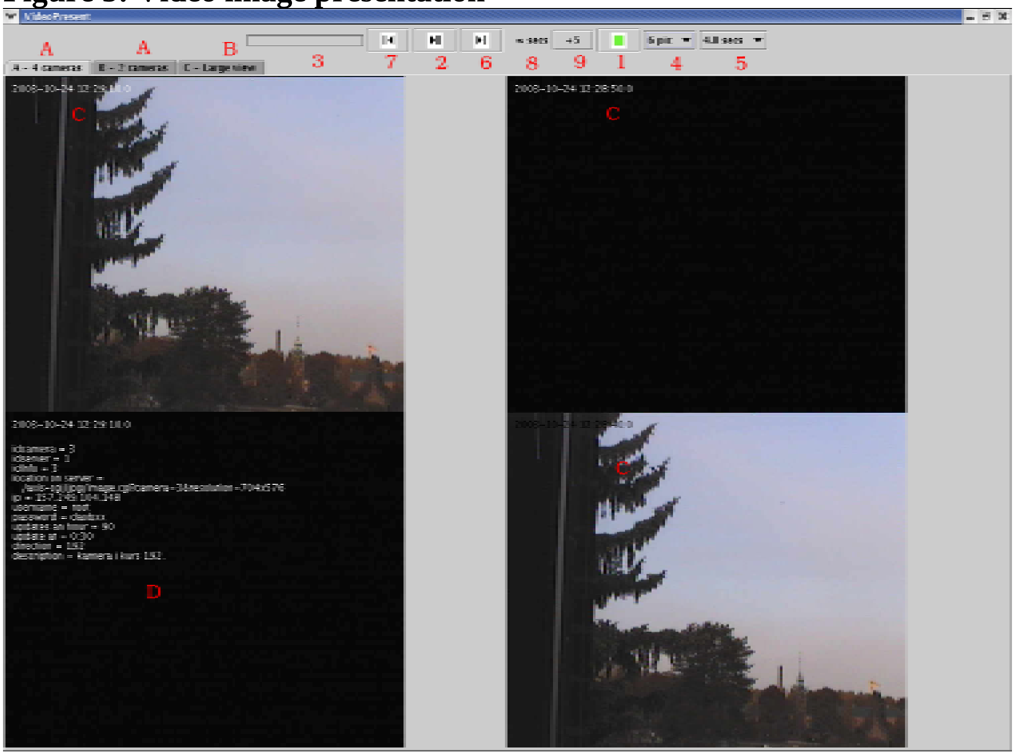
The graphical fields (4 and 5) as developed for TREND forecast users can show altogether 15 different graphs but only 7 visible in a chosen display at the same time. Each shown graph has a tabulator enabling the user to select what information he wants in the graph. By pointing the mouse at a specific graph the user will get information about the content of that graph. For other applications it is possible by database configuration to make many more graphs available on the screen. The restricting factor will be the size of each graphical field in relation to the size of the screen.

Video image presentation.
Normally images from 4 cameras covering a 360 degree horizon is shown on the screen. An example of the user interface for video images is shown in Figure 5 below.

Normally new images will arrive on the screen once a minute.

By pointing on a particular image the chosen image will cover will be enlarged to cover the screen. The upper left corner of each image will give a time stamp for the image. The user can choose to view a sequence of images instead of last image from each camera.

Figure 5: Video image presentation



The user can select the number of images in a sequence. The user also have a possibility to look at selected images by using a pause button in the top field on the screen. To avoid unintended display of old images the status of the video display will automatically go to default showing last image from all cameras after a selected time.

Configuration.

All information and set up tables are stored in the database as configuration tables. Tools to create or change configuration has been developed. As a result of this structure we are left with a very flexible system for different applications for collecting meteorological information via net technology. To add new sensors it is only necessary to write a “driver” for the wanted sensor and put it in the data base by means of existing parameter configuration tables.

Maintenance and operational experience.

The system was operational at the beginning of 2004. Although we have experienced breakdown of some servers, mostly due to power supply failure on the server, the end user has up to now not been left without a valid set of data at his working place. This good experience is due to the design with independent data collection at least two servers for each airport and that the presentation software automatically looks for another server if it is not able to contact the defined main server.

Using the terminal server technology (MOXA) to connect measuring instruments to net communication allows service personal to monitor raw data from each individual sensor system from their working site in Oslo. Such monitoring of raw data will not disturb the normal use of the system, i.e. end users will receive all information undisturbed also when service personal are monitoring sensor data. This functionality is very helpful in relation to troubleshooting.