OVERHAULING FINLAND'S ROAD WEATHER INFORMATION SYSTEM

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1. BACKGROUND

Finland's road weather information system was mostly built between 1989 and 1999. At the start of the new century, the technical and operational limitations of the system were becoming increasingly evident and it was clear that an overhaul was necessary. The overhaul was regularly discussed in the Finnish Road Administration at several levels. The Finnish Road Administration gradually came to the conclusion that the manner in which the different roadside devices produce information should be carefully examined in connection with the overhaul process. The use of outsourced services in the collection and storage of road weather information was also an important aspect in the upgrading process.

A preliminary study carried out in 2008 marked the start of the overhaul process. Using the recommendations of the preliminary study as a basis, a project for specifying the information collection and storage requirements was launched in early 2009. The Finnish system of information collection and storage also covers the calculation of information for variable road signs. For this reason and because it was clear that the calculation system, too, was in need of an upgrade, a second requirement-specification project involving the description of the system was also launched in early 2009.

2. PRELIMINARY STUDY

The aim of the preliminary study was to produce an overall picture of the system of roadside devices producing information and the administrative model supporting it in the coming years. The study was thus intended to provide a basis for the overhaul project planned for the next few years. The preliminary study was carried out by a consultant who was familiar with the road weather information and traffic management systems of the Finnish Road Administration. Experts of the Finnish Road Administration were closely involved in the work through interviews and workshops.

The preliminary study involved the identification and description of the following 12 key elements of the system of roadside devices:

1. Collecting information using roadside devices. Individual roadside devices collect information in accordance with pre-parameterized rules and the prevailing weather conditions and traffic situation. The information collection is with the help of software incorporated in the collection and storage service (CS service). The Finnish Road Administration uses seven different types of collection interfaces in its roadside devices: Road weather station, traffic measurement (real time), traffic measurement (statistics), still image, live image, spatial information of variable road signs, and spatial information of barriers and other guiding devices. Roadside devices may be equipped with additional interfaces in the future. The information-collection frequency for each connection can be determined individually for each station.
2. Collecting information using sensor vehicles. Special software is used for collecting and receiving information from individual sensor vehicles that supply road weather information. The system functions in the same manner as with roadside devices In the future, the information may also be acquired as a service in which the processed information is picked or imported into a database. The content of the information produced by sensor vehicles differs from the measurement data generated by roadside devices, particularly as far as geographical data is concerned. For this reason, the data supplied by sensor vehicles should be treated as a separate interface.
3. Information produced by information systems of other organisations. The CS service has an information-transfer function. Thus, information produced and provided by organisations other than the Finnish Road Administration can also be picked and received. Such organisations include the Finnish Meteorological

Institute, authorities in other countries and different service providers. There may be more interfaces to other systems in the future.
4. Exchange of information for producing numerical road weather forecasts. The information-transfer function of the CS service transmits information from road weather stations to producers of numerical road weather forecasts. The service provider transmits the numerical forecasts to the information-transfer function of the CS service. The forecasts must be compatible with the interface determined by the Finnish Road Administration. In the future, the concept of numerical road weather forecasts may be expanded to include numerical radar image data covering public roads.
5. Producing road and other weather forecasts and radar and satellite images. Road weather and other weather forecasts and radar and satellite images are not transferred into the data warehouse of the CS service. The information producer stores the information using its own extranet server. In order to speed up and ensure the functioning of the service, the information producer may also copy the information on the server of the Finnish Road Administration for the use of the presentation and reporting system (PR system). It should also be examined whether radar and satellite images need to be stored and how the storage should be carried out.
6. Calculating information for variable road signs. The CS service collects the real-time monitoring data required for calculating information for variable road signs. The information collected at road weather stations is available to the information-calculation system (IC system) immediately after the collection. Using the information collected by the traffic measurement stations, the CS service calculates the traffic volumes and speeds, which are then transferred to the IC system. Not all systems have identical requirements concerning basic-sensor calculations and this should be taken into account when determining the system used for the calculations.
7. Controlling the cameras. The position of the cameras can be controlled in two ways. 1) In the CS service, the position of the cameras that are used for collecting standard information is determined in advance. 2) Certain users, such as people working in traffic management centres, may also position and zoom cameras and view images produced by them using a separate user interface. Each camera is steered by server software, which is directly connected with the user interface of the cameras. In exceptional situations, such as in traffic accidents, it must be possible to ensure that the information produced by sensor vehicles in accordance with pre-parameterized rules is not transferred to the Internet or widely distributed through other channels.
8. Database services. The CS service functions as the operational database of the PR system. The database supplies the system with real-time and history data and it is not necessary to store the data again.
The PR system has the following interfaces:

- Operational road weather station data (including road weather and other weather information supplied by other organisations)
- Search for old road-weather-station documents (including road weather and other weather information supplied by other organisations)
- Operational traffic measurement data
- Search for old traffic measurement data
- Operational still images
- Search for old still images
- Search for old spatial information
- Road weather information supplied by operational sensor vehicles
- Search for road weather information supplied by sensor vehicles that are no longer operational
- Operational road weather forecast information
- Search for old road weather forecast information
- Transmission of live images as described in section 10

9. Archiving the information. The CS service is used for storing different types of history data. The storage periods depend on the type of data concerned. During the storage period, the history data must be available in accordance with specific interfaces. Suggested storage periods for different types of data

- Information collected by road weather stations: All material collected so far
- Traffic measurement data: All material collected so far
- Still images: One year
- Spatial information covering the devices: Ten years
- Road weather information collected by sensor vehicles: All material collected so far
- Road weather forecast information: All material collected so far
- Live images: No archiving; images can, however, be archived on case-by-case basis

In long-time archiving, usability of the material must be ensured. The original format may no longer be available at the end of the storage period. This means that it may be necessary to archive both the material and a suitable data-processing program. For information that does not need to be stored for long periods, the archiving costs in relation to benefits must be considered and the decisions must be made on this basis.
10. Distributing live images. The live-image distribution service is part of the CS service. It receives all live camera images and distributes them to specific users.
11. Presenting operational information. The PR system is responsible for processing the information and for supplying it to road condition centres and contractors responsible for the operational steering of winter maintenance, persons supervising the quality of Finnish Road Administration's winter maintenance, traffic coordinators in traffic management centres and other authorities (such as rescue services and municipal bodies responsible for winter maintenance). The user interfaces available to the above-mentioned groups may not be identical. The user interface supporting winter maintenance will be similar to the presently used road-weather user interface, which has proved highly reliable. Outsiders will be able to access the system through the extranet service of the Finnish Road Administration. The PR system will replace the existing user interface applications.
12. Reports and statistics. The PR system will also allow users to search for history data using such criteria as measuring data, time and area. The user interface will allow the presentation of history data in processable reports and the saving of data in different transfer formats so that they can be used in other systems. The reports and statistics will contain statistical information on individual road weather stations and areas of different sizes. The information will be supplied on a weekly and monthly basis or may cover the entire winter season. The way in which the reports and statistics interface functions will also give valuable information about climate change and its impacts on road maintenance.
A number of open questions remained concerning the administrative model. Discussions and clarifications concerning the administrative model continued as part of the requirement-specification project (next stage of the overhaul process). This was necessary because the work on the administrative model and the system entity are interlinked.

3. REQUIREMENT SPECIFICATION

Using the recommendations of the preliminary study as a basis, a project for specifying the information collection and storage requirements was launched in early 2009. The project lasted for six months and helped to produce an overall picture of the situation. This was achieved by examining the technical system entity and its interfaces, by outlining a control and administrative model for the service, by describing the life-cycle model and introduction plan of the service, by determining service-level requirements and by charting impacts on other systems. The project also resulted in recommendations for the next stages of the project.

3. 1 Objective and end use

The purpose of the CS service is to collect and store road weather and traffic information and weather camera images generated by roadside devices and other organisations and to forward the information, in both processed and unprocessed form, to other services and organisations. The service will supply roadside information to professional groups and partners and to other services. The service can also be expanded to cover the collection of the spatial information of variable road signs.

The information supplied by the CS service will be used in the operational steering and quality monitoring of road winter maintenance, control of variable road signs, reports and statistics, monitoring of weather and road conditions by other authorities, and the provision of information and other services.
The service is a critical part of the overall process that allows the Finnish Road Administration to produce road weather and traffic information. The CS service is an integral part of the overall service concept, both technically and in terms of service-provision models. Service providers must therefore possess both the necessary technical capability and the ability to produce the service in accordance with the ITIL framework. In addition to supplying the CS service, the service provider may also be expected to assume responsibility for the establishment and maintenance of the communications links between the stations and the service. This will depend on decisions to be made at a later date. The stations for collecting road weather and traffic information belong to the Finnish Road Administration and their maintenance is not covered by the service contract. Steering of maintenance may, however, be made part of the service in the future.

3.2 Functioning of the system service

3.2.1 Information collection by roadside devices

Individual roadside devices collect information in accordance with pre-parameterized rules and the prevailing weather conditions and traffic situation. The information is collected using a function incorporated in the CS service. There are three different types of stations for collecting information: Road weather stations, automatic traffic measurement stations and weather cameras (still images). More interfaces will be added to the system in the future. In the near future, the system will be expanded so that it will also collect information recorded by live cameras, spatial information of variable road signs and spatial information of barriers and other guiding devices.

3.2.2 Receiving information supplied by other organisations

The CS service can also be used for receiving information produced and provided by other organisations. Such partners include other authorities, different service providers and road projects based on the life-cycle model, such as the section between Lohja and Muurla.
In the future, it may be possible to receive more information from other organisations and additional interfaces for this purpose may be introduced.

3.2.3 Calculation and information processing

The service allows the grouping of road weather and traffic measurement information supplied by roadside devices and other source information systems into a storable form determined by the database structure. Using a deduction process, the service produces new calculated values on the basis of parameterized rules. The deduction process is called basic sensor calculation.
The service provides the information calculation function with unprocessed traffic measurement and road weather data. The CS service also calculates real-time traffic volumes and speeds and forwards them to the IC system.

3.2.4 Storing and archiving information

The system functions as the operational data warehouse and archive for collected and calculated roadside data. The information and the values supplied using basic sensors are grouped and entered into the service database. All road weather and traffic measurement information collected will be stored into the service. The data archived in the existing road weather system will also be incorporated in the service. Still images produced by weather cameras will be stored for 12 months. The necessary metadata covering roadside devices, roadside-information collection methods, functioning of the service and malfunctions will also be stored in the system.

3.2.5 Transmission of information

The CS service provides interfaces for forwarding road weather information, traffic measurement data and weather camera images to other organisations and services. The interfaces are as follows: 1) interface for the presentation and reporting system; 2) interface for the information calculation system; and 3) interface for other system services. The information for the last two weeks should be quickly available. Response times for older and more extensive information entities are less critical.

The user interface functions of the PR system are directly connected with the data warehouse of the CS service. Information can be searched on the basis of the parameters set by the users. The PR system will use the database of the CS service. The interface of the PR system will be determined on the basis of the user interface functions and will thus be put on a more specific basis as the details of the PR system are worked out.

The IC system will receive data in two ways. The system will search for the data it needs by submitting direct database enquiries to the operational database of the CS service. The CS service will also transmit calculated speeds and transport volumes for the use of the IC system in real time. The transmission will be through a message queue.

The latest road weather information and traffic measurement data will be transmitted to services using them (such as the Finnish Road Administration's DigiTraffic service) through an up-to-date interface of other system services. This information will also include weather camera images. The aim is to transmit the information in XML format, possibly using a message queue. Transmission of up-to-date roadside information to systems of other organisations will mostly be done using the Digitraffic service.

The CS service will also provide other services with metadata about roadside information and the functioning of the process. Such information includes the locations and names of stations and service errors.

3.2.6 Administrative user interface

In addition to implementing and maintaining the service, the service provider is also responsible for administering and controlling it in cooperation with other service partners. The CS service will be maintained through an administrative user interface, which will be constructed in connection with the implementation process. The control will be carried out by a variety of means and using a number of different systems. The provider of the collection and monitoring service will supervise the service and its quality and will report on them to the customer. The service will also be supervised by the body providing the Finnish Road Administration with its control and administrative services. The CS service will supply the body with information about the functioning of the service and malfunctions. Response times of the service interfaces will also be monitored using automatic control measurements.

3.3 Control and administrative model

The CS service is part of the service process, in which the roadside devices of the Finnish Road Administration produce information.

3.3.1 Viewpoint of the service provider

Service administration

The service will be administered in an operating environment that is in accordance with the ITIL framework. The service provider must supply descriptions of the most important service-production processes and the roles connected with them. The descriptions must be in a format that supports the ITIL framework. The most important areas that must be described are change management, distribution management and a disaster recovery plan ensuring the continuity of the service and unchanged service quality.

Technical supervision

The provider of the collection and monitoring service will supervise the service and its quality and report on them to the customer. The service will also be supervised by the body providing the Finnish Road Administration with its control and administrative services. The CS service will be integrated into the centralised control system through the interface it determines, providing the system with the control information required for collection and storage. The information about the state of the different process parts offered by the general control interface will be supplemented by a system-specific user interface of the CS service, which can also be accessed by other parties to the service chain.

Administrative functions
The service provider will be responsible for most maintenance and administrative functions of the service. These include the incorporation of new stations into the collection process, updating of metadata and amendments to the calculation rules and interfaces in accordance with the customer's instructions. The customer and its representatives will be able to use the maintenance and administrative interface of the CS service.

Service life-cycle functions
The CS service provider will be responsible for the technical implementation and provision of the service and for developing the service so that it can meet future needs. The service provider must hand over the system components, the collected information and documentation at the conclusion of the service and provide the necessary exit support.

Reporting on service levels (SLA)
A number of service-level criteria have been laid down for the service administration and the availability of the information produced using the service. The provider of the CS service must report on the service levels to the customer. The service will supply the control system with up-to-date information about the operations and errors. Furthermore, the information about service requests and solutions to them will be entered in the ticketing system. Thus the reports can be automatically picked from the control and ticketing systems. The party operating the service desk will also supervise the interests of the Finnish Road Administration in the service-level assessment process.

3.3.2 Service desk viewpoint
The administration of the CS service will be based on the existence of a centralised service desk in the Finnish Road Administration. The service desk is, however, a new function, which is still to be determined. For this reason, it was necessary to produce a preliminary description of how the service desk functions even though it was not within the scope of the requirement specification. The Finnish Road Administration will continue the specification and implementation work concerning the service desk as a separate project parallel to the development of the CS service. The following is a brief description of the tasks of the service desk in relation to the service and the service process as a whole.

Reception of support service requests
The exchange of information concerning the maintenance and development of the traffic and road weather data service process will be coordinated by the service desk. The service will function in accordance with the ITIL framework and its areas of responsibility include registration and classification of malfunctions and service and modification requests, forwarding them to responsible service suppliers and providing users with information about the state of malfunctions and requests and estimated solution times.

Coordination of tickets
Tickets can be generated in two ways. They will be created automatically on the basis of the technical messages sent by the control system or when control staff or end users contact the service desk. The service desk will classify the tickets in accordance with the service agreement and will direct the tickets to different service providers in accordance with the standard principles guiding transaction management. Service

providers must integrate their operations with the service desk ticketing system so that they can receive tickets and update their status values as assignments proceed.

Reporting on service levels (SLA).
The service desk will report on the service levels achieved by the service desk and different service providers. The service desk and any provider of the control service will thus be responsible for supervising the interests of the Finnish Road Administration in the service-level assessment.

4. INFORMATION-CALCULATION SYSTEM

As described above, in addition to the CS service, there are also two other important systems in the scheme.

- The information-calculation system (information for variable warning and speed limit signs and various information displays). Called IC-system.
- Presentation and reporting system (user interface to information). Called PR system.

The specification of the requirements for the information-calculation system of variable road signs was launched in spring 2009, parallel to the collection and storage project. The project involved the determination of the system, which was done by describing the technical architecture, the database and the links with other systems, by charting operational requirements and the manner in which the calculations are carried out and by determining the system configuration. The amount of data, the number of users and the requirements concerning response times and performance were also charted This undertaking also involved the determination of the stages of the service introduction and administration and maintenance during use.
It became clear during the project that the requirements can only be accurately specified when the service is under construction. For this reason, the resulting document was a preliminary report that will provide a basis for requirement specification and further planning.
The document did not contain any opinions concerning the manner in which the system or the service should be purchased. The process concerning the selection of the purchasing model (such as system service and operational service) is still in progress and will require strategy decisions by the Finnish Road Administration.

The following issues were thoroughly covered during the project:

1. The system in general
2. Technical architecture and interfaces to other systems
3. Requirements concerning the functions and user interfaces
4. Non-functional requirements of the system (such as quality and performance matters)
5. Organisation of system administration and maintenance
6. Issues concerning implementation

The system will be used for calculating information for different controllable objects. The object may be a traffic-guidance system or an information display.
The system will not be aware of the type of the object in question; it will simply provide them with specifically structured information.
The task of the system is to calculate information in accordance with the data received. The system will also transmit a flow of real-time data to traffic-control systems. The system will not be responsible for measuring or collecting source data or for guiding individual road signs using the information created.
The information calculated for specific objects will be determined using a set of rules. The rules may refer to such concepts as stations, links, quantities and constants. The calculated information will be transmitted to specific object interfaces.
The system will pick some of its source data from the CS service database. Because of strict reliability and response-time requirements concerning data searches and because the database will receive a large number of enquiries, the IC system should be located in the same local area network as the CS service database.

The system will function on a centralised basis so that a single system will be used for managing the calculation of information throughout Finland. It is essential to guarantee the reliability and availability of the system because a malfunction would mean that all variable road signs in Finland would have to be operated manually.
The calculations made in the system will bee based on a large amount of source data received from different systems. As stated above, the most important data used as a basis for the calculations will come directly through a database connection from the CS service database. Some of the information will come from different source systems through web services.

5. FURTHER MEASURES

Specification of the requirements for the PR system will be the next stage. Updating the PR system simultaneously with other system parts helps to avoid problematic adjustments between the new and old systems. It is essential to ensure that the different elements form a well-functioning entity that works as one system even if the individual elements had been acquired and implemented as independent entities. It is clear that a model in which priority is given to purchasing the system elements as services will make the adjustment work more problematic.

A tendering process, which will be launched at the end of 2009, will mark the start of the service purchasing process. Further discussions on matters requiring clarification will be conducted with the tenderers during the tendering process. The service providers will be selected at the end of the negotiating process after which the construction of the services can start.

The aim is to have the system ready in summer 2011. Summer was chosen because winter maintenance, the most important user of the road weather information system, will be least affected by the dismantling of the old system and the setting up of the new one during that period. The service introduction will be a challenging project. The following three entities will be introduced as part of the introduction: Collection and storage service, presentation and reporting system and the information-calculation system.
The service interfaces will in many respects be different from those used previously. The introductory period will require careful planning and cooperation between different service providers.

It is estimated that the systems will remain in use for about six years. This means that there will be a new tendering process around 2017.