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MULTI-SENSOR INTRANET SOLUTIONS AT SOFIA AND KUWAIT INTERNATIONAL AIRPORTS

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1. INTRODUCTION

Along with its Rainbow® product line, Gematronik develops the WeatherWeb® software package which is a web-based Integrated Meteorological Information System (IMIS). By means of WeatherWeb® the Gematronik radar systems at Sofia and Kuwait International Airport have been successfully integrated into multi-sensor Intranet systems supplying different types of meteorological information to the aviation users. The advantages of the web-based approach to the integration of different sources and types of information, serving a number of different users, is shown.

2. INTEGRATED METEOROLOGICAL INFORMATION SYSTEMS - IMIS

The meteorological equipment at a modern airport comprises a number of different sensors and systems. During the past these systems were used more or less separately, and the forecaster's desk or the controller's position was crowded by computers and separate displays for every single type of information. The maintenance of the equipment required enormous efforts. Finally the user could not derive benefit from using all the information in its inherent integrity.

The Integrated Meteorological Information System (IMIS) is designed to collect, process, disseminate and visualize information coming from different sources and presented in different formats. The processed information in form of meteorological products has to be easily accessible by the number of users. Our approach to this task was to use Web technology and to create an Intranet IMIS. It was called WeatherWeb®.

The WeatherWeb® software is in line with the new concept of Collaborative Decision Making (CDM) and can be used as the "MET" part of a web-based information system for airports or ATS (Air Traffic Service) units. The CDM reflects two tendencies that rapidly become standards for any meteorological and aviation applications. The first tendency is to integrate all information sources on one platform. The second is to provide information sharing between a number of different aviation users, meteorologists, air traffic controllers, airlines, airport authorities. All these users take part in the Air Traffic Management (ATM) and Air Traffic Services. The meteorological information plays an important role in the ATM and ATS decision-making. The CDM requires more detailed, accurate and timely meteorological data, including radar and satellite images, numerical products, real-time data from sensors along the runways, airport reports, etc.

3. IMIS AT SOFIA AIRPORT

After the installation of a Gematronik METEOR 360 AC at Sofia Airport, the development of an integrated system was initiated together with the Air Traffic Services Authority. The first task was to identify all sources and type of information to be integrated.

3.1. Inventory of the data sources and formats

The first step in the development of the WeatherWeb® was to find out all existing sources of meteorological information used for aeronautical purposes.

- *OPMET messages*. Airport reports (METAR, SPECI), terminal area forecasts (TAF), SIGMET and AIRMET information, other alphanumeric messages containing forecasts and warnings are received via the ICAO Aeronautical Fixed Systems (AFS), including SADIS or ISCS. An interface between the WeatherWeb® and the available communication systems had to be developed in order to receive and display the OPMET messages.

- *Numerical Products*. The products of the ICAO World Area Forecasting System (WAFS) as well as other numerical analyses and forecasts have to be delivered to aeronautical forecasters, briefing terminals and ATC systems. These products are disseminated in several formats – coded facsimile (T.4), WMO GRID, GRIB and BUFR codes, all supported by the WeatherWeb®.

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- *Automatic Weather Observing System (AWOS) real time data*. All modern airports have an AWOS to provide data for wind, visibility/RVR, pressure, temperature, dew point, etc. The visualization of the real time data is currently done on dedicated displays and this limits the number of users that can utilize this data. The WeatherWeb® can provide the real time data to an unlimited number of users at the airport or at remote locations.

- *Meteorological Radar and Satellite data.* The radar and satellite images received from the existing facilities are converted to graphical formats that can be viewed by means of a Web browser.

3.2 Inventory of Users

The clients of WeatherWeb® at the airport or the ATC center are:

- Airport meteorologists
- ATC units – tower, approach
- The Airport management
- The Airlines and (maybe)
- The passengers.

These user groups have different requirements for the "MET" information. Thus the system should be flexible and easy to configure according to specific user requirements.

3.3 WeatherWeb® principles of design and functionality

The WeatherWeb® software is intended for the operation by a number of different users at different locations. In order to achieve an expandable and flexible solution the software has been designed on the basis of the Internet and World Wide Web technology by means of HTML and Java languages. The kernel of the system is a Web server and the user has a browser that can be configured according to his specific needs. The WeatherWeb® design based on this technology provides:

- Platform and operating system independence
- Security and functionality
- Quick and easy visualization of different types of information
- Easy customisation according to the local data availability and requirements.

Based on this technology the WeatherWeb® achieves the following results

- Unlimited number of clients connected to the system (restricted only by the capacity of the Web Server)
- No additional software needed on the user site
- All security restrictions are applicable trough the Web Server administration
- Unlimited number of display pages with their own display settings and preferences available on the Server.

3.4. The Use of Java Applets

The WeatherWeb® display system is based on Java Applets. An HTML page contains code that evoke Java Applets residing on the Web Server to be downloaded and started. A Communication Applet makes a connection with the server and sends data to other Display Applets on the same page. The use of Java Applets ensures that:

- All Display Applets are fully customisable – the user can specify their size, position, colours, fonts, etc., by changing the applets <PARAM> tags in the HTML document.
- New pages can be easily created, by placing one Communication Applet and choosing between many Display Applets and setting up their parameters.
- The user can edit or create his own WeatherWeb® display pages using an HTML editor.

4. KUWAIT INTERNATIONAL AIRPORT SENSOR INTRANET

Within the scope of the project "Implementation of Kuwait Airspace System Plan" a Gematronik METEOR® 500C Doppler Weather Radar has been installed at the Kuwait International Airport (KIA). Main task of the Doppler Weather Radar (DWR) is the automatic support for the Kuwait Meteorological Department with radar products for the detection and now-casting of severe weather phenomena. The DWR has the ability to detect sand storms, wind shear events, downbursts, severe thunderstorms with cyclonic or anti-cyclonic patterns as well as to process long-term rainfall accumulation. To operate the DWR in the meaning of "Collaborative Weather Monitoring" the Gematronik DWR is connected to a Low Level Wind Shear Alert System (LLWAS, Almos) in order to increase the probability of detection (PoD) of Microbursts and wind shear events. Other sensor integration like Automated Weather Observation Stations (AWOS) and satellite integration are foreseen.

4.1 System Characteristics

The C-band Doppler weather radar is equipped with a 4.2m reflector and the Gematronik transmitter TXC 500 featuring a full solid-state modulator. The RXC 500 consists of an ultra-low noise RF-frontend with Digital Receiver backend. Analogue devices like COHO, I/Q-Demodulator, AGC-Amplifiers as a major source of non-linearity and instability are replaced. These functions are performed digitally by the Aspen® DRX signal processor. The Aspen DRX processes reflectivity, radial velocity and spectral width data in real-time at

highest resolution and accuracy. In order to establish an efficient and user-friendly control structure that fits to all modules for the single radar installation at KIA the distributed radar control architecture (DIRAC) has been introduced. Numerous controllers communicate via standard TCP/IP local LANs by using Gematronik's News-Server concept and the open macro language format RCL (Radar Control Language). As the METEOR 500C forms the integral part of the meteorological network at KIA, comprehensive BITE (Built-In Test Equipment) information, radar products as well as LLWAS and AWOS data transfer is available at any network node within the Kuwait Airport Data Interchange Network - KADIN.

4.2 Network Configuration

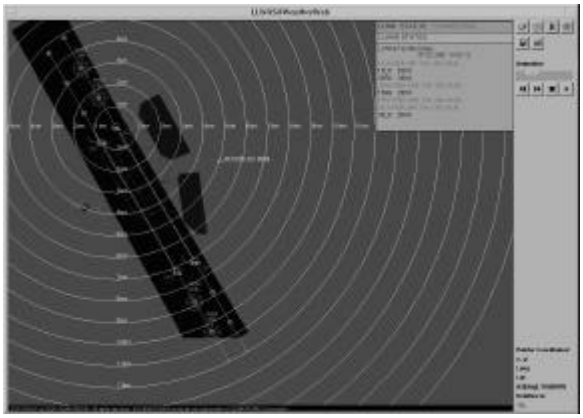
The multi-service network KADIN (supporting voice, video, audio and data) is connected to the DWR network consisting of several VLANs (Virtual Local Area Networks). Each main building at KIA forms a comprehensive part of the KIA Intranet. Each building (air traffic control tower, meteorological department, KIA product users, Kuwait Airways Cooperation, internal and external users) is connected using high speed multi- and single mode fiber optic cable. Standard CISCO network switches, routers and bridges are used in order to create a sophisticated high speed backbone which covers all needs of a modern meteorological network. Remote radar control and maintenance is possible from any point in the World using Internet capabilities and Gematronik' s JAVA based real-time frontend Ravis®.

4.3. Products

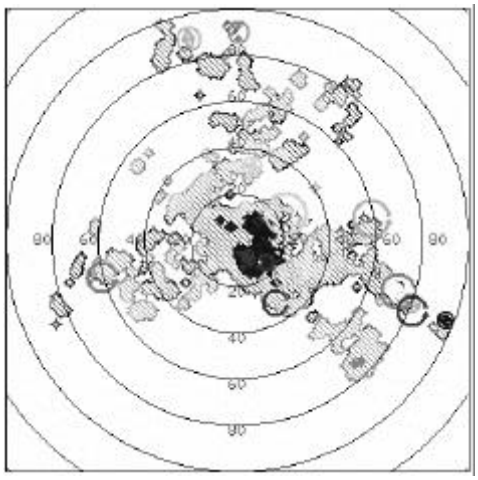
The meteorological processing and visualization software Rainbow® is the integral data processing part of the KIA network. Advanced scan and meteorological product definition, innovative schedule management, tools for off- and on-line processing as well as comprehensive data dissemination are state-of-the-art features. Sophisticated aviation products like Uniform Wind Technique, Volume Velocity Processing, Storm Relative Velocity product, NEXRAD style Mesocyclone Detection, NEXRAD Severe Weather Analysis Display, NEXRAD Storm Structure Analysis and Severe Weather Indicator are used to detect, extract and track severe weather potential. Additionally BITE and severe weather warning messages can be exported using the KIA SCADA frontend (Supervisory Control and Data Acquisition). The comprehensive Rainbow® Alert Management System (RAMS) supports acoustic, voice and visual alerts as well as Alert Script Ignition used by numerous internal and external meteorological users. Rainbow® is used to bring all meteorological signals and events to a concentrated information on the screen showing severe alerts in a very convenient way. Geographical Situation Displays (GSD), pictograms for divergent or convergent patterns or coloured indicators for severe storm/core reflectivity are used.

4.4. Collaborative Weather Monitoring

KIA has been equipped with an Almos Low Level Wind Shear Alert System. Gematronik' s WeatherWeb® package has been chosen to integrate LLWAS data into the meteorological data flow of Rainbow®. The geographical situation display LLWAS@WeatherWeb® shows wind sensor related information like wind speeds, alert locations for Microbursts or shear events, runway oriented loss or gain of head wind and centerfield wind. Using the Rainbow® ESIS system (External Sensor Integration Server) the JAVA based GSD depicts in intervals of 10 sec the data stream of two fully redundant Almos LLWAS servers. The superimposition of LLWAS and radar data is also possible. Additionally any kind of severe alerts will be exported as a BITE message to RAMS or to SCADA.



LLWAS@WeatherWeb® showing two runways (15 and 33) and LLWAS text message window



Severe Weather Indicator product showing

- Divergent and convergent structures
- Cyclonic and anti-cylconic patterns
- Severe storm reflectivity 30 dBZ / core 50dBZ