INTELLIGENT TRANSPORT SYSTEMS AND SERVICES SUPPORED BY STANDARDS

Owen Eriksson
oer@du.se
and
Anders Forsman
Institution for computer science and informatic
Dalarna University
and the research group VITS
Linköping University
afm@du.se

SUMMARY

The topic of the paper concerns the process of delivering information services, and how the use of standards can contribute to this. In order to investigate this topic a case study has been performed at the Swedish National Road Administration (SNRA). The SNRA is an important actor in Sweden in the process of delivering traffic information services. In this process the SNRA is dependent of co-operation with other authorities as well as private service providers. The delivery of traffic information services depends on information exchange between different IS, and this exchange is based on national and international standards.

BACKGROUND

ITS is the concept used to describe how information technology can be used in the transport sector (1). The idea with ITS is that the services should bring extra knowledge to travellers and drivers in order to improve transport activities. In cars, ITS is used for helping drivers navigate, avoid traffic hold-ups and collisions. On trains and buses ITS is used for managing and optimising fleet operations and to offer travellers automatic ticketing and real-time traffic information. At the roadside ITS is used for co-ordinating traffic signals, detecting and managing incidents and to display information for drivers and travellers.

In the ITS-sector the use and implementation of standards are important, because there is a need for standards that promote high quality and effective communication between actors, companies and information systems. In order to develop ITS it will be important to be able to combine information from these systems and databases, and this means that it will be necessary to standardise the interfaces between different systems and databases. This is also the reason why a lot of money and work have been spent on developing standards in the ITS-sector (2, 3, 4). However the question is if the standards really are implemented in the right way in the systems and if they contribute to the information exchange needed in order to provide ITS-services. In order to investigate this question a case study has been performed at the Swedish National Road Administration (SNRA).

THE CASE STUDY

The SNRA is an important actor in the ITS-sector in Sweden and one reason for this is that the SNRA provide both basic traffic information to service providers, and traffic information services to travellers and drivers. Traffic information services are a type of ITS services that deal with road conditions, weather information and information about accidents. In the process of delivering traffic and information services the SNRA is dependent of co-operation with other authorities as well as private service providers. The delivery of traffic information services is also dependent on exchange of information between different IS, and furthermore this exchange is based on national and international standards.

THE PURPOSE OF THE CASE STUDY

The main purpose of the case study has been to investigate two traffic information services. The case study has been focused on the standards used and how they influence the exchange between different IS and actors. The main purpose and the results of the study can be divided into three parts:

1. To describe how the information exchange is performed between the systems used in the process of delivering traffic information.
2. To describe the standards implemented in the systems and how they are used.
3. To evaluate how the standards are used and the effects they have on the information exchange and the ability to provide traffic information services.

METHOD

In the case study a qualitative research approach (5) has been chosen and the data used in the analyses have been collected with the help of:

1. Written documents which describes the standards and the information systems. The documentation analyzed is produced by the SNRA and by the European Committee For Standardization (CEN).
2. Analyses of the systems that constitutes the ISA at the SNRA which are used for providing traffic information. The systems have been studied by observing how the functionality of the systems can be used, and by examining the information content of the databases.
3. Guided interviews have been performed with people that are working with the development and maintenance of the systems and standards that constitutes the ISA. Throughout the case study the answers have been documented and feed back to the respondents in order to reduce the risk of misinterpreting the answers.

TRAFFIC INFORMATION SERVICES

Traffic information services are a type of ITS services that deal with road conditions, weather information and information about accidents. The users of the traffic information and services are travellers and drivers who can use the information when

they are on the road (on-trip information), or are planning to get out on the road (pre-trip information). The aim with on-trip information is to provide drivers and travellers with dynamic information about congestions, accidents and road conditions in order to make better and more informed decisions during the trip (6). The aim with pre-trip information is to make it possible for travellers to plan and to choose the way to travel in a better and more informed way.
The SNRA is the authority in Sweden, which is responsible for communicating traffic information to travellers and drivers, and the most important information system which is used for this purpose, is the TRISS-system (see figure 1).

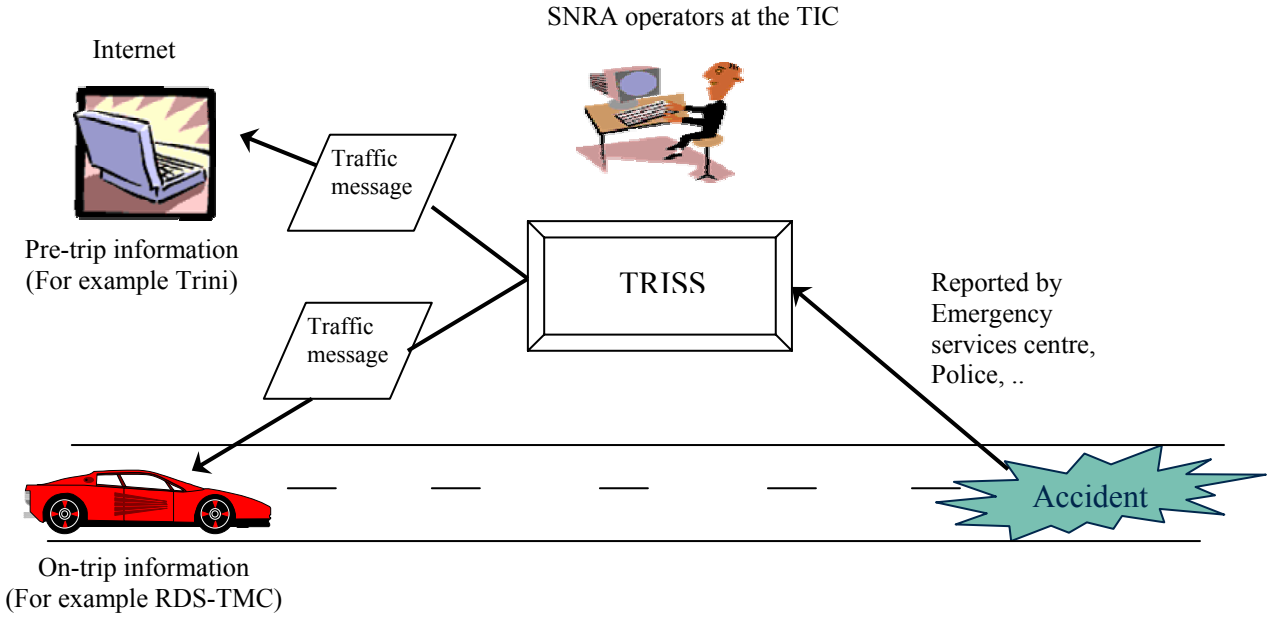

Figure 1. The TRISS-system is used for the communication of traffic information and messages.

The TRISS-system is used by the operators at the Traffic Information Centers in Sweden to create a number of different traffic messages. However all traffic messages (see figure 2 below) communicated with the TRISS-system can, in principle be divided into two parts:

1. Part 1 which describes the event.
2. Part 2 which describes the location of the event.

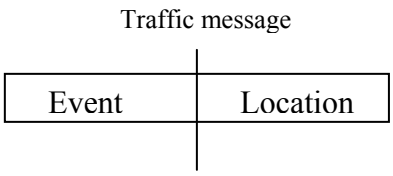

Figure 2. A traffic message can in principle be divided in two parts, an event and location part

1) Description of the event
The description of the event is some kind of traffic related information. This can be information about accidents, road conditions and so on.

2) Description of the location of the event
The location part of the message contains information that describes the location of the event, a location that is related to the road network. The location can be a specific point on the road, for example an accident can happen at a crossroad. But the location can also have an extension, e.g. a roadwork which starts at one point of the road and finishes at another.

The communication of traffic messages from the TRISS-system is performed with the help of several channels and services. Two of the traffic information services, which are provided by the SNRA, are the Trini and RDS-TMC services.

Trini

The information service called Trini (see figure 3) is a pre-trip information service which is available on the Internet. The Trini-service gives travellers the opportunity too search for traffic information based on geographical locations related to the road network.

The traffic messages delivered with Trini contain information road conditions, accident and road works. The figure 3 below illustrates a traffic message communicated with the help of the service.

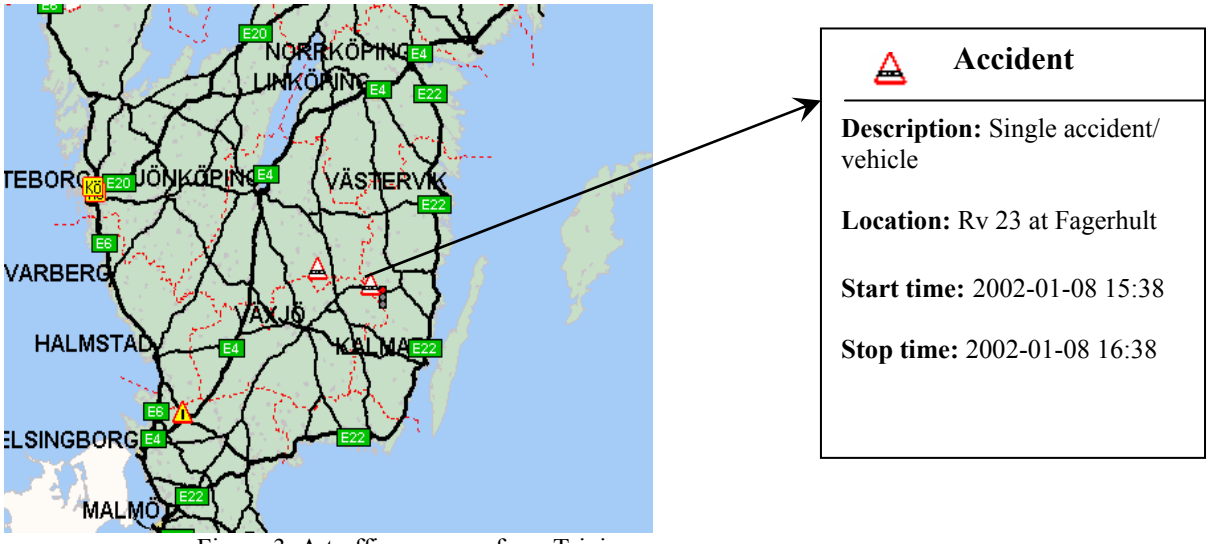

Figure 3. A traffic message from Trini

The figure illustrates that the location of the accident is a road named “Rv23” at “Fagerhult” which is a place related to the road network

RDS-TMC

The RDS-TMC-service (3) is a on-trip traffic information service for travellers and drivers communicated with the help of the RDS radio channel. RDS-TMC is an

abbreviation for **R**adio **D**ata **S**ystem-**T**raffic **M**essage **C**hannel. The messages that are sent through the RDS-TMC channel have a limited and fixed size. In a RDS-TMC message the event and location is described with numerical codes to fit into the limited size of the message.
When the message is received the numeric codes have to be matched with the location code table and a pre-defined event list which is stored in the RDS-TMC receiver of the car. The location code table contain pre-defined places which are used for translating the code into a textual description, and the pre-defined event list is used for the translation of the event code, see figure 4 below.

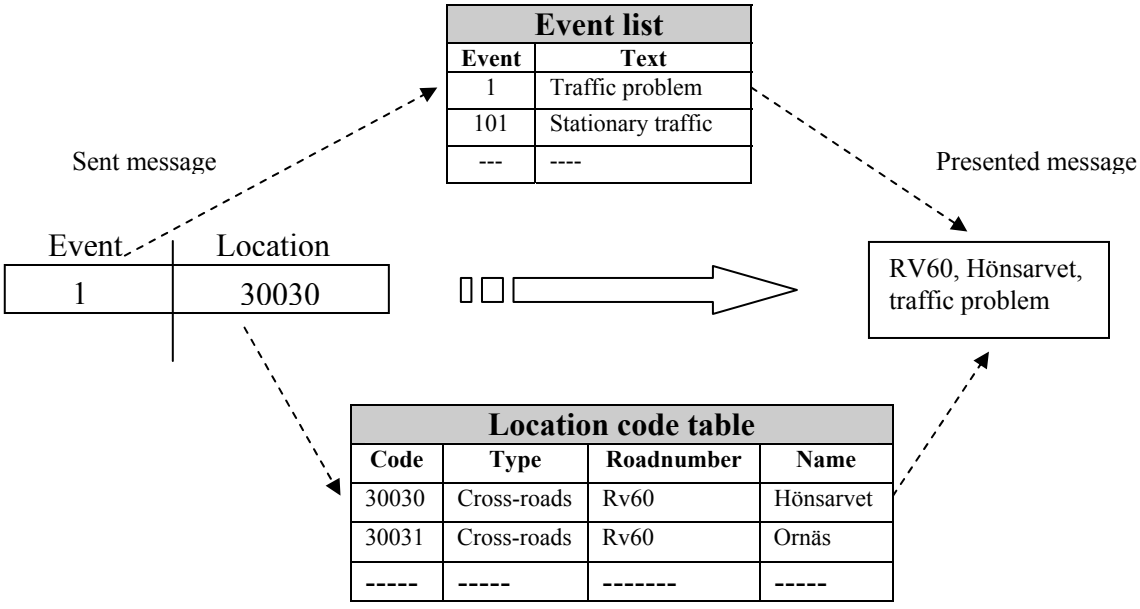

Figure 4. The transfer of a RDS-TMC traffic message

The left part of figure 5 shows the message sent and the numerical codes of the event and location. The middle of the figure shows the location code table and the event list which are installed in the receiver of the car. The right part of the figure shows the message presented for the driver after the translation. In this case the event code 1 is translated to the text “traffic problem”, and code 30030 is translated to ”Rv 60, Hönsarvet”.

INFORMATION SYSTEMS ARCHITECTURE

The Trini and RDS-TMC services are dependent on an information systems architecture (ISA) at the SNRA which consists of three information systems:

- The TRISS-system.
- The Place code system.
- The Milano-system.

These systems are illustrated in figure 5 below and they constitute the implemented information system architecture at the SNRA needed for the production of traffic information services

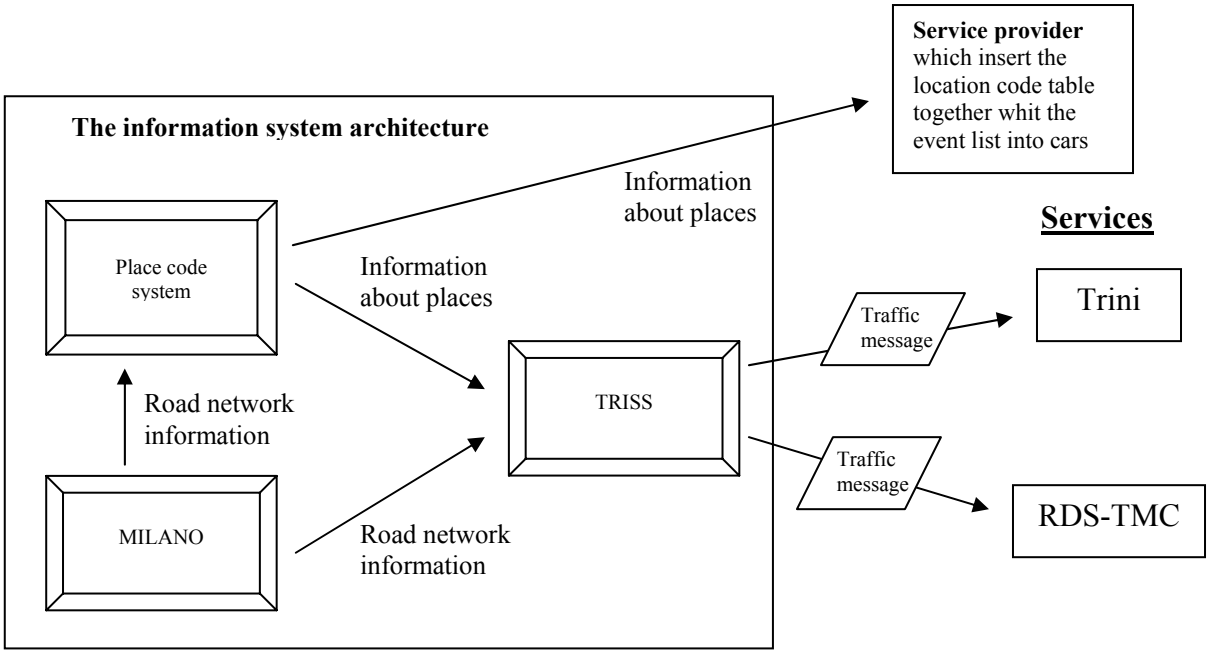

Figure 5. The implemented information systems architecture at the SNRA which is used for producing of traffic information and services at the SNRA.

The TRISS system

TRISS is the system where the traffic information is stored and communicated to travellers and drivers. The system is used by the operators at the Traffic Control Centers who are responsible for the traffic messages that are communicated. The traffic messages communicated consist of two parts, the event part and the location part. In the location part of the messages are codes and textual names of pre-defined places used, and this information is imported from the Place Code-system. The location part of is also related to road network information, and the information about the road network is imported from the Milano-system.

The Place Code system

The Place Code system contains information about code and names of pre-defined places, these places are used in traffic messages to describe the location of different events. The system is used by the operators at the Traffic Control Centers who use the system to create, code and name places which are stored in the Location Code database, which consists of a number of tables e.g. the location code table. The places which are coded and named in the Place Code system are also related to the road network information which is imported from the Milano-system.

The information about the codes and names of the pre-defined places are exported to the TRISS-system and to private service providers who e.g. use the location code table and the pre-defined event list when they develop and install the RDS-TMC service into the receivers of the cars.

The Milano-system

The Milano-system contains information about all the roads which the SNRA is responsible for. The system contains information about how the road network is constituted, it describes the nodes and links, road numbers and names of the roads. The information structure of the Milano-system is based on the conceptual road network model which is described in the next section.

STANDARDS

The exchange of traffic information at the SNRA is based on national and international standards, and in this section the standards which are used in the Milano-system, the Place Code-system and the TRISS-system are described.

The road network model

The purpose of the conceptual road network model is to describe how the road network is constituted (7). The three most important concepts used in the roadwork model are described below (se also figure 6).

1. Node: A node is a crossing between roads.
2. Link: A link is the connection between two nodes. A link has a direction because it starts in one node and ends in another.
3. Linkpoint: Points at a link which are represented by geographical coordintes, and the linkpoints are used for describing the geometry of the link and how it is located on the map

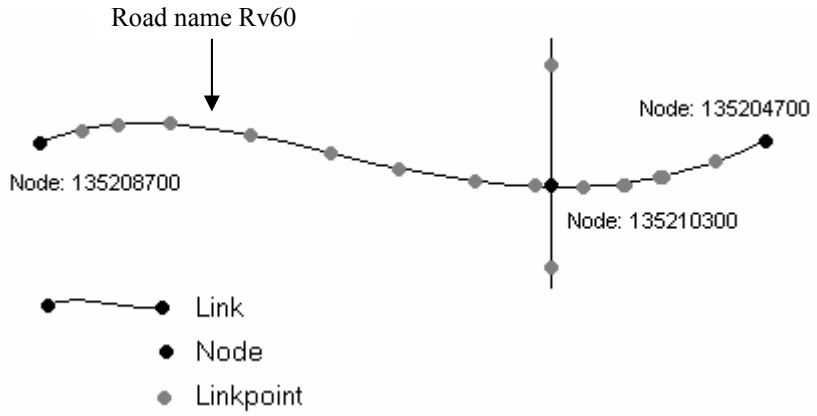

Figure 6. Road network model and its concepts

The basic idea behind the road network model is to separate the topology (the links and nodes) from the geometry (the linkpoints). The nodes of the road network model are identified by numerical codes, and the links are identified by their start-node, end-node, and the date when the link was opened for traffic. The road network model is used for standardizing road network information at the SNRA, and a further development and a

later version of the road network model is now authorized as a Swedish national standard.

Location code

Information about locations is a very important part of a traffic message, and the Location Code is an European standard designed by CEN to support the definition of locations used in traffic messages. The standard describes how places, which are related to the road network, can be coded and named (4). These places are stored in a location code database which consists of a number of tables which are defined in "the recommended location data model"(8). One of the tables in that database is the location code table see the figure below.

CODE	TYPE	NAME
1284	1st order segment	Borlänge
30030	Cross-roads	Hönsarvet
30031	Cross-roads	Ornäs
30032	Cross-roads	Kalrsvikbacka
------	----------	------
------	----------	------

Figure 7. Example from Location code table

In the location code table are the codes and names of the places stored. For example, figure 7 shows that a place with the code "30030" and the name "Hönsarvet" has been created and stored in the location code table.
A basic intention with the standard is that it should be possible to use the standard and the systems based on the standard throughout Europe. The primary aim for the standard is to support the RDS-TMC service which is based on the ALERT-C message standard (see below). However the Location Code standard is also used for describing the location for other types of traffic messages and services.

ALERT-C

To support the communication and information exchange of traffic information in Europe the standardisation organisation CEN have created the ALERT-C standard (9). The standard describes how traffic messages should be coded and distributed to drivers and travellers with the help of the RDS-TMC service. The standard describes how traffic information concerning traffic events related to the road network can be managed and coded. The Location Code standard which was described above is a part of the ALERT-C standard.
An important part of the standard is the event list (10). The event list consists of a number of pre-defined traffic events and the entries in the list are defined and approved by CEN. This implies that the entries in the event list are the same for all countries in Europe. However the event list is translated into different national languages. In figure 8 below we can see a number of events in the event list translated into English.

TEXT	CODE
Traffic problem	1
Stationary traffic	101
Stationary traffic for 1 km	102
Traffic problem expected	55
Fuel spillage accident	206
Road closed due to accident	240
Roadwork's	701
Animals on road	922
Heavy frost	1115
------	---
------	---

Figure 8. Example of events from the event list

Figure 8 show that the event code "1" means "Traffic problem" and that event code "701" means "Roadwork's".

Relationships between the standards

The three standards described above are related to each other in the context of the Milano-system, the Place Code-system and the TRISS-system. The relationships between the standards used are described in figure 9 below.

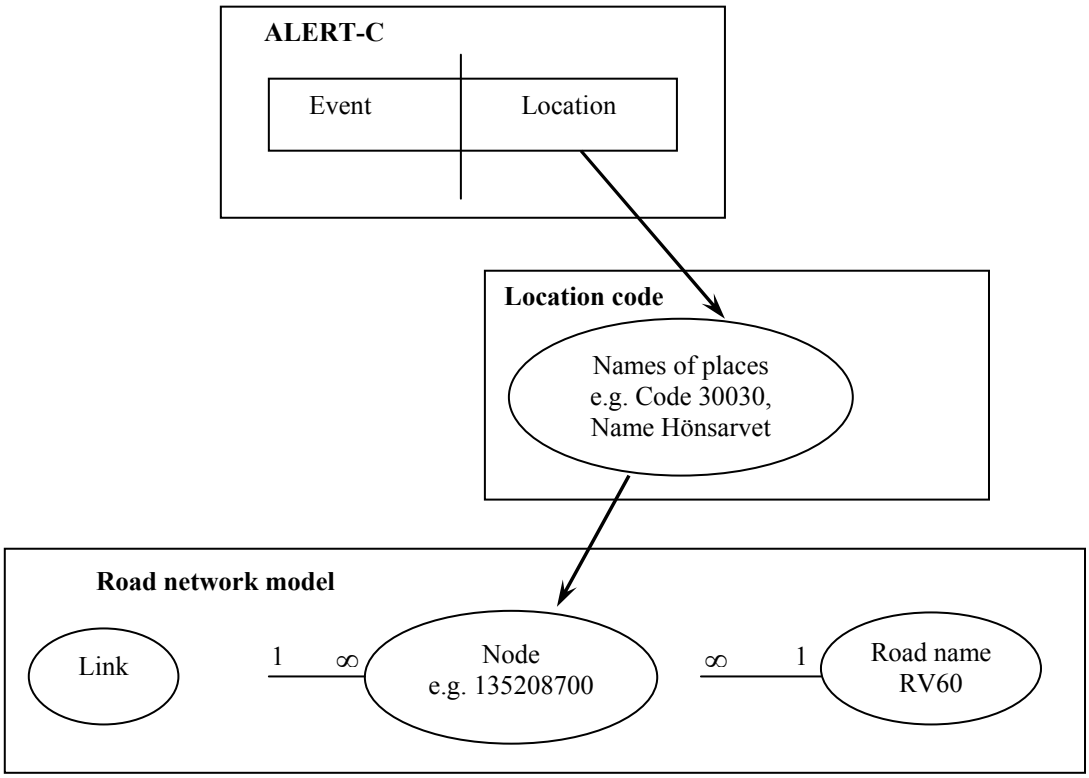

Figure 9. The relationships between the standards used.

ALERT-C
The Alert-C standard is used in TRISS for communicating RDS-TMC messages.

Location Code standard
The Location Code standard is the basis for the Place Code-system where information about names of places is coded and managed. The Location Code standard describes how the database schema in the Place Code system should be organised and rules for how the database should be managed. The Location Code standard is used in TRISS for describing the location of traffic messages, but also in other types of traffic messages. This is also the reason why information about the places created in the Place Code-system is exported to the TRISS-system.

The Road Network model
The information structure and the database schema of the Milano-system which contains information about the national roads in Sweden is based on the road network model (11). The road network model is also used in the Place Code system because the places created in the Place Code system are related to the nodes of the road network model. This is also the reason why the road network database is exported from the Milano-system into the Place Code system.

EVALUATION OF THE STANDARDS USED

The purpose with this section is to evaluate the standards and how they contribute to the information exchange and the communication of traffic messages.

ALERT-C

A major problem with the use of the ALERT-C standard is that the message defined in the standard is to limited due to the low bandwidth of the RDS-channel. The message sent has a limited and fixed size that doesn't give room for a detailed and flexible textual description of the traffic event, and the location of the event. The event is described with a code and when the message is received, the code of the event has to be matched with the pre-defined event list which is stored in the receiver in the car. The problem is that the event list is predefined and it is not possible to send information about an event which is not in the list approved by the standard. This implies that although an event really does not fit any of the entries in the event list, it has to be translated to a predefined event.
Another problem (which is similar to the problem described above) is that the predefined event list is to general which implies that it is a hard to adjust it to the specific needs of a single country. For example, in Sweden there are a number of events which is related to road conditions during the winter which is not covered in the pre-defined event list.
A third problem which is imposed by the standard is that only one event can be related to a location when a message is sent. This implies that although there can be a number of events that occur at a specified location, only one of these events can be transmitted.
The problems described above which all have to do with the ability to express what really has happened creates confusion concerning the meaning of the message, and can

imply that the travellers and drivers does not trust the information communicated with the RDS-TMC service.
An advantage with ALERT-C is that the standard makes it possible to translate the messages to the language that the traveller prefers, no matter in which country the traveller is using the RDS-TMC service. For example if the system is installed in Sweden, with the event list in Swedish, the traveller will get the messages in Swedish no matter in which country the service is used.
Another advantage is that the standard is well documented which implies that the standard gives a good support for how the RDS-TMC service should be developed, managed and maintained.
The fact that the ALERT-C is a European standard implies that the development and change of the standard is performed with caution and is based on mutual agreements between a numbers of countries in Europe. However this is also a disadvantage because the users of the standard think that it takes to much time and effort to propose changes of the standard, e.g. to propose additional events to the event list.

Location Code

One problem area which has been identified concerns how the Location Code standard is used when places are coded and created in the Place Code system. The problem is that places are coded and created in the wrong way compared to the intention of how it should be used. For example the intention of the standard is that the places should be coded from the travellers point-of-view because the places used in the messages should be places which the traveller can recognise and understand. Still in the Place Code system we can see that the better geographical knowledge an operator has of a certain geographical area, the more places are coded in that area. This implies that the creation of the places is primarily based on the operators point-of-view rather than the travellers point-of-view. Another problem concerns how the standard is used for a different purpose. The Place Code system has e.g. been used for the creation of places which are used for describing the location of physical objects, e.g. road culverts, and not traffic events.
The problems described above is causing other problems further down the line because places which are useless for the purpose of communicating traffic messages have to be deleted. Another problem is that place codes which have been used an deleted cannot be reused again. This implies that there is a risk that the place codes which are available will run out, because there is a limited domain of 65000 codes available.
The standard is described in a comprehensive documentation and this is good because it supports the use of the standard. However the comprehensive documentation does also create problems. It implies that there is a lot to read and it is hard to describe how the standard should be used in such a way that it is not misused or misunderstood.
Despite the problems, which have been described above, is the Location Code standard a useful tool for describing locations used in traffic messages. The standard create norms and rules which can be used both in the process of creating and coding places, and as a norm for evaluating the usefulness and quality of information about location related to the road network.

The road network model

Information about how the road network is constituted is important in order to describe the location of traffic events, and this implies that it is important to be able to exchange information about the road network. This also means that it is important that this information can be related and interchanged between the systems. The advantage with the road network model is that it creates a standardized way of describing the road network which makes it possible to relate this information to other information. The basic idea behind the road network model is to separate the topology from the geometry. This separation is important because the topology describes the basic structure of the road network and the geometry how it is located in the geography. This implies that the geometrical description of the road can be changed without changing the basic information structure of the road network. It also means that information can be related to the network with the help of the nodes and links that constitute the topology.

CONCLUSIONS

Services based on traffic information are important in the ITS-sector. In order to produce and distribute these services is it essential with effective and high quality information exchange between different information systems and actors. This communication is performed with a business language (12) in a business context with a number of actors. In this context the business language consists of messages and concepts which concern traffic events and the location of these events. This business language is also used and standardised in the information systems used for communicating traffic information and services.

In the case study has the three important systems the TRISS-system, the Milano-system and the Place Code-system. These systems and the information exchange between these systems are based on a number of standards.

One lesson learned from the case-study is that it is important to recognise that the standards are created with a specific purpose, and that it is important to keep that context in mind when the standards are used. If the intention and the context of the standards is not understood it can cause a number of problems which have been described in the paper, e.g. the problems with the use of the Location Code standard.

It is also important to acknowledge that the standards can impose unwanted restrictions for how the business language can be used because the standards set the rules for what can be expressed in the messages. Other problems concerns the process of changing the standard, and the comprehensive documentation and the complexity of the standard which implies that it is not so easy to understand how the standard should be used and implemented.

However the conclusion from the case study is that the use of the standards are important for the information exchange between the systems analysed, and that the standards are essential in order to provide traffic information services. It would for example be impossible to create the RDS-TMC service without a documented standard that describes how the messages should be structured and communicated. The standards are also important for securing the quality of the communication and information, because the standards can be seen as a mutually agreed norm which can be used for implementing, measuring and discussing quality.

References

(1) Ertico (2001), What is ITS. (WWW document)
http://www.erico.com/what_its/what_is.htm

(2) Vägverket (2000), TMC en NY Trafikinformationstjänst, In Swedish, 2000:129, Vägverket

(3) TMC (1999), TMC Compendium –Alert-C Coding handbook, F02.1,

(4) CEN (2000), Traffic and traveller information (TTI) – TTI messages via traffic message coding – part 3: Location referencing for ALERT-C, Final draft prENV ISO 14819-3.

(5) Alvesson M. Sköldberg K. (1994), Tolkning och reflektion - Vetenskasfilosofi och kvalitativ metod, Studentlitteratur, In Swedish, Lund

(6) Rodseth J., Jenssen, G.D., Meon, T., Asmundvaag, B. (2001). ICT in Road Traffic, Proceedings of the Eight World congress on Intelligent Transport Systems, 30 sep – 4 oct, Sydney, Australia.

(7) Vägverket (1999), Del 6 Vägnätsmodellen, Handbok för: Ajourhållning av vägnätsdata och vägdata, v2.2, In Swedish,Vägverket

(8) TMC (1999), TMC Compendium –Recommended Location Data Model, F01.1,

(9) TMC (1999b), TMC Compendium –Alert-C Coding handbook, F02.1,

(10) CEN (2000), Traffic and traveller information (TTI) – TTI messages via traffic message coding – part 2: Event and information codes for Radio Data System – Traffic message Channel (TMC)

(11) Vägverket (2000b), Teknisk beskrivning av Milano version 3, In Swedish,Vägverket ADB

(12) Goldkuhl G. and Lyytinen K.(1982), A Language Action View on Information Systems. In: Ginzberg and Ross, editors, Proceedings of 3rd International Conference on Information Systems: Ann Arbor.