Web-based distribution of road weather information to winter road maintenance contractors in a multiple contractor environment.

Introduction

Since the 1970s, the Finnish road weather information system has been gradually developed into an aid to winter maintenance. Recently, winter maintenance of the road network, and especially commissioning of maintenance, has undergone major changes. The former Finnish National Road Administration (Finnra) has been divided into the Finnish Road Administration, which takes care of administrative tasks, and the Finnish Road Enterprise, which does contracting. Winter maintenance is being opened to competition, and the goal is that by the end of 2004 winter maintenance on all the public roads in Finland will be done by contractors selected through a bidding process. The new method of operation put pressure on the road weather system. It became necessary to make the road weather system and the information it contains available to all the contractors doing winter maintenance as easily and reliably as possible. To satisfy this need, a Web Road Weather project was started in the beginning of 2000, which resulted in a new web-based application for users of road weather information.

Brief history of road weather information

From the late 1970s on, road weather service systems have been developed to aid winter maintenance in various parts of Europe. Finland has actively participated in this development work right from the beginning. Testing of a road weather system began in Finland in the early 1980s. The system proved to be beneficial, and in 1987 Finnra assumed primary responsibility for the development of the system. At the same time development of the system was speeded up significantly.

The first microcomputer-based road weather system was taken into use in parts of Finland at the end of the 1980s, at which time 66 road weather stations were in use. In 1990 the central stations that gathered information were converted into Unix-based systems. With this change the entire country has been included in the system since 1992. The first road weather cameras were taken into use the same year. The number of road weather stations grew rapidly; in the winter of 1994-95 there were already 200 road weather stations.

The next major steps to improve the usability of the system were taken in the middle of the 1990s. An Image Product application was introduced in the beginning of 1995, which made it possible to monitor images of the weather and driving conditions. During the following year storage of road weather information was centralized in one database server that covered the entire country. A Road Weather Windows workstation application and a new data collection application for the WindowsNT operating system were taken into use in 1997. Both applications have been developed further since then.

In 2000 the Finnish Road Administration needed to acquire a new road weather application that would enable viewing of a wide range of images of weather and driving conditions and monitoring of conventional road weather information. The application also needed to be easily applied as a tool for external contractors.

Move to a multiple contractor model

In the early 1990s, winter maintenance was solely the job of Finnra. At first, road master areas in the districts took care of winter weather monitoring and winter maintenance quite independently, but as the road weather system evolved they began to centralize monitoring. The districts'

weather centers monitor the weather, driving conditions and changes in conditions and, if necessary, alert supervisors to take charge of maintenance work.

In 1994 the first regional contract handled by an external contractor was implemented as a pilot project in the Kirkkonummi area. The following year pilot projects were set up in the areas of Loppi and Luopionen. In 1998 the maintenance of five areas for the following three years was subjected to actual bidding. Five additional areas were subjected to bidding the year after.

Area bidding contests were suspended for a year because of the operational separation implemented at Finnra in 2000, but when Finnra was divided into the Finnish Road Administration and the Finnish Road Enterprise, 23 areas were subjected to bidding in 2001. The contractors that were chosen had overall responsibility for maintenance of the road network and the traffic surroundings. Contracts that were not included in the bidding are being implemented as negotiated contracts with the Finnish Road Enterprise.

25 – 30 new areas per year will be subjected to bidding in 2002 – 2004, so by the end of 2004 all 100 areas in Finland will be maintained by contractors chosen on the basis of competitive bidding.

While previously there was only one maintenance agency, in the winter of 2001 – 2002 there will be five, already. A couple of years from now there will most likely be a few more.

When winter maintenance was taken care of within our own organization, it was quite straightforward to arrange the installation and use of the road weather system for its users. Now that the Finnish Road Administration and the Finnish Road Enterprise have been separated and several other entrepreneurs have also begun to take care of winter maintenance, road weather information, road weather forecasts, images of weather and driving conditions and other related information need to easily accessed and viewed also outside the Finnish Road Administration. This requirement introduced new challenges to the technical architecture of the road weather system.

Today Internet and extranet-based systems are one solution for making it easy to distribute applications and information between different companies and their telecommunications networks.

Conventional distribution of road weather information

Finland's road weather system is a typical client/server application. Users' workstations are located in a fixed telecommunications network. A road weather application in the workstation queries a database for information, and the database sends the requested information to the workstation that asked for it. The information is presented in graphical form in the workstation's road weather application. The application functions well and its response times are very short.

The system has a centralized database for road weather information. On the basis of user feedback, the application is very easy to use, but its technical architecture is not the best possible in light of the Finnish Road Administration's present operating idea, where several different contractors take care of winter maintenance.

Problems with the "old" system in a multiple contractor environment

Fixed network address/connection

The old road weather system requires a user (= contractor) outside the Finnish Road Administration to have a fixed network address, which in Finland typically means the telecommunications connection must be fixed. A fixed network connection with a fixed network address is usually a more costly solution than a connection in which the network address is retrieved each time a connection is made. Finland offers very inexpensive, quick connection modes in which the network address may change each time a connection is made. For example, a

generally available ADSL connection with a bit rate of 512 kbit/s costs 300 – 500 FIM ($ 45 – 75) a month.

Local installation

The application must always be installed locally, which means that version updates, configuration, troubleshooting, etc., are more difficult. The old road weather application always requires separate installation at the workstation end. In addition, the database connection also has to be installed in the workstation. The road weather application only runs on WindowsNT4 and Windows 2000 operating systems. If the features of the application need to be changed after installation, the modification has to be done locally at the workstation. New versions of the application must be installed locally at the workstation. Local installations can be avoided by standardizing the workstations and automating the distribution of new versions. However, standardization of the structure and content of the workstations does not fit into the environment of most contractors. Different environments may also cause problems in the operation of the road weather application.

Changes in contractors (applications, connections)

The fact that the competitive bidding of the new operating model may result in changes in contractors also poses a problem from the standpoint of the application. New installation requirements arise each time a new workstation is added to the road weather system. Old connections have to be shut down and the application has to be removed from the previous contractor's workstations. Connections have to be opened for the new contractors and the application and necessary related software have to be installed. The workstation architecture of the new contractor also has to be matched with the road weather workstation application. The workstation's operating system may also be a limiting factor.

Two separate applications

Finland's road weather system still requires two separate applications in the user's workstation. One application is used to examine road weather information and the other application is used to view different types of image products. Therefore, the addition of new workstations requires the installation and commissioning of two separate applications. Connections have to be established to both the road weather system database and the image product server.

Access to the internal network, information security risk

In the old model the workstation has to be directly connected to the database and image product server. This solution isn't good from the standpoint of information security, because the servers in question are in the Finnish Road Administration's internal telecommunications network. Breaking into either server would provide access to all the computers in the Finnish Road Administration's network.

New web-based distribution of road weather information

To make the road weather information more readily accessible to the winter maintenance contractors than it was in the old system, in the spring of 2000 the Finnish Road Administration began developing a new web-based solution for distributing road weather information. The project progressed quickly via the specification phase to implementation by the end of the year. The Web Road Weather application was ready in the spring of 2001 and the commissioning phase got underway in the autumn of the same year. With the new application it will be possible in the winter of 2001 – 2002 to monitor ten different kinds of weather images, camera images from 180 road weather and traffic cameras, and road weather information from 280 road weather stations. The application is currently being used by both the Finnish Road Administration and external contractors.

Web Road Weather is a road weather application that runs on an Internet browser. When prompted by the user, the workstation application retrieves desired information from a road weather system web server especially set up for this purpose and displays the information in graphical form. Technically speaking, the information retrieval happens in such a way that the web server retrieves the information desired by the user from the database server and the image product server and sends it to the user. Thus, the user does not have a direct connection to the data banks. Web Road Weather is part of the Finnish Road Administration's extranet solution. The extranet provides user identification and better information security. The user and the user's Web Road Weather application communicate only with a separate extranet server. The extranet server sees the Road Weather web services as its own and provides them as its own services to identified users with the correct user rights.

How have the problems with the old system been solved?

The user needs nothing more than an Internet connection. Because this is a web-based application that is used with a browser, the user needs only a browser and an Internet connection to use the service. According to the requirements of an extranet solution, the user needs a username and a password with which the user can be identified. After being identified, the user is provided access to certain services. Winter maintenance contractors make an agreement covering the winter maintenance contract and are given a password allowing them to use the service.

Web Road Weather is a web-based Java application that is automatically downloaded the first time it is used. The new Web Road Weather application is easy to install. While the application is downloading, it checks the user's workstation and browser for necessary components and if necessary, offers the possibility to download them. Each time the application also makes sure the latest version is being used. It is very easy and quick to add new workstations into the road weather system. Today an Internet connection and browser are standard features on nearly all workstations. No separate installation visits are needed to install the road weather application, because everything is taken care of automatically the first time the user visits the home page of the road weather application.

It is not necessary to make separate connection agreements between two companies; all the user needs is an ordinary, normal Internet connection. An Internet connection can be obtained quickly and its operation is reliable (at least at the present time in Finland). The client also saves time and trouble because no separate monitoring of connection agreements, routers, firewalls, etc. is needed.

Viewing of road weather information and image products now takes place within the same application. The new web-based road weather application integrates viewing of road weather information and different kinds of image products related to road weather. This possibility of viewing different forms of information with the same application is one of the biggest functional improvements of the road weather application from the user's point of view.

In the new solution the road weather application and the user's workstation only have access to the Finnish Road Administration's extranet server. The extranet server provides the services of the road weather system to a user external to the Finnish Road Administration as if the services were the server's own. Naturally, from the standpoint of information security this solution is excellent and significantly better than the old system. In the new solution only the extranet server is able to penetrate the Finnish Road Administration's firewall to retrieve road weather information, while in the old system all the users had access to the road weather service servers in the Finnish Road Administration's internal network (intranet). The extranet server also checks the users' identification and approves them as legitimate road weather information users.

With the new solution the Finnish Road Administration's internal users will also gradually begin using the new web-based road weather application. For now, though, they also have the possibility of using the old client-server-based road weather application because all its features haven't been incorporated into the new road weather application, yet. So far, the conventional client-server application is also a little quicker than the new web-based solution. From here on, though, system development resources will focus on the new web-based solution.

User interface of the new system

Large desktop

Because it is necessary to simultaneously view different windows containing several different kinds of images from rainfall radar and road weather cameras and road weather information, the user's computer should have a sufficiently large desktop to permit effective monitoring of different types of information and images related to weather and driving conditions. For this reason, the workstation should have several displays. This way it's possible to increase the size of the desktop and view several images at one time. Like all other applications, the Web Road Weather application is able to utilize a large desktop completely. Of course, it's possible to use the application with one display, but active monitoring requires several large displays. It's normal to use three or four 21" displays, which usually gives a desktop resolution of 3600 – 4800 x 1024 pixels.

Possibility to save desktop settings

The Web Road Weather application allows the user to save his or her own desktop settings. This way windows that are carefully placed on different screens can be quickly displayed again later. Thus, the next user can easily return the desired desktop by restarting the application, and time is not wasted in opening windows and placing them on the different displays of the desktop.

Menu structure

Different types of images and road weather information in the Web Road Weather application are clearly divided into separate menu groups. Each group contains 1 – 3 clear subdivisions, depending on the number of different selectable items there are. This makes it easy for the user to pick the information to be displayed.

Information and its presentation

Radar and satellite images

Several different kinds of weather images can be obtained from Finland's and Scandinavia's rainfall radar and Meteosat and NOAA satellites. Different-sized satellite images of clouds and radar rainfall images, rainfall summation images, rainfall state images and rainfall movement prognoses can be viewed as individual images or time-based animations. Animations make it easier to detect the movement and development of rainfall areas than it would be by just viewing a single latest image. The images in the Web Road Weather application have a time bar at the bottom showing the time when they were captured. The animation is easy to interrupt, and by manually using the time bar it is possible to view the areas of rain at different times in the same window at the desired speed and in the desired order.

Road weather camera images

There is such an abundant number of road weather and traffic cameras that by using subdivision they can be they divided into submenus according to district, for example. Contractors may divide them up differently, for example, by monitoring area. The camera images often make use of time animations. Another new feature of the Web Road Weather application is the possibility to view a master animation of the latest images of several cameras in one window. This saves desktop space, and the camera animation of a given camera can be opened for closer examination if necessary.

Road weather information

Road weather information can be examined using graphs, tables and maps just like the old Road Weather Windows application. Because the response times of the map server are too long in the current version of the application, the map displays cannot be zoomed yet. The graphical display may have several X-axes and sets of bars for the presentation of different sensor information. The graphical display is used to examine sensor information of one station over different time intervals, which makes it easy to spots any trends in the values. Tables are generally used to monitor the latest measurement information of several stations.