Specifications for Establishing a Road Data Infrastructure

Per ISAKSSON, Sweden

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SUMMARY

EuroRoadS - a project co-funded by the European Commission and ten project partners representing road administrations, mapping agencies, universities and private enterprises - has laid the ground for a European road data infrastructure. The project has identified the business environment and user requirements and based on that, developed specifications to enable a uniform and efficient data transfer between producers of road data and providers of information and services for end users. Furthermore the project has developed methods for evaluation and quality control.

Demonstration and prototype activities have validated the usefulness of the framework of specifications.

The project is also seen as an important contribution to the work with specifications for transportation networks related to the implementation of the INSPIRE directive. This work will be initiated in the beginning of 2008.

The paper has a focus on the information refinement process, some characteristics of the EuroRoadS specification framework - choice of basic standards, reference systems (direct, indirect), data exchange - experiences from practical use of the specifications and some ideas for deployment and development.

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1. INTRODUCTION

The scope of the EuroRoadS project was:

– To lay the ground for the creation of a pan-European standardised, seamless, updated and quality assured digital road data infrastructure built on identified user requirements.
– To simplify exchange of digital road data within and between different countries.

Comprehensive work directives of the project:

– To support collection and maintenance of data within the organisational level where it can be most effectively carried out
– To make use of existing data and create efficient tools to achieve seamless interoperability between existing data bases
– To involve all relevant stakeholders
– Use existing standards
– Set up efficient quality models
– Focus on core European road data

The delivered specification framework consists of:

– **A road network information model** that defines road network objects and a method for how road related objects (attributes) can associate to the network.
– **A definition of core European road data** within the proposed structure. This point out a basic level of data content proposed to be the data set that in the future might be provided to the European market.
– **A specification of a data exchange model and format**
– **A meta-data catalogue**
– **A terminology catalogue**
– **A quality model**

2. THE INFORMATION REFINEMENT PROCESS – POSITIONING OF THE SPECIFICATIONS

2.1 The information refinement process (handling of road data)

Figure 2-1 describes the business and data refinement process, where the end user of data and services is placed to the far right in the figure. Different content providers ideally shall be viewed as keepers of data of a certain domain or possibly also competing providers of data for the same domain.

From a specification development perspective, the business refinement chain can be viewed in the opposite direction (from right to left). In the end, the service users are the ultimate owners of requirements that propagate back all the way to the data providers.

End users will need services that make use of data from different domains.
Every content provider can not (or very seldom) be the one and only provider of data for a certain end user service.

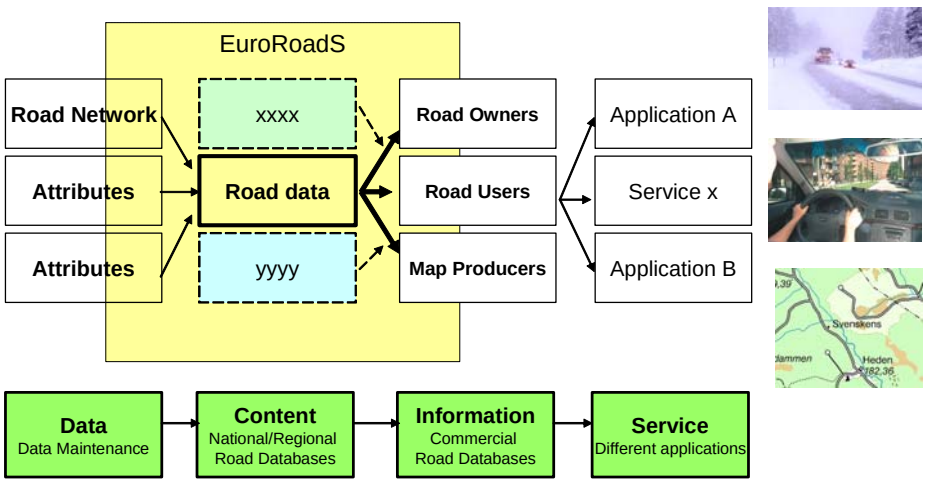

Figure 2-1: Business and data refinement process

Here follows a more in depth description of each step in the information chain.

2.1.1 Data provider

Step one in the information chain includes data capture of different kinds of ”raw” data, e.g. existing databases with road networks, geocoded addresses, and information on road technical descriptions, traffic regulations, administrative details, etc. This kind of information is available from national mapping agencies, national road administrations, municipalities and the private mapping industry.

2.1.2 Content provider

Step two is about production – or compilation – of basic data (reference data) needed for many applications, such as intelligent transport systems (ITS) , mobility management, traffic management, road maintenance, traffic safety, environmental and society planning. This compilation will make use of existing databases with road information, but it is also foreseen that the specification for reference data will have an impact on the future structure of national or regional databases with road data.

2.1.3 Information provider

Step three includes data which are adjusted and ”wrapped up” in order to suit a specific application, for example a road map for a vehicle navigation system.

2.1.4 Service provider

Step four is about more advanced services with different kinds of functions, e.g. to develop a fleet management system due to specific user requirements.

3. CHARACTERISTIC OF THE EUROROADS SPECIFICATION FRAMEWORK

3.1 Choice of basic standards

One work directive of the project was that product models and exchange formats should be based on TC211/ISO 19100 (the international standard for geographical information).

In the work with definition of core European road data the ambition has been to reuse existing national road database solutions, GDF, RADEF and results from the Speed Alert project (Speed Limit).

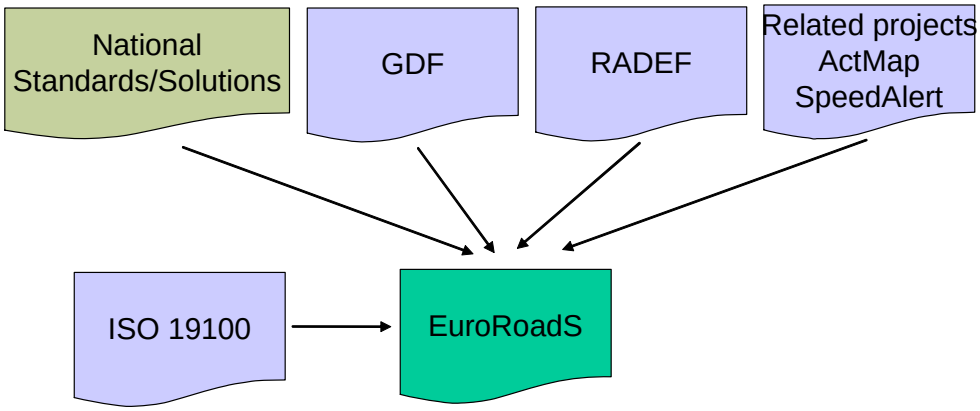

Figure 3-1: Use of basic standards and reuse of definitions

3.2 Reference systems

When dealing with road networks and road data there has historically been common to use linear referencing methods. If road data is to be used together with other georeferenced spatial data it is necessary to be able to use geodetic reference systems.

3.2.1 Direct reference systems

Geodetic reference systems
Regarding choice of geodetic reference system it is advisable to follow the recommendations in the INSPIRE Reference Data and Metadata Position Paper. INSPIRE has recognised that ETRS89 is the most appropriate geodetic datum to use within Europe. This means that all national (condensed) geodetic reference systems (projections) based on ETRS89 are usable.

The chosen direct – geodetic - reference systems is of significant importance as it is mostly needed to handle border nodes and if you want to make mapping between different indirect – linear - reference systems. This because of the lack of relations between the different linear reference systems used.

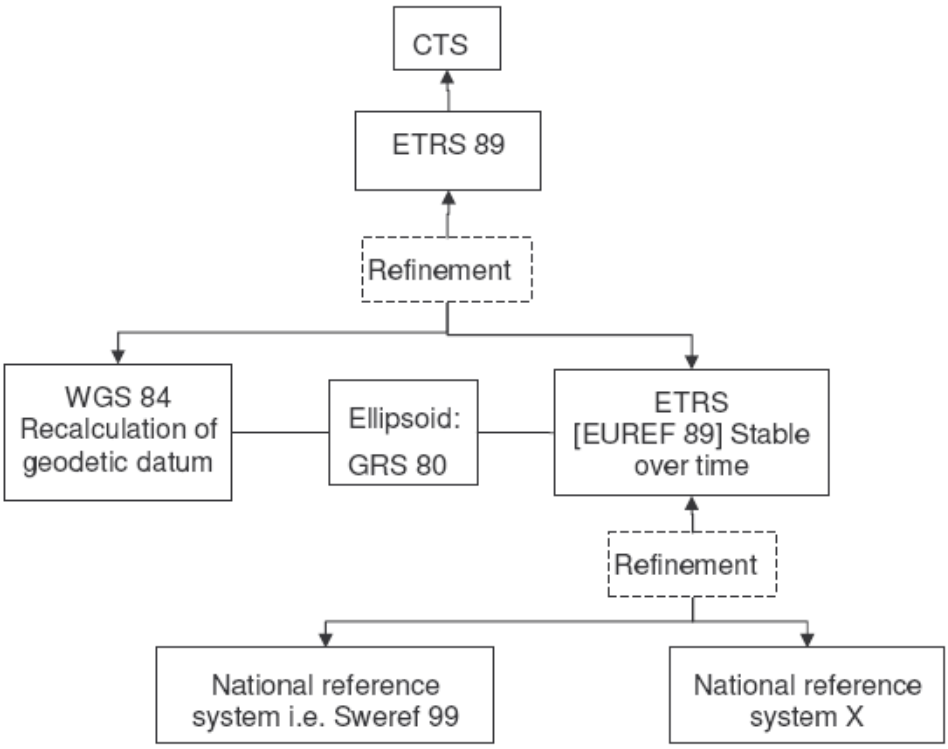

Figure 3-2: Choice of geodetic reference systems

3.2.2 Indirect reference systems

Linear reference systems

When using road data it is often practical to express the position of an object as an absolute distance or a relative distance from a known crossing/junction, milestone etc.
In some European countries there is an existing linear system (LRS) that is physical secured by the use of mile poles/milestones (kilometre poles).

3.3 Data exchange

Important work directives of the project were:

– The road data exchange format must be able to handle both complete data sets and just data changes (transaction handling)
– It is important to solve border linking (the merging of adjacent road datasets)

3.3.1 Road network model

Road network information model

The road network information model expresses the various road data concepts in a formalized way using application schema rules from ISO 19100 in order to create a "unified and harmonized road data language". Using these rules means in practice to create application schemas using the UML language defining classes that represent the various concepts from the EuroRoadS domain. This is fundamental for exchanging data.

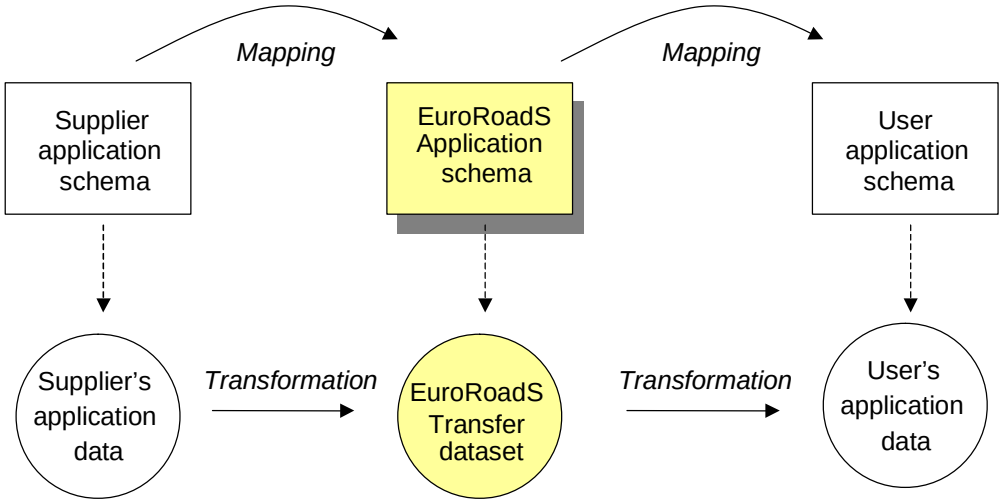

Figure 3-3: Use of application schemas when exchanging data

Road network model requirements:

– Support existing road data solutions (e.g. at public authorities).
– Topology/geometry and only geometry.
– Linear referencing and geometry attributes.
– Stable identities when changes occur.
– Support possibility to supply attributes only (properties are connected to the road network using linear referencing).

Unique universal identifiers (UUID/GUID)

Unique universal identifiers (UUID/GUID) are used in the EuroRoadS specification framework to secure that each element can be properly addressed. This will require each content provider to keep track of two identifiers within their system. Their own initial identifier of the object from the own system, and a EuroRoadS identifier that will be supplied with every delivery within EuroRoadS.

EuroRoadS exchange format

When providing data in EuroRoadS format, each content provider will need to transform their data according to the EuroRoadS representation. If the mapping needed is complex – direct (1:1) mapping impossible - it will obviously be difficult to keep track of identifiers.
Data users may also need to transform data received, in the EuroRoadS format, according to their own data model.

3.3.2 Core European road data - Road attributes and features

Core European road data includes a definition of referred road network and a specification of common features (feature catalogue). It also contains specified generalisation rules for the road network and rules for edge matching at nation and dataset borders.

Attributes and features

There are three types of road network attributes and features:

– **Mandatory attributes**
– Data that must be given in an exchange file. *(Geometry, Universal ID (UUID/GUID), Form of Ferry, Form of Node, Form of Way, Functional Road Class)*

– **Optional attributes and features**
– Optional data that have common descriptions. *(some examples - Border Node Information, Manoeuvre, Grade Separated Crossings, Number of Lanes, Junction Information, Object Identification, Restrictions for Vehicle, Road Number, Road Width, Road Surface, Speed Limit, Steep Gradient)*

– **User defined attributes and features**
– Possibility to define and supply unique data

Definitions have been reused from GDF, RADEF, existing national road database solutions and results from the Speed Alert project (Speed Limit).

There are two different ways described of how to exchange information about roads, one is to attach information as attributes directly to the link and the other is to connect features to the road network using linear referencing.

Border nodes

To be able to handle edge matching at nation and/or dataset boarders a solution for Border Node Information has been specified.

The specification for edge matching:

– Agree on geometry for the border (neighbours need to communicate and agree with each other)
– Identify roads that cross the border
– Add a node attribute to each border node

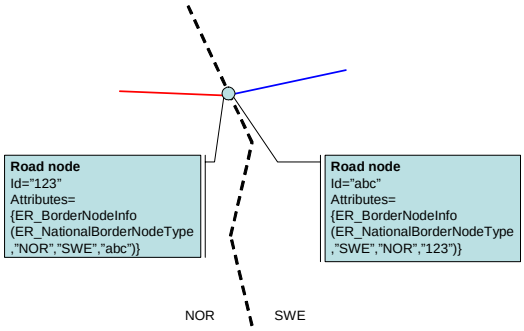

Figure 3-4: Edge matching – border nodes

3.4 Use of the specifications

Organisations that would like to use the specifications and supply a EuroRoadS exchange file, needs to:

– For the purpose of data exchange, transform selected data sets in accordance to the EuroRoadS framework specification (mapping data)
– Adjust data at borders ("talk to the neighbours")
– Transform coordinates to a common coordinate system (projection) based on ETRS89
– As the EuroRoadS specifications are rather open and flexible it is advisable to document how the specifications are to be used (profile)

The efforts depend on how existing data is structured and stored !
If the mapping of data is complex it will probably be difficult to produce change transactions when exchanging updates.

4. EXPERIENCE FROM PRACTICAL USE OF THE SPECIFICATIONS

As the EuroRoadS specifications consist of both information models (conceptual) and implementation specifications (GML based exchange formats) there was a need to verify the usefulness of the framework of specifications. The verification of the project results has been carried out by tests and demonstrations.

4.1 Test and verification in the EuroRoadS project - Demonstrations

Test and verification were carried out at four test sites - Austria, Bavaria, France, Sweden-Norway (edge matching).

Objectives for the test and verifications were:

– Demonstrate and validate the use of the EuroRoadS specification framework.
– experiences with transfer and use of similar data from different public sources
– experiences with metadata and related services
– Demonstrate a complete data chain from data acquisition to final services.
– show case for a concrete data chain from end to end with one application operating in different test fields based on the respective supplier's data
– Support dissemination and networking through concrete implementation results.

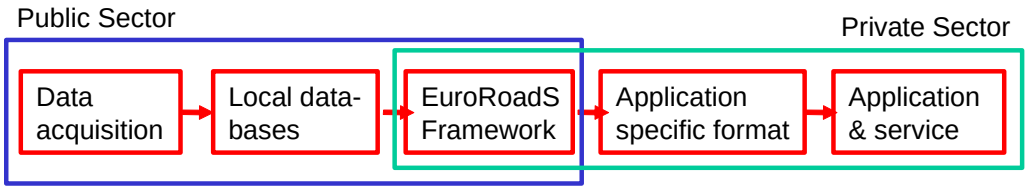

Figure 4-1: the euroroads data chain from data acquisition to final services

Speed limit data was chosen as show case for the information chain and it was tested in a mobile end-user application providing speed limit information while driving ('SpeedAdvice').

Figure 4-2: speedadvise test application

The information model offers different levels and possibilities to suppliers for delivery of their data (network and speed limit). You can either chose to use the specifications in a "selective" or "exhaustive" way.

Test sites France and Austria – "selective" use of EuroRoadS content:

– EuroRoadS provided speed limit data are transferred from supplier to third party map for the application

– Low level road network description sufficient

Test sites Bavaria and Sweden-Norway – "exhaustive" use of EuroRoadS data set:

– Transferred data - road network and speed limits - are used in final application

– More complete road network description needed than for the "selective" use scenario

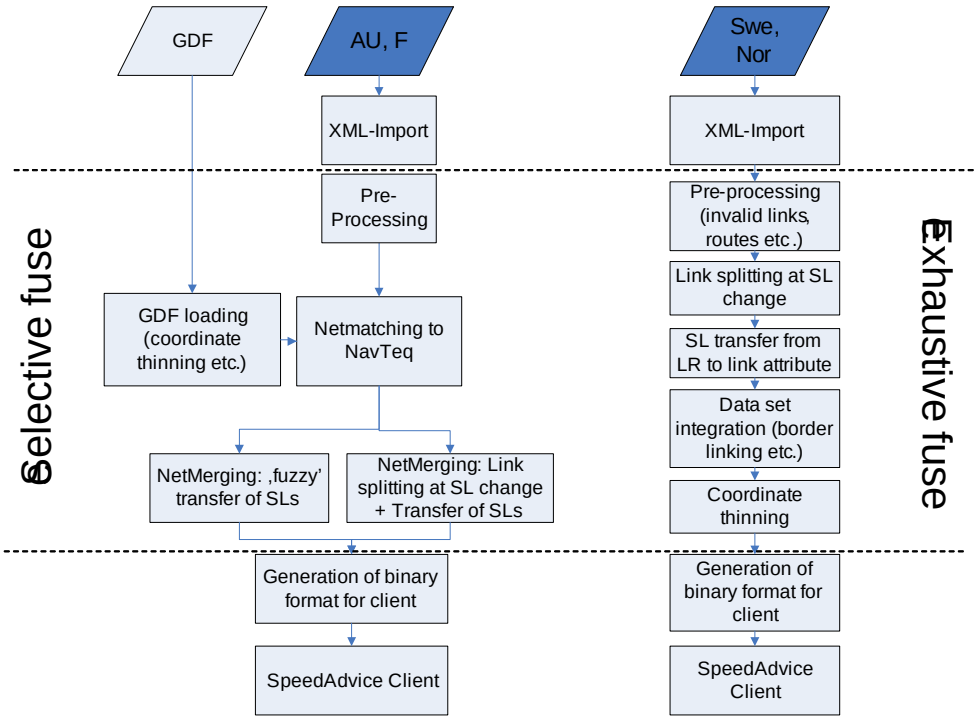

Figure 4-3: Processing steps – "selective" and "exhaustive" use.

Some lessons learned from using the specification framework within the EuroRoadS project demonstrations:

– EuroRoadS framework documents generally of high quality, documentation is consistent

– Concepts of the information model are well described

– EuroRoadS exchange format (GML) for complete data sets covering large areas leads to very large data volumes.

– Information model for network description offers a lot of flexibility and liberty for usage/interpretation by supplier:

– Low entry barrier for supplier with regards to data model and mapping issues
– Currently harmonisation effort on the data user side if different suppliers are used as input
– Balance for harmonisation of supply side and use side efforts to be found
– Processing steps and effort depends on
– The supplier information model and the target application model
– Supplier model differs for demonstrator for each supplier!
– Use scenario: “selective” vs. “exhaustive”
– Selective requires some reference transfer technique: Net-matching introduces some errors
– Data user efforts are increasing as soon as provided data have to be changed for the use in the final application, e.g. link splitting.

4.2 STBR II - Sustainable Transport in the Barents Region, Phase II

Subproject WP 4-1 - Road Information Exchange System (Barents Road Database) – in the STBR II project has had a specifically focus on – “the measures and methods that are needed to make the road and traffic data, stored in national road databases, available to all road authorities in the region, and more generally to other interested parties as well”.

The objective of WP 4-1 was to establish an effective “Barents road data exchange system”. Important work directives of the project was to follow directives on EU-level (INSPIRE) regarding spatial information and to make use of already presented results from the EU-funded EuroRoadS project when handling road network and road data.

The scope of this project was to – in a prototype - introduce harmonised road and traffic data – from Sweden, Norway and Finland - as new thematic information into the existing GITBarents Internet-based infrastructure.

The document “Barents specification of road data” has, to a great extent, been based on the existing specifications delivered by the EuroRoadS project. To get the expected functionality in the Barents Road Data Base a few more features were added and for some existing features clarifications of definitions was needed. The specifications of the added features and the clarified definitions will be sent to the EuroRoadS Forum as a proposal for extension and update of the EuroRoadS specifications of core data.

The project has only dealt with the initial data delivery and the focus has been on harmonisation and mapping of existing national data to the core data specifications.

Some lessons learned and some conclusion from this project:

– Considering the complexity of the needed mapping descriptions it is obvious that the ability to map existing data into the extended EuroRoadS specifications differs between participating countries.
– This will affect the quality and usefulness of data.
– Delivery of updates will probably be difficult if direct mapping (1:1) is impossible.
– Is important to do further work on the harmonisation.
– It is important remove any uncertainties of how encoding of features and attributes should be done to guarantee quality in data deliveries.
– The INSPIRE directive will probably lead to that all European countries will review their national definitions of road data and hopefully harmonise existing definitions in the national databases.
– When data is visualised in the prototype it was experienced that the level of detail and accuracy differs in the data deliverer.
– There is a need to harmonise policies for data distribution and the rights to use the data among all information providers.
– The question of the role of public authorities in the data refinement has to be addressed.
– Historically public authorities have covered the entire chain from data capture to end-user applications. In the future public authorities probably will focus on the role as content provider.

5. DEPLOYMENT AND DEVELOPMENT OF THE FRAMEWORK

5.1 EuroRoadS contribution to INSPIRE

The EuroRoadS specifications is an important contribution to the work with specifications for transportation networks related to the implementation of the INSPIRE directive.

Road data is important as a basis for e.g. transport planning, measurement of environmental influence of traffic, safety, pricing.

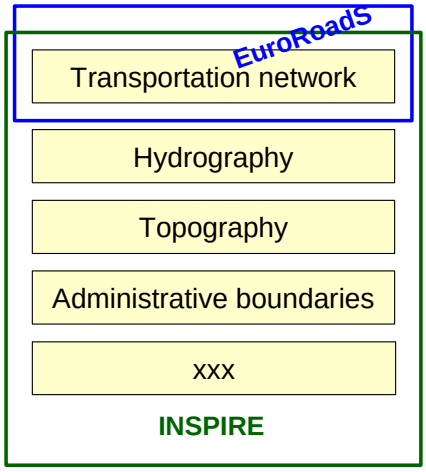

Figure 5-1: Road data is a part of "Transportation network" in the INSPIRE perspective.

5.2 Need for extensions and development

Some proposal for extensions and development.

5.2.1 Core data

Added features and clarified definitions from the Barents-project need to be processed and decided updates of the EuroRoadS specifications of core data must be added.

5.2.2 Reference systems

Map-based on-the-fly location referencing

To make road data useful to third party map providers it is in most cases important to be able to use some "map-based on-the-fly location referencing" – Net–matching caused some problems in the test sites.

The EuroRoadS specifications need to be extended with e.g. AGORA-C, Location Code to increase the hit rate.

REFERENCES

EuroRoadS deliverables:
Wikström L., TRIONA AB: "D6.3 Road Network Information Model", 19/10/2006
Svärd T., National Land Survey of Sweden: "D6.5 Final specification of core European road data", 17/10/2006
Kaufmann T., Wiltschko T., USTUTT: "D6.8 Metadata Catalogue", 18/10/2006
Wikström L., TRIONA AB: "D6.10 Road network exchange model", 19/10/2006
Wikström L., TRIONA AB: "D6.11 Final specification of Road network exchange format", 26/10/2006
Haspel U., OBB: "D 6.12 Terminology catalogue", 06/10/2006

Barents deliverables:
Isaksson P., SRA: "Barents STBRII specification of road data", 10/03/2008
Isaksson P., SRA: "Project report: WP4-1 Road Information Exchange System (Barents Road Database)", 10/03/2008

EuroRoadS deliverables can be found at www.euroroads.org
Barents deliverables can be found at http://www.barentsinfo.fi/stbr/documents_stbr.asp

BIOGRAPHICAL NOTES

Per Isaksson was born in 1952. He completed a Master of Engineering degree at KTH in Stockholm (The Royal Institute of Technology) in 1978. He has worked as a data systems engineer at the Swedish Road Administration (SRA) since 1984. His main responsibilities include the data infrastructure and data capture techniques for the national road database (NVDB) and he participates in national standardisation (geoinformation, road construction). He also works as a geodetical surveying supervisor at the SRA. The author is a participant in various EU projects, such as EuroRoadS, FeedMap, Barents STBR II and ROSATTE.

CONTACTS

Mr Per Isaksson
Information Technology - Road Network Systems
Swedish Road Administration
SE-78187 Borlänge
SWEDEN
Tel. +46 243 75620
Fax +46 243 75890
Email: per.isaksson@vv.se
Web site: www.vv.se