ROad **S**afety **ATT**ributes exchange infrastructure in **E**urope

D5.1
Test and validation plan

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Abstract: The ROSATTE Test and Validation Plan describes the processes for verifying and validating the implemented tools and procedures on each test site, tackling quality aspects, user and system requirements, indicators and the respective evaluation methods.

Keyword list: assessment objectives, user requirements, system requirements, indicators, evaluation methods, success criteria, verification, validation, quality, test sites

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List of Abbreviations

AADT	Annual average daily traffic
AC	Attributive Correctness
ACR	Attribute consistency of received road safety features
ADAS	Advanced driver assistance systems
ASFA	Association des Sociétés Françaises d'Autoroutes
AWV	Agency Roads and Traffic
BALI	BAse de données des LImites de vitesses
CGPC	Advisory Board of the Ministry in charge of Transport
CIF	Completeness of a integrated Road Safety Feature
CIS	Completeness of a integrated Road Safety Feature Dataset
CRF	Completeness of a received Road Safety Feature
CRS	Completeness of a received Road Safety Feature Dataset
DSLM	Digital Speed Limit Map
DT	Data Processing Time
DU	Database Up-to-dateness
FL	Flanders
FR	Functional Requirements
GA	Geometrical Accuracy
GA	Start- / Endpoint geometric accuracy
HUD	Head up display
INSPIRE	Infrastructure for Spatial Information in Europe
INTREST	Intermodal Referencing System for Transport Related Data in Bavaria
ISA	Intelligent Speed Adaptation
LA	Local Authority
LROP	Laboratoire Régional de l'Ouest Parisien
MOW	Department Mobility and Public Works
MP	Map Provider
NFR	Non-functional Requirements
NPRA	Norwegian Public Road Authorities
OBB	Bavarian Board of Building
SL	Speed Limit
SRA	Swedish Road Administration
TC	Topological Correctness
TfL	Transport for London
TLRN	Transport for London Road Network
TNE	Transport Network Engine
TRO	Traffic Regulation (legal) Order
UA	Update Service Availability Rate
UR	User Requirements
VMS	Variable-message sign
WSDL	Web Services Description Language
XSD	XML Schema Definition

References

1. EuroRoadS, deliverable D2.2 Report on quality frame for information, T. Wiltschko and T. Kaufmann, 2004. Available from: http://www.euroroads.org/php/documents.php
2. ROSATTE, deliverable D1.1 State of the Art, 2008. Available from: http://www.ertico.com/en/activities/safemobility/rosatte/publications/publications.htm
3. ROSATTE, deliverable D1.2 Requirements and Overall Architecture, 2008. Available from: http://www.ertico.com/en/activities/safemobility/rosatte/publications/publications.htm
4. ROSATTE, deliverable D2.1, Conceptual specification of how to establish a data store, 2009. Available from: http://www.ertico.com/en/activities/safemobility/rosatte/publications/publications.htm
5. ROSATTE, deliverable D3.1 Specification of data exchange methods, 2009. Available from: http://www.ertico.com/en/activities/safemobility/rosatte/publications/publications.htm
6. NextMAP, deliverable 2.2 Final enhanced map database requirements, 2002. Available from: http://www.ertico.com/assets/download/nextmap/2_d22p.zip
7. MAPS&ADAS, deliverable 12.31 Safety Digital Maps Requirements, 2004. Available from: http://prevent-ip.org/en/public_documents/deliverables/d1231_safety_digital_maps_requirements.htm
8. Enhanced Digital Mapping Project, Final Report, 2004. Available from: http://www.nhtsa.gov/DOT/NHTSA/NRD/Multimedia/PDFs/Crash%20Avoidance/2004/FinalRept_111904.pdf
9. Enhanced Digital Mapping Project, Appendix to Final Report, 2004. Available from: http://www.nhtsa.gov/DOT/NHTSA/NRD/Multimedia/PDFs/Crash%20Avoidance/2004/USDOT_EDMapFinalReportAppendix080105.pdf

Executive summary

This document is the ROSATTE Test and Validation Plan, which describes the processes for assessing whether the project fulfils the system and user requirements. It proposes evaluation methods for each of the system and user requirements, including validation indicators that have to be checked.
The test plan gives theoretical background about quality models, quality characteristics and evaluation methods.
Furthermore, this document specifies how to document the changes on the source and target side of the exchange, and how to analyze whether the source and target databases correspond. This test plan gives general guidelines to be applied in each test site.
Finally, the test and validation plan is also aimed at describing each test site, specifying what kind of attributes will be supported on the test site, what areas and which administrative levels are to be involved in collecting the data, what evaluation methods will be applied.
Six test sites will be implemented: two in France, one in Bavaria (Germany), one in Flanders (Belgium), one in London and one joint test site in Norway and Sweden.

1 Introduction

1.1 ROSATTE Contractual References

ROSATTE is a STREP submitted for the call FP7-ICT-2007-1. It stands *for ROad SAfety ATTributes exchange infrastructure in Europe.*

The Grant Agreement number is 213467 and project duration is 36 months, effective from 01 January 2008 until December 2010. It is a contract with the European Commission, DG INFSO.

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1.2 Project Objectives

The ROSATTE project intends to develop the enabling infrastructure and supporting tools that will ensure European access to road safety attributes including incremental updates. This infrastructure will facilitate administrative internal functions as well as supply of data to third parties e.g. for safety relevant services.

The **overall objectives** of the project are to:

1. Facilitate access to, exchange and maintain European-wide core road safety spatial data from national/regional/local sources by standard procedures
2. Enable multi-level aggregation and update of European-wide safety map data
3. Assess the technical and organizational feasibility of this infrastructure

1.3 Key issues / Project scope

Accurate and up-to-date safety related road network attributes are particularly important for efficient road operation and administration, and for safe driving along the European road network.
For data users, the reality today is however a rather complex landscape of multiple data providers, multiple formats, varying availability and quality of data and long delays between data updates. Road authorities and infrastructure operators are usually at the beginning of the information chain, being responsible for the physical implementation, equipment and maintenance of roads.
The major problem is how to ensure timely and easy access to road information owned and maintained by thousands of road authorities. In addition mechanisms are needed to enhance the quality of the available data in terms of accuracy, correctness and up-to-datedness, and to enable multi-level (local/national/European) aggregation of the data. With respect to a future continuous delivery and integration of updates of road attribute data, road authorities that provide such updates will be responsible for the timeliness delivery (within an agreed time period after the change of the attribute on the road), and for the correctness and positional accuracy of the data. Data integrators on their side will

be responsible for correct interpretation of the received data, and correct inclusion in their digital map databases. For certain safety critical attributes, an independent certification body may be created that will be responsible for surveillance of the methods and procedures used.

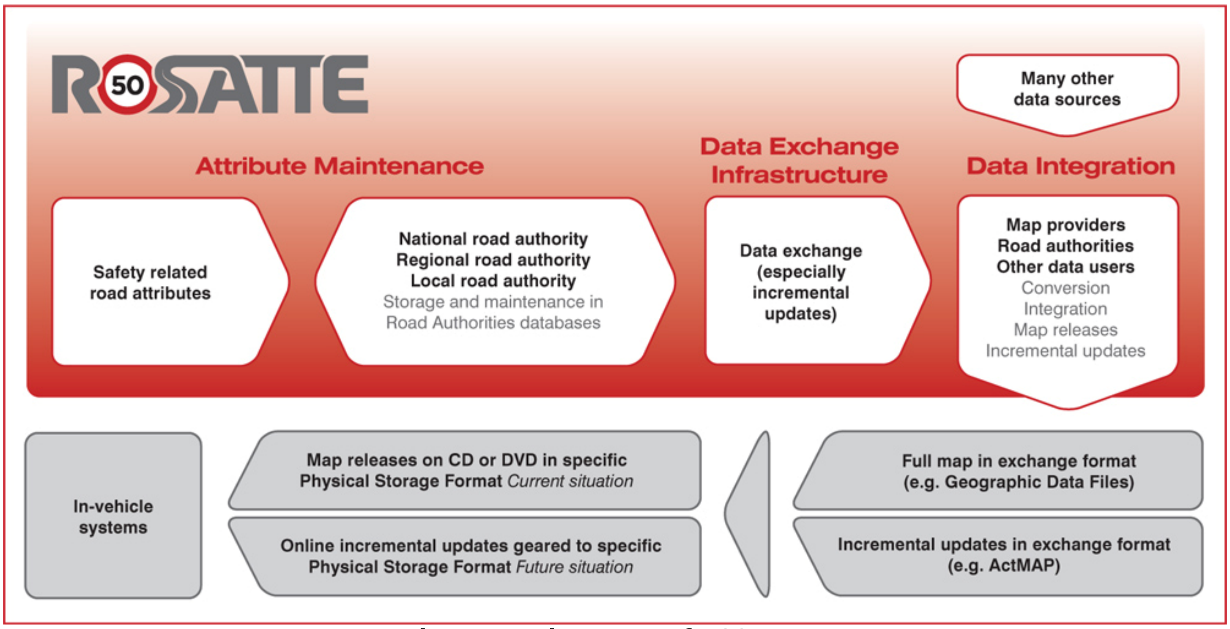


Figure 1 - The scope of ROSATTE

1.4 Purpose of the document

This test and validation plan provides a general framework for the project test period. Its purpose is to define the process that will be conducted to determine to what extent the project has succeeded in meeting its system and user requirements.At this stage of the project, the ROSATTE exchange infrastructure has been worked out, but the test sites have not completely finished their planning. This report has therefore to some degree only a preliminary character.
The test site leaders are responsible to plan and implement all test activities that are to be carried out in their respective test site in cooperation with the WP 5 leader. Each test site will then summarize the results and experiences of the test period in a detailed test report. All these test reports are then aggregated in deliverable D5.4 “Aggregated test report including detailed test reports”.
The test and validation phase is part of the quality management concept. The QM concept based on the six-sigma approach is elaborated at USTUTT and will be described in D5.2 Report on data quality management concept.

1.5 Structure of the document

Besides this introduction part, the document consists of the following chapters:

Chapter 2 – Assessment objectives and approach
This part derives assessment objectives and describes the approach that will be used for the assessment.

Chapter 3 – Assessment method

The main part of the document contains the system and user requirements defined in the previous phase of the project, coupled with the respective assessment methods and indicators.

Chapter 4 – Assessment at test sites

This chapter gives details how the verification and validation is conducted in the different test sites.

Test site	Country	Leader
ASFA	France	ASFA
BALI	France	LROP
Bavaria	Germany	OBB
Flanders	Belgium	FL
Norway / Sweden	Norway / Sweden	NPRA; SRA
London	United Kingdom	TfL

Table 1 - Test sites overview

2 Assessment objectives and approach

2.1 Assessment objectives

The assessment objectives have to answer the following questions, reflecting the project objectives:

1. Does the ROSATTE exchange infrastructure and mechanism facilitate
   - provision of and
   - exchange of

   European-wide road safety data from public authorities to third parties?
2. Does the ROSATTE exchange infrastructure and mechanism enable
   - multi-source integration and
   - updating

   of European-wide road safety data by map integrators?
3. Is the ROSATTE framework technically feasible?
4. Is the ROSATTE framework organizationally feasible?

It is therefore the objective of the project's test and validation phase to

- Assess the data quality along the data processing chain
- Assess the safety attributes exchange process
- Assess the safety attributes integration process
- Assess the publishing process
- Assess the feedback process
- Assess the adequacy between chosen formats and data

Figure 2 illustrates the overall ROSATTE architecture and defines the responsibilities for each work package involved in the maintenance and exchange mechanisms:

- WP2 : Safety attributes maintenance
- WP3: Data exchange infrastructure
- WP4: Data integration at Map Providers side

It describes the chronology of the actions in the exchange mechanism. Arrows indicate data flow, with names corresponding to the described use cases. Thick arrows indicate flow of road safety attributes. The publish-find-bind pattern used in service oriented architectures is illustrated with "1" for publishing, "2" for finding, and "3" for binding.

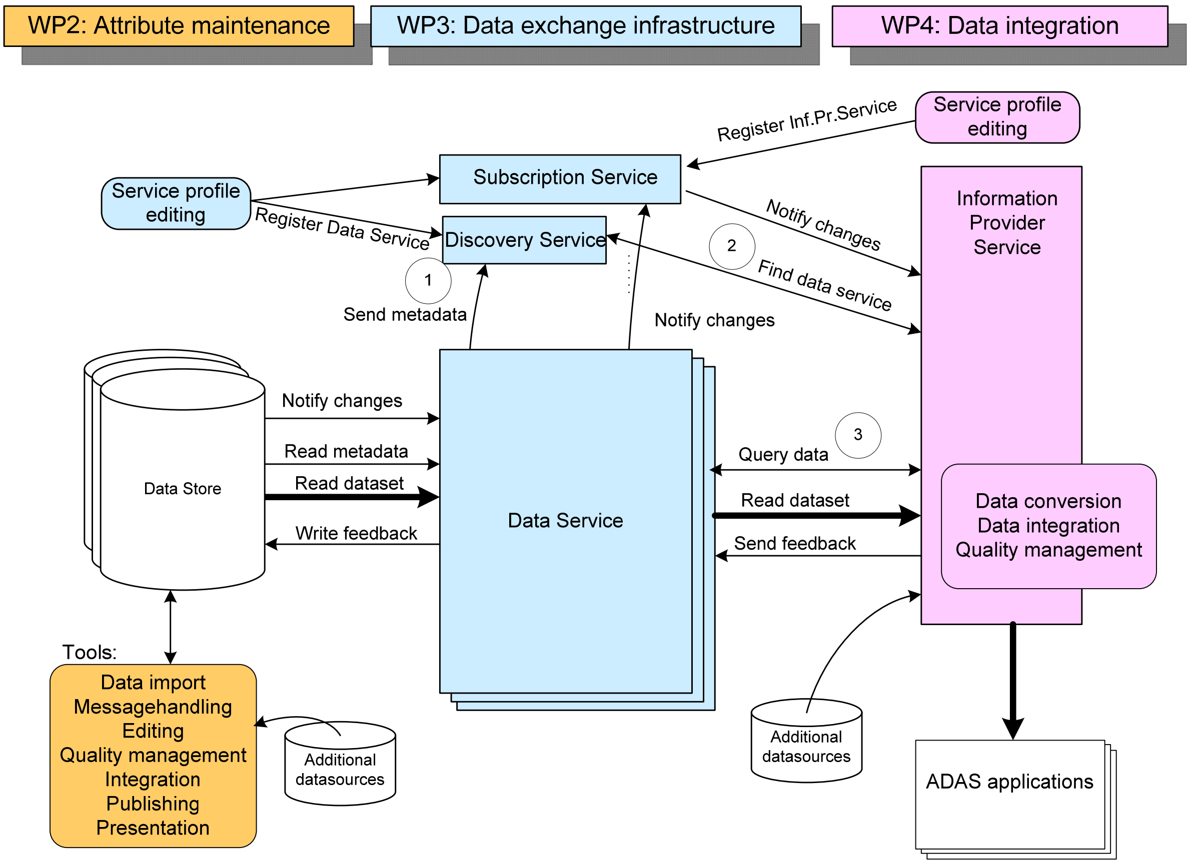


Figure 2 - Components and data flow [3]

The next section will present the assessment approach used to verify and validate the above objectives.

2.2 Assessment approach

The assessment is divided into two parts: verification and validation.

- Verification will concentrate on testing if the implementations fulfill the functional and non-functional requirements, which were derived from the user requirements.
- Validation will determine if and to what extend user requirements are met with the developed ROSATTE framework.

By implementation we mean the components implemented on the providing and receiving sides of the data exchange, symbolized by the light-blue rectangles in Figure 3.

By framework we mean the data exchange architecture and specification as defined in D1.2 [3], D2.1 [4] and especially D3.1 [5], symbolized by the connections in Figure 3.

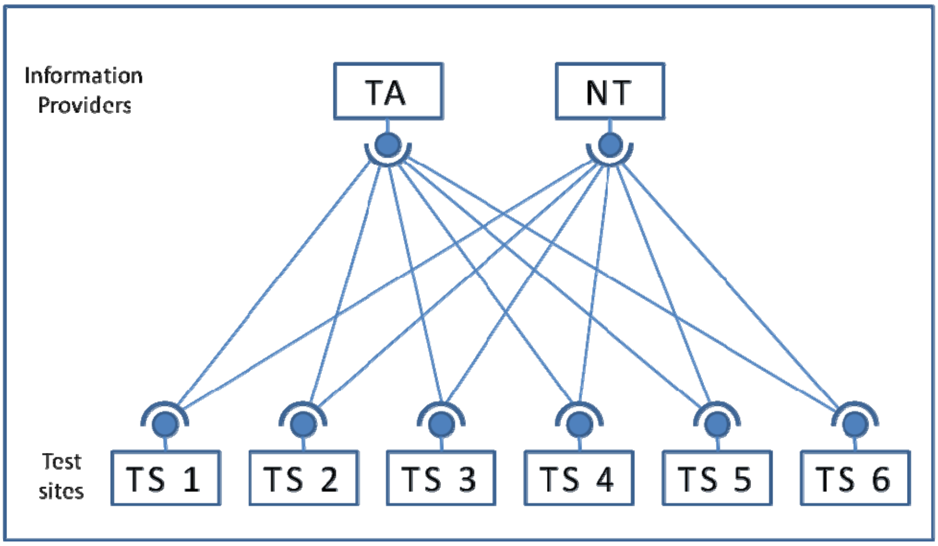


Figure 3 - Assessment approach

As described in Figure 4, the assessment process starts with the definition of the user requirements. They are very general and describe the user's need on the project results. Derived from that, the functional and non-functional requirements specify what the individual project parts have to be able to. After compiling the specifications, the implementation phase can be started at the test sites. During and after the implementation, it has to be verified whether the project fulfills all functional and non-functional requirements. After knowing that the developed infrastructure works, it has to be assessed whether also the user requirements are met. This is to be done in the final validation step. Chapter 3 presents the requirements, the respective evaluation methods and indicators.

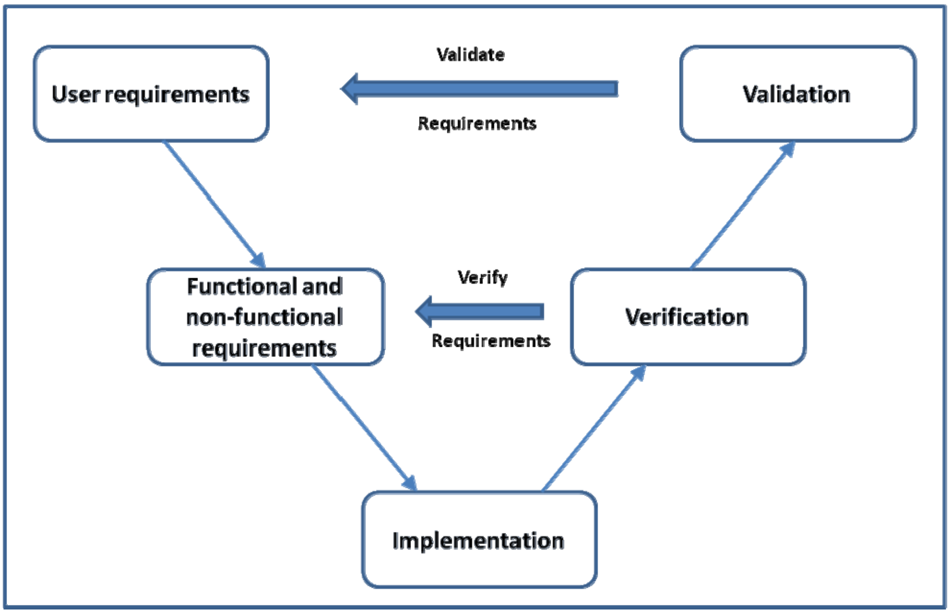


Figure 4 - Verification and Validation process

Chapter 4 describes how the assessment will be conducted at the test sites. The test site will process both, real and simulated data. The usage of real data enables the test sites to demonstrate their full workflow from data acquisition, data maintenance and exchange up to the integration at the map providers. However, the composition of these datasets is very specific to the test sites and not suitable to compare them among each other. Therefore also simulated data will be processed, reflecting several standard scenarios and operations.
According to the defined assessment methods, some of the indicators can be answered by inspection or questionnaire etc. Others require a quantitative assessment. The data needed will be provided by local authorities and map providers in form of shape files containing the processed road safety features and the underlying road network. These files can be compared and the respective indicators evaluated. Additionally, the feedback about the integration status of each processed road safety feature will be evaluated.

The test and validation plan consist of the following components:

- General guidelines to be applied in each test site
- Specification of supported attributes
- Involved areas (test sites)
- Involved administrative levels in each test site
- Compilation of test procedures and evaluation methods
  (what is to be tested and how?)
- Documentation of changes in the source and target database
- Test procedures to check the correspondence of source and target database

As ROSATTE delivers road safety attribute updates that finally are used in end-user applications, the compliance with user needs is of vital importance for the project. Since ROSATTE is based on a very heterogeneous supplier structure, and many of those suppliers already have implemented their data acquisition and data maintenance processes, it is also very important to comply with the needs of the project data suppliers. Therefore, the assessment process should be directed to verify that the final ROSATTE solution for European wide road safety attributes' exchange indeed meets the needs of both the users and key stakeholders. All these needs have been investigated and summed up in the project deliverable D1.2 – Requirements and overall architecture [3]. Chapter 3 shows all requirements with their respective assessment methods and proposed validation indicators.

The project is being regarded successful if it can be shown that the project objectives could be fulfilled by the methods and tools that have been developed and implemented. Not all the objectives have to be necessarily met at all the test sites.

Although big efforts have been made by the partners to implement the full data processing chain as defined during the project, we still could face the situation that at some test sites cannot follow the procedures described in this test and validation plan. From a today's perspective the following scenarios could appear. The respective actions have been defined also in the following.

- <u>Implementation of the process chain not complete</u>
  If the test site implementation is not fully complete (e.g. missing automated location referencing) but still able to produce road safety feature updates that are suitable to be integrated by the map providers, the test processes should be conducted as described in this document, even if manual interaction is necessary.

Otherwise the testing might not be very useful.

- Implementation of the process chain (partly) not working
  If the test site can still provide updates that are suitable to be integrated by the map providers, the testing should be conducted as described in this document. Otherwise the scenarios defined in this document could be used to identify possible problems and try to resolve them.

- Test procedures deliver wrong data format
  Should some of the test sites are not able to deliver the test results in the required data format, they should try to come as close as possible to the format described in this document. Even the provision of a transformation rules could be useful.

- Test scenarios cannot be processed in the required amount, area, feature type, operations, …
  Should some of the test sites not be able to perform the test scenarios in the required way, they nevertheless should try to follow the defined scenario descriptions as close as possible, in order to have at least some results of that test specific test site.

3 Assessment method

For both the verification and validation stage, an assessment method will be defined. Where the assessment method requires quantitative analysis, indicators and the associated success criteria will be defined.

3.1 Verification

3.1.1 Verification of functional requirements

The following table links the functional requirements with the respective indicators and evaluation methods. The functional requirements were defined in deliverable D1.2 [3].

Table 2 - Functional requirements, validation indicators and evaluation methods

ID	Requirement name	Assessment Method	Indicator
FR-1	Data discovery A specification of a Discovery service with metadata shall be available.	*Use case not implemented, but ROSATTE exchange is conceived as INSPIRE conformant. Hence INPSIRE metadata services will be usable for ROSATTE service discovery.*	n/a
FR-2	Standardized access Data Services and their use shall be specified.	Check by inspection: • Is the data exchange specification available and maintained? • Are service descriptors (WSDL, XSD) available and maintained?	Binary: Yes/No
FR-3	Data subscription Guidelines specifying how to subscribe to road safety attributes in the ROSATTE exchange infrastructure shall be provided.	Check by inspection: • If a standardized access method is available and implemented at each test site and on the map integrator side	Binary: Yes/No
FR-4	Specification of Quality management procedures Guidelines specifying how to quality assure received road safety attributes shall be specified.	Check by inspection: • Is there a quality management procedure?	Binary: Yes/No
FR-5	Incremental updates The ROSATTE infrastructure shall provide both incremental updates and full updates of road safety attributes.	Check by inspection: • Whether test sites have been able to supply both full and incremental updates by using the ROSATTE infrastructure	Binary: Yes/No

ID	Requirement name	Assessment Method	Indicator
FR-6	Unambiguous location referencing The road safety attributes provided through the ROSATTE infrastructure shall be structured to enable unambiguous decoding and interpretation of the referenced locations. Different locating methods allowed.	Test if the location referencing method used leads to reliable decoding	Rates for topological correctness (TC) and accuracy (GA) shall be quantified for the different test sites (see definitions in chapter 3.1.2)
FR-7	Data Store initiation The project shall provide guidelines for Data Store design and initiation.	Check by inspection: • Check if data store initiation guidelines are available.	Binary: Yes/No *(Remark: shall be covered by D2.1)*
FR-8	Data import The project shall define guidelines for import of road safety attributes and road network data. If suitable import tools are non-existent, new tools shall be developed.	Check by inspection: • Whether guidelines exist. • Whether import tools exist.	Binary: Yes/No
FR-9	Workflow support The project shall produce a specification of tools and guidelines for integrating data maintenance with legal workflow.	Check by inspection: • Whether tools have been specified and guidelines provided for integrating data maintenance with legal workflow.	Binary: Yes/No
FR-10	Presentation and maintenance tools The project shall develop specifications of how to present and maintain the road safety attributes. If existing tools are not suitable, new tools shall be developed.	Check by inspection: • Whether specifications for presentation and maintenance of road safety features have been developed • Whether suitable tools have been either identified or developed	Binary: Yes/No
FR-11	Feedback loop A feedback channel from information providers back to enacting authorities shall be provided.	Check by inspection: • If a feedback channel has been included into the ROSATTE framework	Binary: Yes/No

ID	Requirement name	Assessment Method	Indicator
FR-12	Integration tools Tools to integrate road safety attributes into existing information providers systems shall be developed if existing tools does not provide the satisfactory functionality.	Check by inspection: • If existing tools with sufficient functionality for integration of road safety attributes have been identified or otherwise have been developed	Binary: Yes/No
FR-13	Flexible type definitions	Check by inspection: • Whether the type definitions are flexible to allow for future extensions and modifications	Binary: Yes/No

3.1.2 Verification of non-functional requirements

The non-functional requirements taken from D1.2 [3] will be verified with quantified indicators as described below. For each of these indicators, a success criterion will be defined with respect to example applications in section 3.3. These success criteria define the level that the respective indicators have to reach in order to be regarded successful. Future implementations of the ROSATTE framework are of course free to use the evaluation methods defined in this document but redefine the success criteria, e.g. from more concrete user requirements.

It has also to be noted that the parameters in this section only describe the influence of the ROSATTE data processing on the safety features. The initial data quality (e.g. depending on the acquisition methods) will not be measured. Respective metadata elements can be used to express the initial data quality.
Since only safety feature updates are exchanged, the results of the validation do only reflect the quality (e.g. accuracy, completeness, up-to-dateness, …) of these update features. Information about the complete dataset at the map providers (e.g. coverage) cannot be given.

NFR-1: Availability

Update service availability rate (UA)

- **Definition**

  The update service availability rate describes how often the services requested by the Map Providers respond. The rate is evaluated as a mean value for every Local Authority-Map Provider combination.

- **Evaluation procedure**

  Map Providers count the total number of update service requests and the number of successful replies. Rate is computed as percentage of performance.

- **Data / Information to be acquired**
  - N_R Total number of requests
  - $N_{U\text{-}rec}$ Number of received road safety feature updates at map providers

- **Computation**

$$UA = \frac{N_{U-rec}}{N_R} \cdot 100\%$$

- **Example**

  For only 95 of 100 update requests the local authority server could be reached due to communication problems. In this case, the Update Availability Rate would be:

$$UA = \frac{N_{U-rec}}{N_R} \cdot 100\% = \frac{95}{100} \cdot 100\% = 95\%$$

NFR-2: Up-to-dateness (Validity)

Data Processing Time (DT)

- **Definition**

  The Data Processing Time describes for every Local Authority-Map Provider combination the mean time that is needed to process a road safety feature update from the first database input to the final integration into the map providers' databases.

  Remark

  The time for data acquisition and internal processing at the local authorities will not be considered here since the local authorities are fully responsible for the duration of this process and ROSATTE as a project has no influence here.

- **Evaluation procedure**

  Local authorities store the timestamp T_{LA} when a new road safety feature update has been entered into their database. Map providers will also record the timestamp T_{MP} when they have integrated the respective update.

  The individual processing times can be evaluated for a complete set of updates for each test site – map provider combination.

- **Data / Information to be acquired**
  - T_{LA} Local authority timestamp
  - T_{MP} Map provider timestamp

- **Computation**

$$DT = \frac{\sum_{i=1}^{i=N_{U-\text{int}}} T_{MP,i} - T_{LA,i}}{N_{U-\text{int}}}$$

- **Example**

  DT_i=18.02.2010 22:30 – 18.02.2010 10:45 = 11:45

- **Remark**
  - The processing time mainly depends on the update cycles of the respective databases.

NFR-3: Completeness

Completeness of a received Road Safety Feature (CRF)

- **Definition**

  This parameter describes whether a Road Safety Feature received by the map providers contains all mandatory attributes according to the specification (individual attributes depend on the type of Road Safety Feature).

- **Evaluation procedure**

  USTUTT compares the attribute tables of each update feature from the local authorities' and map providers' shape files whether all expected attributes are filled in. If at least one mandatory attribute is missing, the complete update feature is regarded as not complete.

- **Data / Information to be acquired**
  - $N_{U\text{-}rec}$ Number of received road safety feature updates at map providers
  - $N_{UR\text{-}cmpl}$ Number of complete received features

- **Computation**

  $$CRF = \frac{N_{UR-cmpl}}{N_{U-rec}} \cdot 100\%$$

- **Example**

  A map provider receives 50 Road Safety Feature updates, from which 48 are complete. Two feedback messages for the incomplete features will be generated and send to the local authorities and the evaluation body. Therefore

  $$CRF = \frac{48}{50} \cdot 100\% = 96\%$$

  of the received features were complete.

- **Remarks**
  - This describes the data inspection that is usually done by the map providers to check the quality of the incoming data
  - The completeness of non-mandatory attributes (e.g. conditions) cannot be checked here, therefore this might be an important issue for the map providers internal quality checks but not as a project evaluation parameter

Completeness of a received Road Safety Feature Dataset (CRS)

- **Definition**

  This parameter determines whether the map providers receive all expected elements of a Road Safety Feature update dataset.

- **Evaluation procedure**

  The number of updates that are entered into the local authority database within the respective test period is documented in the respective shape file to be provided by the respective local authority. The map providers will retrieve the updates for the same period. The number of received updates can be derived from the feedback message log since for every received update, could it be integrated or not, a corresponding feedback message will be created and send out.

- **Data / Information to be acquired**
  - $N_{U\text{-}LA}$ Number of safety features in the local authority database
  - $N_{U\text{-}rec}$ Number of received road safety feature updates at map providers

- **Computation**

  $$CRS = \frac{N_{U-rec}}{N_{U-LA}} \cdot 100\%$$

- **Example**

  The local authority enters 50 Road Safety Feature updates into their database. After the internal processing, location referencing and data exchange, the map provider can only receive 45 updates. Therefore the rate of completeness for this dataset is

  $$CRS = \frac{45}{50} \cdot 100\% = 90\% \text{ .}$$

- **Remarks**

  This parameter is especially important to check the ROSATTE update generation at the authority databases. In some test sites at least the legal orders are entered into the database where not the updates but only the complete situation is stored. ROSATTE update messages are then created either regularly or on demand and provided to the map providers.

Completeness of a integrated Road Safety Feature Dataset (CIS)

- **Definition**

  This parameter determines the number of updates that could be integrated into the map provider's database. Compared with the number of safety features that were provided by the local authority, this parameter expresses the loss of safety features during the ROSATTE data processing.

  Assuming the local authority provides full coverage of updates, this parameter also reflects the coverage of objects in the map provider database.

- **Evaluation procedure**

  The number of updates that are entered into the local authority database within the respective test period is documented in the respective shape file to be provided by the respective local authority. The number of integrated features at the map providers can be determined from the map provider's evaluation shape file.

- **Data / Information to be acquired**
  - $N_{U\text{-}LA}$ Number of safety features in the local authority database
  - $N_{U\text{-}int}$ Number of integrated road safety feature updates at map providers

- **Computation**

  $$CIS = \frac{N_{U-\mathrm{int}}}{N_{U-LA}} \cdot 100\%$$

- **Example**

  The local authority enters 50 Road Safety Feature updates into their database. The map provider can integrate 48 updates. Therefore the rate of completeness of integrated features is

  $$CIS = \frac{48}{50} \cdot 100\% = 96\% \ .$$

Completeness of a integrated Road Safety Feature (CIF)

- **Definition**

  This parameter determines the rate to which the integrated updates are complete (i.e. all mandatory feature attributes are present).

- **Evaluation procedure**

  All integrated features have to be checked, whether they are complete. If at least one mandatory feature attribute is not present, the complete feature is considered not complete.

- **Data / Information to be acquired**
  - N_{U-LA} Number of safety features in the local authority database
  - $N_{UI-cmpl}$ Number of complete integrated features

- **Computation**

$$CIF = \frac{N_{UI-cmpl}}{N_{U-LA}} \cdot 100\%$$

- **Example**

  The local authority enters 50 Road Safety Feature updates into their database. The map provider can integrate 48 updates. Therefore the rate of completeness of integrated features is

$$CIF = \frac{48}{50} \cdot 100\% = 96\% .$$

NFR-4: Correctness

Attributive Correctness (AC)

- **Definition**

  This parameter describes whether or not the attributes of the Road Safety Features integrated by the map providers correspond with the attributes that have been inserted by the local authorities.

- **Evaluation procedure**

  Compare individual entries in the attribute tables at local authorities and map providers. If at least one attribute per feature does not coincide between the two attribute tables, then the whole feature is considered not correct.

- **Data / Information to be acquired**
  - $N_{U\text{-}int}$ Number of integrated road safety feature updates at map providers
  - $N_{UI\text{-}Acorr}$ Number of attributive correct integrated features

- **Computation**

$$AC = \frac{N_{UI-Acorr}}{N_{U-\mathrm{int}}} \cdot 100\%$$

- **Examples**
  - A map provider receives a road safety feature update. The feature is of type SpeedLimit and the attribute SafetyFeaturePropertyValue is “72”. Since only values in steps of 10 are allowed, this attribute is considered not correct.
  - A second road safety feature was originally of type Warning Sign – Dangerous Curve, but after the integration step, the type was Warning Sign – Danger and therefore the attribute WarningSignType is not correct.
  - A third road safety feature is of type Maximum Height but the integrated height value is 4.20m instead of 4.10, therefore this attribute is not correct.

Topological Correctness (TC)

- **Definition**

  This parameter describes whether the topological course of the linear road safety feature after the integration corresponds with the original one that was entered into the local authority's database.

- **Evaluation procedure**

  The topological course of the linear feature in both shape files has to be compared. Therefore the corresponding feature course has to be identified in the receiving map. It has to be checked whether the integrated feature follows this course and has the same direction. Deviations in the start- or endpoint are not considered here, they are treated by the parameter "Start- / Endpoint geometric accuracy (GA)".

  In case the two routes deviate from each other, this certain feature is considered topologically not correct.

  Remark:

  If the topological deviation is caused by significant map deviations between the sending and receiving road network, the topological correctness will not evaluated for this feature.

  Since the feature locations in two different road networks have to be compared, this step is done by manual inspection and analysis.

- **Data / Information to be acquired**
  - $N_{U\text{-int}}$ Number of integrated road safety feature updates at map providers
  - $N_{UI\text{-}Tcorr}$ Number of topologically correct integrated features

- **Computation**

$$TC = \frac{N_{UI-Tcorr}}{N_{U-\text{int}}} \cdot 100\%$$

- **Example**
  - If the start point of a feature lies on the other side of an intersection after the integration, the topology has changed and is not correct any more. Figure 5 shows such a case. The red line indicates the road safety feature provided by the local authority. The orange line represents the feature as it was integrated by the map provider. In this case, the integrated feature is too long and ends on the opposite side of the intersection. Therefore, the result is topologically not correct.

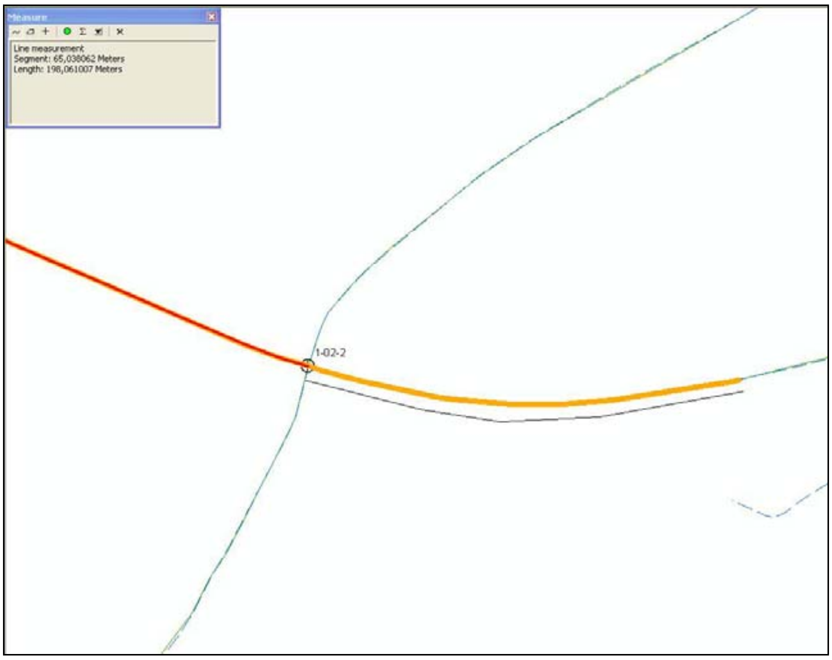


Figure 5- topological incorrect integration

- o Figure 6 shows a significant deviation of the integrated start- / endpoint (orange) from the local authority reference location (orange) but it still lies on the same link. Therefore, the feature is still topologically correct, but the start-/endpoints might have a lower accuracy (see separate accuracy parameter)

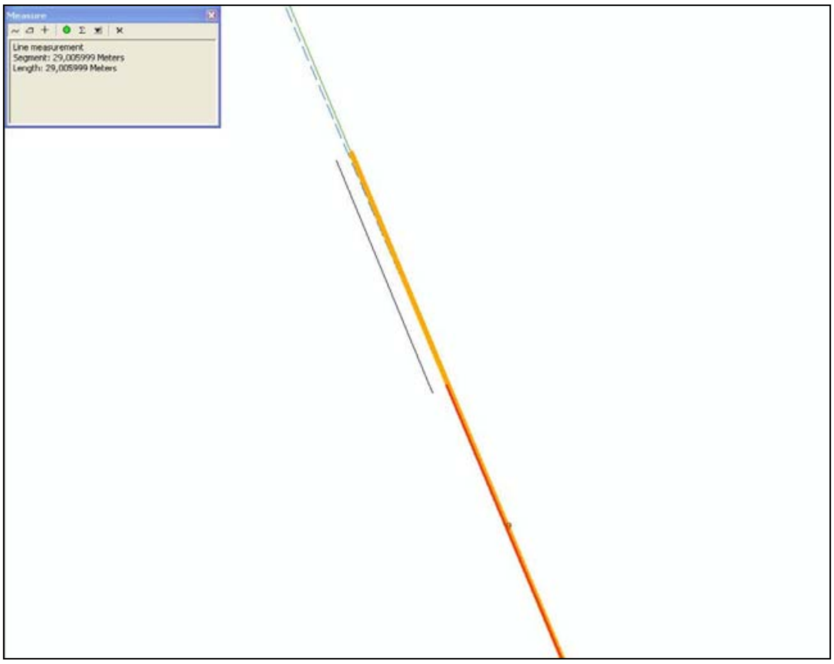


Figure 6 - Topological correct integration

NFR-5: Consistency

Attribute consistency of received road safety features (ACR)

- **Definition**

  This parameter describes whether the attributes of the received road safety features correspond with the data format specification.

- **Evaluation procedure**

  Compare attribute format with data specification and compute ratio number of consistent updates / total number of received updates.

- **Data / Information to be acquired**
  - $N_{U\text{-}rec}$ Number of integrated road safety feature updates at map providers
  - $N_{UR\text{-}Acon}$ Number of attributive consistent received features

- **Computation**

$$ACR = \frac{N_{UR-Acon}}{N_{U-rec}} \cdot 100\%$$

- **Example**

  An attribute is of type numeric, but its value is text.

  A time stamp is stored in seconds, starting on January 1st 00.00.00 1970 (UNIX Time) instead of representing the current date and time in the format YYYY-MM-DD hh:mm:ss.ssss as described in the specification and is therefore not consistent.

NFR-6: Accuracy (i.e. added inaccuracy)

Start- / Endpoint geometric accuracy (GA)

- **Definition**

  This parameter describes the geometrical deviations of the start-/endpoint of a linear Road Safety Feature or of a point feature, respectively, between the local authority and the map provider road network.

  The parameter should be independent from possible map deviations. However, this is not always possible to the full extend, so it is tried to account for map deviations as much as possible.

- **Evaluation procedure**

  In a first step, the “original” location from the local authority network has to be mapped onto the map provider network. This mapped location is referred to as the “reference” location in the following, and has to be differentiated for two situations:

  - **At intersections:**

    Reference location in the map provider network has the same distance from the intersection point as the original location in the local authority map.

  - **Apart from intersections:**

    Reference location point is achieved by orthogonal projection of original location point from local authority network onto map provider network

  Then the reference location point (which represents the original location in the local authority network) and the location integration result are available in the same map provider road network and can be compared with each other. This comparison is done by just measuring the distance between these two points.

- **Data / Information to be acquired**

  - $N_{U\text{-}int}$ Number of integrated road safety feature updates at map providers
  - $D_{LA\text{-}INT}$ Distance between the reference location and the corresponding integration result on the map provider network

- **Computation**

$$GA = \frac{\sum_{i=1}^{i=N_{U-\text{int}}} D_{LA-INT}}{N_{U-\text{int}}}$$

- **Example**

  The Example in Figure 7 shows that the original local authority road safety feature ends at an intersection. The corresponding reference location therefore is the respective intersection in the map provider network, although it significantly deviates from the local authority network by about 11m. Since the map provider's integration result exactly ends at the reference location point, the accuracy parameter in this case would be 0m.

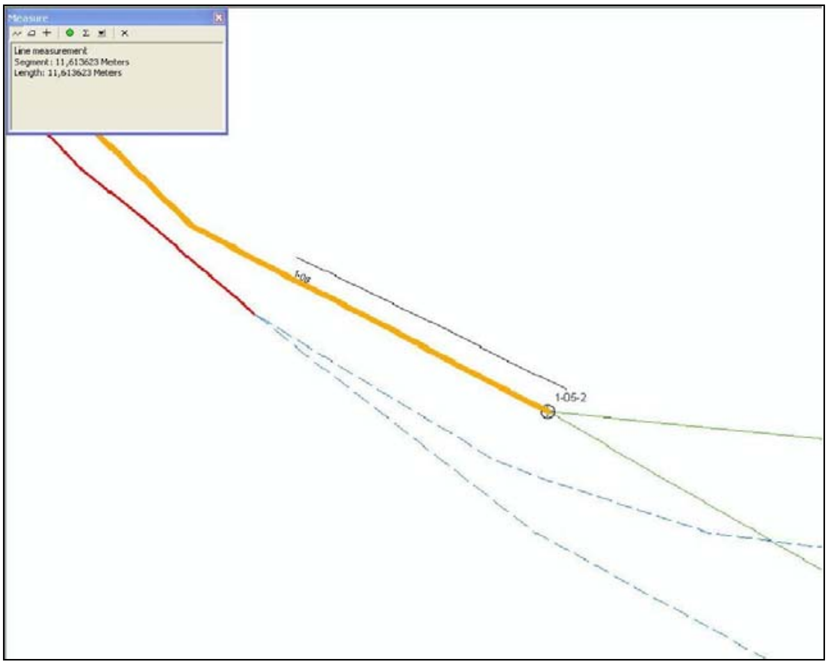


Figure 7- Correct and accurate integration

Optional indicators

Database Up-to-dateness (DU)

- **Definition**

  The road safety features used in ROSATTE change in reality with a certain change rate. The databases involved exchange information with fixed intervals. This parameter describes how many road safety features change within this database update cycle.

  As a consequence, one could find out that the database update intervals are not sufficient to achieve a desired level of actuality / validity.

- **Evaluation procedure**

  Local authorities determine the change rate for the respective road safety attributes. Local authorities and map providers determine how often their databases will be updated / synchronized.

- **Data / Information to be acquired**
  - $N_{U\text{-}LA}$ Number of safety features present in the database
  - N_{RWC} Number of real world changes *(e.g. per year)*
  - I_{CU} (Common) Database update interval *(e.g. in days)*

- **Computation**

$$DU = \frac{N_{RWC}}{N_{U-LA}} \cdot \frac{I_{CU}}{365} \cdot 100\%$$

- **Example**

  For a certain Local Authority, 10 of 1000 speed limits change per year.

  The database update rates are:
  - The local authority database is updated daily.
  - ROSATTE updates are generated from this database every 3 days.
  - Map providers will check for new available updates once a week.

  The lowest update frequency here is weekly, therefore I_{CU} = 7 days.

$$DU = \frac{10}{1000} \cdot \frac{I_{CU}}{365} \cdot 100\% = 0.02\%$$

  This means that 0.02% of the safety attributes for one Local Authority change within the common database update interval of 7 days.

NFR-7: Reduced data update delay

Please refer to NRF 2.

3.2 Validation

In this part, the user requirements previously defined in ROSATTE D1.2 [3] are coupled with validation indicators and validation methods.

3.2.1 Map provider requirements

Table 3 - Map providers' user requirements, validation indicators and evaluation methods

ID	Requirements name	Assessment method	Indicator	Corresponding verification indicator
UR-1	Data discovery: Map providers need to be able to find providers of available road safety attributes.	Use case not implemented (see FR1)	n/a	n/a
UR-2	Data subscription: Map providers need notifications when relevant data changes.	Done in FR-3	see FR-3	FR-3
UR-3	Unified access: Map providers need a unified way of access and retrieval of road safety attribute data across Europe.	Check by inspection: • If map providers can access and retrieve road safety attribute data in a unified way across Europe.	Binary: Yes/No	relates to FR-2
UR-4	Data updates: Map providers need both initial supply and incremental updates of road network safety attributes, expressed according to one unified data model. Updates can be initiated by change notifications from road authorities.	Check by inspection: • If initial supply is supported by the ROSATTE interface. • If incremental updates are supported by the ROSATTE interface. • If change notifications are supported by the ROSATTE interface.	Binary: Yes/No (for each item)	first two covered by FR-5; third covered by FR-3
UR-5	Location referencing: Map providers need a location reference which enables unambiguous decoding and interpretation of the	Calculate a success rate of decoding for all received updates, for each test site.	Location reference decoding success rate (success criteria of TC	relates to FR-6, NFR-4 and NFR-6

ID	Requirements name	Assessment method	Indicator	Corresponding verification indicator
	referenced location.		and GA have to be fulfilled)	
		Determine by inspection for samples of the provided sets of locations from each test site the accuracy in terms of an accuracy statistic.	accuracy statistic (use same indicator as for NFR-6)	relates to FR-6 and NFR-6
UR-6	Quality: Map providers need quality assured data to integrate into their own databases in order to ensure the quality of the end user products	Check by inspection whether quality metadata are provided with delivered data sets	Binary (yes/no)	relates to FR-4
		Check by inspection whether data providers follow defined quality management procedures	Binary (yes/no)	relates to FR-4
UR-7	Update delays: Map providers need notifications and data updates at a rate that is suitable compared to the lifetime of the affected data.	Measure for samples for each test site the time between an update is entered into the local database and its reception by the map providers, and provide statistic	time delay statistic (see NFR-2)	relates to NFR-2

3.2.2 Road authority requirements (data store operator, enacting authority, road network manager)

Note that only user requirements with relation to data exchange fall into the scope of this validation, others are considered outside (i.e. internal to specific public authority operations)

Table 4 - Road authorities user requirements, validation indicators and evaluation methods

ID	Requirements name	Assessment method	Indicator	Corresponding verification indicator
UR-7	Data Store initiation: If missing, road authorities need guidelines for data store design and initiation. (These guidelines are one expected result of WP2.)	Outside immediate validation objectives on data exchange • (D2.1 includes guidelines for data store operation)	none	none
UR-8	Initial Supply/ data import: Road authorities need a way to import road network and road safety attributes from different sources. This includes both the initial supply and updates.	Outside immediate validation objectives on data exchange • (Data supply through ROSATTE implies necessarily that data store exists and was initiated - No further checks necessary) • (D2.1 includes guidelines for data store operation)	none	none
UR-9	Integration of the attribute supply in to the work flow of regulations: Road authorities need a way to integrate data maintenance into the legal work flow, with minimum extra effort.	Outside immediate validation objectives on data exchange • (only relevant for authorities with sourcing linked to regulations)	none	none
UR-10	Data presentation and maintenance: Enacting authorities, data store operators and road network managers need tools for data presentation and maintenance.	Check whether attributes can be viewed in the data store (preferable in a map view) • See Implementation documentation in D2.2 (Could also be considered outside immediate validation objectives)	Binary (Yes/No)	
UR-11	Data publishing, both for the ROSATTE infrastructure,	• Check whether supply to ROSATTE interface	Binary (yes/no)	

ID	Requirements name	Assessment method	Indicator	Corresponding verification indicator
	and for public websites: Data store operators need a data publishing mechanism which is flexible and easy to adapt.	is available (implicit to any automatic data transfer to information providers) • Check whether other publishing mechanism (safety feature maps) are in place		
UR-13	User feedback: Data store operators, road network managers and enacting authorities need feedback from users to improve quality.	• Check whether feedback interface of information providers is implemented and accessible • Collect (written) feedback from public authorities in the test sites if feedback is considered useful	• Binary (Yes/No) • Qualitative feedback (any improvements proposed?)	
UR-14	INSPIRE conformance: INSPIRE has become a directive, and conformance is a requirement for data owners.	Ask independent expert involved in Inspire to review ROSATTE exchange specifications: • Check whether technologies used conform with INSPIRE. • Check whether published data can be used according to INSPIRE specifications. • In case INSPIRE specifications are not clear enough, clarify check if ROSATTE contradicts INSPIRE stipulations	• Positive list of inspire conform aspects of ROSATTE exchange OR • Negative List of aspects which are in contradiction to INSPIRE	none
UR-15	Existing work and standards: To protect investments, ensure acceptance, and save time and effort, work should build on existing work and standards.	This step was undertaken during the ROSATTE exchange specification phase: • check by inspection (external review) if selection of technologies in D3.1 correspond to INSPIRE	Binary (Yes/No)	none
UR-	Quality management:	• Initiate review by test	Binary	Link to UR-

ID	Requirements name	Assessment method	Indicator	Corresponding verification indicator
16	Data store operator, enacting authorities, road network managers need quality management in order to guarantee the provision of quality assured data.	sites, whether ROSATTE requirements on metadata can be met by their data maintenance operations Could also be considered outside immediate validation objectives on data exchange (Quality management does not influence quality of exchange mechanisms, but that of the exchanged data)	(Yes/No)	13 (feedback as part of quality mgt)

3.3 Example applications and requirements

Road Safety Feature information (e.g. from traffic signs) can be used for a big variety of applications. Some previous research projects have defined requirements on such information, however they only referred to accuracy as this seems to be the most important explicit requirement parameter.

During the NextMAP project, speed limit assistant applications have been discussed, mainly for driver information and warning [6]. The general requirement on the accuracy of speed limit signs was set to 5m, even with a decreasing tendency over time.

MAPS&ADAS used the results and experiences from NextMAP and other research projects and defined speed limits or traffic signs in general as important input for map enhanced driver assistance systems such as WILLWARN, SASPENSE, CURVESPEED ASSIST HOTSPOT WARNING and SPEED LIMIT INFORMATION [7]. However, no detailed requirements on the accuracy of such traffic sign information are provided.

More detailed requirements on speed limit and stop/yield sign locations were defined within the Enhanced Digital Mapping Project (EDMAP) [8]. Especially Appendix B.4 "Summary of Map Database and Vehicle Positioning Requirements" was of interest [9]. All numerical requirements were extracted from the tables in this appendix. A summary is given in Table 5.

Table 5 - EDMap applications and requirements

		Curve Speed Assist	Stop Sign Assist	Speed Limit Assist	Intersection Collision Avoidance	Lateral and Longitudinal Control
Near-term	Speed Limits	5m	-	-	-	-
	Stop Sign	-	1m	-	-	-
	Stop Ahead Sign	-	5m	-	-	-
	Yield Sign	-	5m	-	-	-
Mid-term	Speed Limits	5m	-	-	-	-
	Stop Sign	-	1m	-	-	-
	Stop Ahead Sign	-	5m	-	-	-
	Yield Sign	-	5m	-	-	-
Long-term	Speed Limits	-	-	-	10m	10m
	Stop Sign	-	-	-	1m	-
	Stop Ahead Sign	-	-	-	5m	-
	Yield Sign	-	-	-	5m	-

Based on the information gathered from these previous research projects, the ROSATTE project has categorized possible applications of the ROSATTE data in 3 levels:

1. **Information,**
2. **Warning, and**
3. **Control**

For each of those levels of application, several example applications are listed in the following sections.

3.3.1 Information applications

Speed Limit Assistant:

A 10 m accuracy is proposed in the EDMap final report [8] and its annex [9]. It is subject to the relative speed meaning that the accuracy of a 30 km/h speed zone should be higher than a 120km/h one. Therefore a roughly proportional rule should be used for the accuracy of the different speed limits signs. Considering one second reaction time this would lead approximately to:

30 km/h → 10m accuracy,
50 km/h → 15m accuracy,
70 km/h → 20m accuracy,
90 km/h → 25m accuracy,
120 km/h → 35m accuracy.

Stop and yield sign Information:

This application would only show a stop icon on the HUD as an information to the driver; potentially with some distance information. A stop sign accuracy of 4 m is considered appropriate.

Restriction signs information:

For most restriction signs, the place of the post sign does not matter as the rule applies to the whole road segment in the given direction. This is true especially for the “no Entry”

and "no vehicular traffic" signs. Other restriction signs requirements such as the ones for the "Passing prohibited" can be aligned with the speed limit requirements. The position of navigation signs linked to crossings such as the "forbidden turns" and "turnaround" does not need to be accurate, but the link to which is applies needs to be unambiguous.

Navigation signs information:
This application shows to the driver the navigation signs that are along the road, for example, lane information on a highway or roundabout information. An accuracy of 30 m is considered as sufficient as this kind of information is provided well before the actual point of interest.

Warning signs information:
This application shows to the driver the warning signs that are along the road. Similarly to the navigation information, the accuracy does not need to be very high as this kind of information is provided well before the actual danger.

3.3.2 Warning applications

Curve Speed and speed limit assistant:
Speed limit sign position is 5m Accuracy in the EDMAP report which is seen as very low requirement. A Speed limit sign accuracy of 10 to 30 m is considered more reasonable (see more detailed set of requirements in section "Speed Limit Assistant").

Stop Sign Assistant (Warning):
This application would work together with the stop sign information application. The stop sign accuracy of 2m is considered appropriate for a warning application only based on the map information. The warning would need to be adapted to the deceleration profile of the vehicle in relation with the Stop sign distance/presence information.

3.3.3 Control applications

From a today's perspective, control applications will not only rely on map data. In order to get the most reliable estimation of vehicle state and vehicle vicinity, all available sources of information will be used. Maps might just be one of these sources. The observation of the vehicle vicinity, such as road geometry determination or traffic sign recognition and especially the stopping location may also use video- and/ or infrared sensors.

Curve Speed Assistant:
Speed limit sign position accuracy is not a real issue as the speed limit is normally set at a relatively long distance before the dangerous curve rather it would be recommended that speed profiles with average speed at each shape point should be provided. In this case, EDMAP recommends a shape point accuracy of 1 m.

Stop Sign Assistant:
A 30cm accuracy of the stopping location as well as a 1m accuracy of the stop sign is recommended in the EDMAP report. The stopping location is not mapped as such in the digital maps. However, for this kind of application, a video sensor would locate the stopping location in relation with the information provided by the stop sign location on the map. In this case, the stop sign location accuracy could be relaxed to 2 m.

Forward Collision Warning / Avoidance:
The application focuses on the lane geometry and Lane width accuracy of 50 cm and 30 cm respectively. ROSATTE did not address these attributes.

3.3.4 Summary of requirements

Table 6 gives an overview over all the non-functional requirements defined in section 3.1.2 and allocates the respective success criteria for the different application levels defined above. An Entry level was added to account for the quality of data in non-mature countries at present.

Table 6 - General success criteria overview

Parameters	Entry level	1* (information application)	2* (warning application)	3* (control appl.)
Update Availability	>80%	>90%	>95%	>99%
Up-to-dateness	3 months	Month-week	1 day	1 hour
Completeness	>80%	>90%	>95%	>99%
Completeness of a received feature	>80%	>90%	>95%	>99%
Completeness of a received dataset	>80%	>90%	>95%	>99%
Completeness of a integrated feature	>80%	>90%	>95%	>99%
Completeness of a integrated dataset	>80%	>90%	>95%	>99%
Attributive Correctness	>80%	>90%	>95%	>99%
Topological Correctness	>80%	>90%	>95%	>99%
Attributive consistency	>80%	>90%	>95%	>99%
Geometric accuracy	50m	20m	10m	5m

The accuracy requirements described above can be described even in more detail for the different types of road safety features, as shown in Table 7.

Table 7 - Detailed accuracy requirements per post sign type

	Information	**Warning**	**Control**	**Comment**
Speed limit signs	Speed dependant (1 sec): 30 km/h → 10m accuracy, 50 km/h → 15m accuracy, 70 km/h → 20m accuracy, 90 km/h → 25m accuracy, 120 km/h → 35m accuracy. At least on Highways and main roads with high completeness.	5m	5m plus shape points	Mostly for Speed limit assistant and curve speed assist. Also valid for passing prohibited signs
Stop and yield signs	4m	2m	1m (2m if sensor present)	Mostly for stop sign warning application
Restriction signs	Need coverage, correctness and completeness however there is no strict accuracy requirement.			Dependant on type of signs (segment or intersection restriction)
Warning signs	30m	30m	N/A	
Navigation signs		N/A		

4 Assessment at test sites

In order to compare the added value and the specific circumstances of the test sites the differences and characteristics are presented in this chapter. It shows in particular the:

- Different data that is available
- Different areas / structures of the TSs
- Different national administrative conditions / circumstances

The first part of this section provides an overview, which safety attributes are supported by the respective test site.

The second part gives details about the actual testing and validation at the test sites. The qualitative assessment indicators defined in chapters 3.1.1, 3.2.1 and 3.2.2 will be checked at all test sites to see whether the full required functionality was implemented. The quantitative assessment indicators defined in chapter 3.1.2 will be also validated at all test sites. The individual levels of performance can be derived to compare the test sites.

Table 11 shows the number of safety features that are to be processed by each test site together with their respective type, environment and constellation.

4.1 Supported attributes at the different test sites

The three following tables were already presented in the first ROSATTE deliverable D1.1 - State of the Art [2]. Here they are updated with information from the test sites to show which attributes will be tested on each one of them.

Table 8- Supported attributes at each test sites

Safety Attributes	Example of ADAS application	Change frequency	Supported in the test site					
			ASFA	BALI	Bava.	Fland.	Nor/Swe	TFL
Speed limit	Speed alert	Very high (7-9% /year)	Y	Y	Y	Y	Y	Y
Traffic signs (other than SL)	Enhanced navigation (e.g. truck)	High	N	N	Y	Y	Y	N
Lane information (number, width, divider, connectivity	Lane keeping assistance, Lane departure warning, Curve warning	Medium	N	N	N	N	N	N

Safety Attributes	Example of ADAS application	Change frequency	Supported in the test site					
			ASFA	BALI	Bava.	Fland.	Nor/Swe	TFL
)								
Traffic lights	Intersection assistance	Medium	N	N	N	N	Y	N
Crossings (pedestrian, tram)	Enhanced navigation Vulnerable road-users protection	Medium	N	N	N	N	N	N
Toll barriers, motorway junctions, tunnel access	Obstacles / change of lighting / speed limit / inter-vehicle distance management	Very low (new road or reshaping)	N	N	N	N	N	N
Gradient (slope)	Curve warning Fuel consumption assistance (car and truck)	Very low (new road or reshaping)	N	N	N	N	N	N
Transverse gradient (banking)	Roll-over warning system (truck) Curve warning	Low (new road or reshaping)	N	N	N	N	N	N

Specific for speed limits :

General (implicit) speed limits	National speed legislation. Not necessarily signposted	Supported attribute on the test site					
		ASFA	BALI	Bava.	Fland.	No/Sw	TFL
G.1 - Static fixed - Infrastructure	Speed limits depending on road category (motorway, other road, built up area…).	Free flow section static SL	Y	Y	Y	Y	Y
G.2 - Static	Speed limits that are	N	N	Y	N	Y	N

General (implicit) speed limits	National speed legislation. Not necessarily signposted	Supported attribute on the test site					
		ASFA	BALI	Bava.	Fland.	No/Sw	TFL
variable - Environment/weather	subject to prevailing environmental or weather conditions. E.g. Rain and snow speed limits in France, and dependent on visibility in Germany. Day and night dependent speed limits would also fall under this category.						
G.3 - Static fixed - Vehicle	Vehicle (and equipment) dependent speed limits. E.g., trucks, buses, and use of studded winter-tyres.	N	N	Y	Y	N	N
G.4 - Static fixed - Driver	Driver dependent speed limits. E.g. young drivers	N	N	N	N	N	N

Specific (explicit) speed limits	Local regulation. Signposted	Supported on the test site					
		ASFA	BALI	Bava.	Fland.	No/Sw	TFL
S.1 - Fixed speed limit, signposted - Static fixed	Permanently signposted by means of static road signs. Typical applications are specific speed limits for tunnels, dangerous curves, bridges, and built-up areas.	Y	N	Y	Y	Y	Y
S.2 - Variable speed limit, fixed signposted - Static variable	Speed limits, fixed signposted indicating a variable speed limit. A typical application is a specific speed limit regulation during school hours. Outside the school hours, the default speed limit for the area will apply. The enacted regulation behind a variable speed limit (S2 and S3) is in each case <u>not</u> limited in duration and consequently states no date or time when	N	N	Y	N	Y	N

Specific (explicit) speed limits	Local regulation. Signposted	Supported on the test site					
		ASFA	BALI	Bava.	Fland.	No/Sw	TFL
	it expires.						
S.3 - Variable speed limit, variable message sign **- Dynamic**	Speed limits, posted on variable message (road) signs (VMS), which may be of a permanent or mobile nature. A typical application is speed limits displayed by VMS over motorways to control traffic flow in the case of, for example, bad weather conditions or risk for traffic congestion. Depending in this case on the traffic or weather conditions the displayed speed limits will be variable. The enacted regulation behind a variable speed limit (S2 and S3) is in each case not limited in duration and consequently states no date when it expires.	N	N	N	N	N	N
S.4 - Temporary speed limit, fixed **signposted**	Speed limits, fixed signposted indicating a speed limit restricted to a defined time period. These speed limits can vary depending on the regulation. The enacted regulation behind a temporary speed limit (S4 and S5) is in each case limited in duration and consequently states the date and time when it expires. A typical application is speed limit restrictions during a roadwork, which is predefined to a specific period. Another typical case is during police traffic control or accidents when police or other authorised actor decides to post a specific speed limit until accident area is cleared or traffic control completed.	Y	N	Y	N	Y	N
S.5 -	Speed limits, posted on	Y	N	N	N	N	N

Specific (explicit) speed limits	**Local regulation. Signposted**	**Supported on the test site**					
		ASFA	**BALI**	**Bava.**	**Fland.**	**No/Sw**	**TFL**
Temporary speed limit, **Variable Message Sign (VMS).**	variable message (road) signs (VMS), in case of a temporary situation. A typical application is during road works. As in S.4, the speed limit regulation is temporary, but in this case it is displayed on a VMS to enable different speed limits during and outside working hours. These speed limits can be of stationary or movable nature. The latter enables the signposting through use of VMS sign to "follow" when the roadwork moves along the road. The enacted regulation behind a temporary speed limit (S4 and S5) is in each case limited in duration and consequently states the date or time when it expires.						
S.6 - Recommended maximum Speed - static fixed	These maximum speed recommendations are not enacted regulations but are speed recommendations designed to minimise traffic congestion and enhance traffic safety.	N	N	Y	N	N	N
S.7 - Pre-announcement of speed limits (e.g. towards end of motorways)	Announcing the approach to a speed limit, usually by a fixed signpost with additional text indicating the distance to the actual speed limit.	N	N	N	Y	N	N

4.2 Test scenarios and specification of test samples

The test sites perform two different test scenarios. The normal test site operation is used to process real data from the data acquisition up to the integration at the map providers. The major drawback, however, is that not all test sites might be able to deliver enough data of this kind. Therefore within the second scenario, the simulated operation, all test sites can process and provide simulated updates of a sufficient amount and distribution, so that the results are more reliable than from the normal operation.

4.2.1 Normal test site operation

Normally most of the actual safety features are based on traffic regulations carried out by municipalities, public road authorities or the police. Using these regulations, national or local road data bases are updated using the paper document itself as a script or by using a specific data base for traffic regulations as in Sweden. Usually several persons are allowed to update the national or local data base according to their role and authorization.

From the national or local road data base the safety features need to be uploaded to a ROSATTE data store where they can be used by the map providers following certain specifications and standards.

In a test site operation it is very important to keep control of all the updates or changes in the road data base and to have a rather detailed documentation of the updates.
For example, at the Norwegian part of the Norwegian/Swedish test site the following process is implemented:

- A new instance of the national road data base was created as a copy of the production data base containing the road network and the actual safety features or attributes.
- Every single update is documented with information about the attribute ID, type of change, date from which the update is valid, type of road (national, municipality, private, motorway etc.), road reference (linear reference) and street name. A screen dump showing the location on a map or orthophoto is also delivered.
- A transaction file with the all the updates are manually controlled before importing to a ROSATTE data store (incremental updating).

During the normal test site operation, the test sites process road safety feature updates based on new traffic regulations or other inputs. They can control and document their updates as shown in the example above. For project testing, however, the test sites need to provide their results in the common format as shown in section 4.2.3.

4.2.2 Simulated test site operation

Generally when speaking about static data like fixed speed limits and traffic signs like obligation to stop and other warning signs, there are rather few changes along the road network during one year. To be able to test and validate the data exchange chain in ROSATTE, it is therefore necessary to simulate updating of a certain quantity of different data. This will also give us better control of the updating process, since in a normal situation many persons will probably update the same data base.

The test sites therefore will process simulated safety feature updates along their specific data processing chain and provide the updates to the map providers in the data format that has been specified in D3.1 [5].
Since the location of the road safety feature has probably a significant impact on the location referencing, the test sites should use safety features located in urban and inter-urban areas as well as on motorways.

Tables 6 and 7 show the detailed time planning for the individual test sites.

Table 11 gives an overview on the number of safety features each test site should process in a respective environment and constellation.

Table 9 - Test preparation timetable

Test site	Location referencing encoders implemented	Initial supply available (Local Authority)	Update generation implemented (Local Authority)	Data retrieval and processing implemented (TeleAtlas)	Data retrieval and processing implemented (Navteq)
ASFA	29/01/2010	29/01/2010	29/01/2010	05/2010	07/2010
BALI	06/ 2010 (Setra)	Ready	Regularly		
Bavaria	07/2010	07/2010	08/2010		
Flanders	done	done	done		
London	06/2010	07/2010	07/2010		
SWE-NOR	done	done	done		

Table 10 - Test and validation timetable

Test site	Begin of test and validation at test site (update processing)	End of data processing and provision of validation data (Local Authority)	Initial and update data available for download by Map providers	Deadline for data integration and provision of validation data (TeleAtlas)	Deadline for data integration and provision of validation data (Navteq)
ASFA	05/2010	07/2010	05/2010	06/2010	06/2010
BALI	07/2010	12/2010	06/2010	07/2010	07/2010
Bavaria	07/2010	08/2010	06/2010	07/2010	07/2010
Flanders	04/2010	05/2010	05/2010	06/2010	06/2010
London	07/2010	07/2010	07/2010	08/2010	08/2010
SWE-NOR	03/2010	05/2010	05/2010	06/2010	06/2010

Table 11 - Test Scenarios

Test site	Bavaria	NOR-SWE	London	ASFA	BALI	Flanders	Sum
Insert							
linear speed limits	***100***	***100***	***50***	***50***	***100***	***100***	***500***
Urban	**30**	**30**	**50**	**0**	**30**	**30**	***170***
without conditions	10	10	50	-	30	10	
with conditions	10	10	-	-	-	10	
combination of different conditions	10	10	-	-	-	10	
Inter-urban	**50**	**50**	**0**	**0**	**50**	**50**	***200***
without conditions	10	10	-	-	50	10	
with conditions	30	30	-	-	-	30	
combination of different conditions	10	10	-	-	-	10	
Motorways	**20**	**20**	**0**	**50**	**20**	**20**	***130***
without conditions	10	10	-	30	20	10	
with conditions	5	5	-	20	-	5	
combination of different conditions	5	5	-	-	-	5	
one direction	25	25	15	35	25	25	***150***
both directions	75	75	35	15	75	75	***350***
valid from/valid to	10	10	-	10	-	10	***40***
adjacent features	10	10	10	10	10	10	***60***
overlapping feature	-	15	-	-	15	-	***30***
zones	-	-	-	-	20	-	***20***

Test site	Bavaria	NOR-SWE	London	ASFA	BALI	Flanders	Sum
safety features (other than speed limits)	***25***	***60***	**-**	**-**	**-**	***90***	***175***
Urban	**0**	**20**	**-**	**-**	**-**	**30**	***50***
without conditions	-	20	-	-	-	10	
with conditions	-	-	-	-	-	10	
combination of different conditions	-	-	-	-	-	10	
Inter-urban	**25**	**20**	**-**	**-**	**-**	**30**	***75***
without conditions	25	20	-	-	-	10	
with conditions	-	-	-	-	-	10	
combination of different conditions	-	-	-	-	-	10	
Motorways	**0**	**20**	**-**	**-**	**-**	**30**	***50***
without conditions	-	20	-	-	-	10	
with conditions	-	-	-	-	-	10	
combination of different conditions	-	-	-	-	-	10	
one direction	10	20	-	-	-	30	***60***
both directions	15	40	-	-	-	40	***95***
valid from/valid to	10	20	-	-	-	20	***50***
adjacent features	-	-	-	-	-	-	***0***
overlapping feature	-	-	-	-	-	-	***0***
prohibited turn	-	15	-	-	-	15	***30***
variable message sign	15	-	-	25	-	-	***40***
Modify							
the location (linear features: starting point and/or ending point)	20	25	20	20	20	20	***105***
the feature property value (e.g. speed limit, type of warning sign,…)	20	20	20	20	20	20	***100***
valid from / valid to	10	15	-	10	-	20	***35***
the direction	20	20	20	20	20	20	***100***
the condition	20	25	-	20	-	20	***85***
Delete							
complete objects (all categories)	20	25	20	20	20	20	***125***

4.2.3 Reporting of test results

The local authorities at the test sites will perform the test in a normal and a simulated mode, as described in this section. In order to be able to assess all the results of the different test sites, they have to report the results for both modes with the help of shape files and feedback message logs. This will be described in more detail within this section.

4.2.3.1 Shape files

The map providers will receive the road safety feature updates and process them. Both the local authorities at the test sites and the map providers will report their road safety features in shape files. Each authority / map provider has to provide two kinds of shape files. One containing the road safety features (safety feature layer) and one containing the underlying road network (network layer). The provision of the network layer is necessary to be able to assess the road safety features in their topological context. The network layers will be used for validation purposes only and not disclosed to any other partners or other parties.
Since different operations will be performed during the test period, it is necessary that the safety feature layer shape files are created after the insert, modify and delete operations have been performed. Otherwise the intermediate features cannot be inspected.
The shape files need to have to following format:

1. Network Layer

Geometry

Attributes
- Street name
- Functional road class
- Form of way (u.a. Multiple Carriage way)
- Direction of traffic flow
- Country, State, County, City, …
- Build-up-areas, water, greens,… (for visualization only, not absolutely necessary)

2. Safety Feature Layer

Geometry
- → Polyline / Point

Attributes
- Timestamp (acc. ISO 19103, e.g. 1998-09-18; 18:30:59)
    - LA: time of database entry
    - MP: time of integration
- SafetyFeatureID = ProviderID + ID
- SafetyFeatureTypeCode
- SafetyFeaturePropertyValue
- SafetyFeaturePropertyTypeCode
- Valid from/to
- ConditionSet
- Direction
    - Linear features: Direction information can be derived from Shape-geometry (Order of points)
    - Point features: tangent on the respective link (has to be provided as an shape file attribute since this information cannot be extracted from the shape file geometry)

4.2.3.2 Feedback message log

Since not all evaluations can be based on the shape files (e.g. delete operations), it is necessary that the map providers also log the feedback messages that are created for every road safety feature update that has been processed. The feedback message format has been defined in D3.1 Specification of data exchange methods [5].

4.3 Test site specifics

Based on the previous section all test sites have to perform the verification and validation stage for their specific attributes. The reported results will then be processed, analysed and compared and presented in D5.4. (Aggregated test report).
In this section, the test sites show their specific setup and how they want to conduct the test and validation phase.

4.3.1 Test site ASFA

4.3.1.1 Test site overview

The motorways companies APRR/AREA and COFIROUTE (2200km and 1100 km) have existing road equipment data bases which give the opportunity to test the data chain between infrastructure operators up to map providers for static safety attributes. The implementation will be defined in order to have the best representative and demonstrative quality. In addition to static safety attributes this test will be an opportunity to explore the handling of temporary and dynamic safety attributes within a motorway network environment. This test will concern two different places: on one hand on the A10/A71 Junction (near Orléans, 100 km south from Paris region), and on the other hand on the A43 motorway and tunnels (Alps region).
The A10-A71 junction is particularly interesting because of the widening works of A71 that will be ongoing during years 2009-2010, as they will cause changes in speed limits.
The A43 tunnels allow to access to an interesting case of speed limits succession. Speed limits regulation on this section is controlled by dynamic display systems allowing to adapt easily temporary speed limits in case of a long work period, or dynamic speed limits in case of a specific event.

4.3.1.1.1 Covered area

A10 and A71 are motorways on COFIROUTE network. Just before the A10/A71 junction, the last 6 kilometres on A71 are being widened from 2x2 lanes to 2x3 lanes. The works started in May 2008 and will end in December 2010; they include the modification of the A10/A71 interchange and the creation of a second bridge over Loire river. The speed limits are modified as works progress.

A43 Tunnels of Dullin and Epine is a motorway section on AREA network about 20 km long containing 2 speed limit regulations in each direction and VMS speed limit display systems allowing temporary speed limit regulations.

Figure 8 - The ASFA test site area

4.3.1.1.2 <u>Involved administrative levels in collecting the data</u>

The public authority involved for regulation decisions and associated legal forms is, in the case of French motorways, the county authority depending from the state.
The level involved in collecting the data is, on local level (on network scale), the private motorway company responsible for operating the network.

4.3.1.1.3 <u>Timescale of the test</u>

The test period is fixed to a 3-month period starting in May 2010, exchanging static data and testing the update chain.
The test site part testing temporary speed limit exchange could be led on a 2-week period simulating a work period in one of the tunnels.

4.3.1.2 Aspects of architecture to be validated

In the ASFA test site, the decision to add or modify existing traffic regulations is made by the respective enacting road authority. In France, private motorway companies are responsible for the maintenance of the motorways, including the traffic signs. So the motorway company will install the traffic signs according to the new regulation mentioned above, and they can also use temporary or dynamic speed limits. The company will then update their internal road database accordingly. From that database, the central ROSATTE data store is derived. Using a web service, the ROSATTE updates are made available to the

ROSATTE information providers. Both data store and web services are operated centrally by Autoroutes Trafic for all motorway companies. Figure 9 gives more details about this data flow.

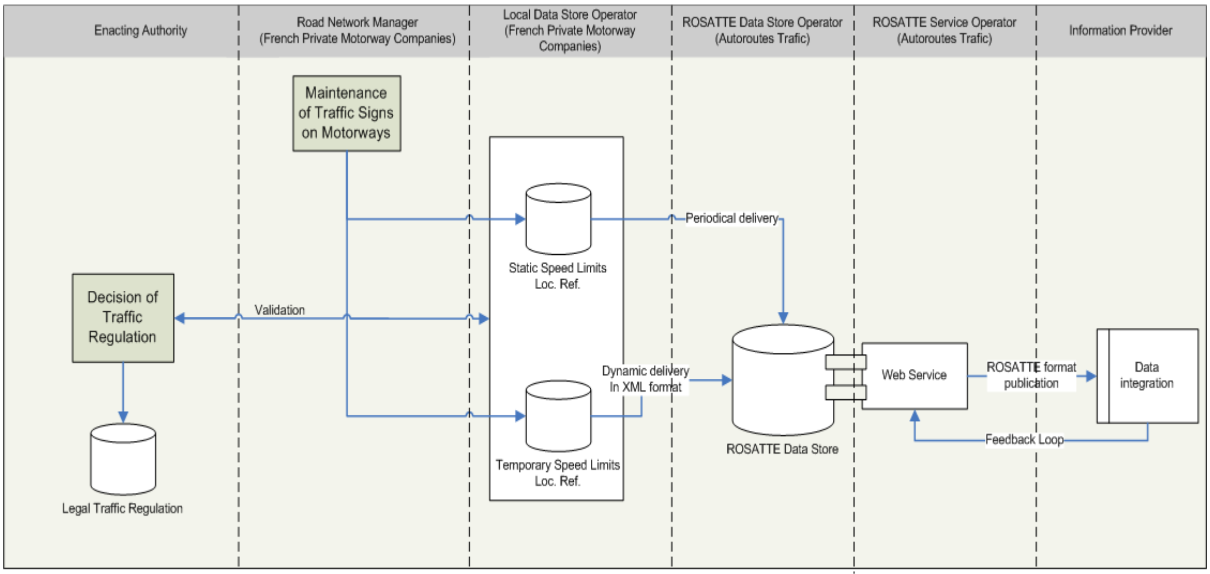


Figure 9 - Data flows for static and temporary speed limit update

The following safety attributes should be supported:

<u>Static speed limits</u>

Autoroutes-Trafic, which is the ASFA entity that manages French motorway static speed limits database, handles a database that lists all static speed limits on motorways free flow sections (as opposed to access and exit ramps) and is able to provide data for a part of the network on a web service or an other media containing geographical coordinates of linear speed limits frontiers.

<u>Temporary speed limits</u>

Such speed limits temporary variations are common on motorway environment and tend to be more and more used. Temporary speed limits conceptual specification needs to include a time characteristic (as starting date and hour and ending date and hour) and its modelling on a map needs to have a variation possibility. It is very important for the network manager to be able to inform road users about the temporary variations of speed limits according to messages on display systems and the radio, to ensure efficiency of traffic management.

<u>Dynamic speed limits</u>

Dynamic speed limits are typically about reductions of speed limits caused by heavy traffic, rain or pollution alerts. The difference with temporary speed limits is that the starting and ending periods are not known in advance. Apart from this, they will be managed like temporary speed limits, with a data feed generated every five minutes from the motorway operator to Autoroutes-Trafic's database.

4.3.1.3 Test site specific assessment objectives

The specific objectives that are going to be validated on the ASFA test site are:

- Build a (common) centralized speed limits data store

- Temporary speed limits handling
- Measure the accuracy and precision of the ASFA data
- Define speed limits maintenance processes
- Create a speed limit demonstrator over the internet
- Be able to publish a data compatible with ROSATTE format for the supported attributes considered (Static speed limit and temporary speed limit)
- Reduce time rate between the change on the field and update notification
- Realize an update containing a timing information that will be reported at the time of its integration

4.3.2 Test site BALI

4.3.2.1 Test site overview

The Advisory Board of the Ministry in charge of Transport ("CGPC") proposed the following statement: "Show how the Speed limit database operates in a pilot district (…) in order to validate planned technical process options (collecting, processing and broadcasting data via the Internet) as well as administrative and legal provisions, (…). The experiment would involve organising and implementing the proposed operational device, on the scale of a district and during a sufficiently long observation period."
This is the BALI project, from the French acronym for "BAse de données des LImites de vitesses" (speed limit database).

4.3.2.1.1 Covered area

The BALI test site takes place in the Yvelines county, in the west of the Paris. Indeed, the previous LAVIA (=ISA) project experiment area was mainly located in this county.
This zone covers a broad range in terms of road environment (urban centres, zones of activities and suburban residential zones, semi-rural or natural zones). The road network of this zone comprises various categories of roads, from urban or residential streets which are limited to 30 km/h and even 20 km/h, and up to motorways (130 km/h).

Road network and traffic of the area (2008):

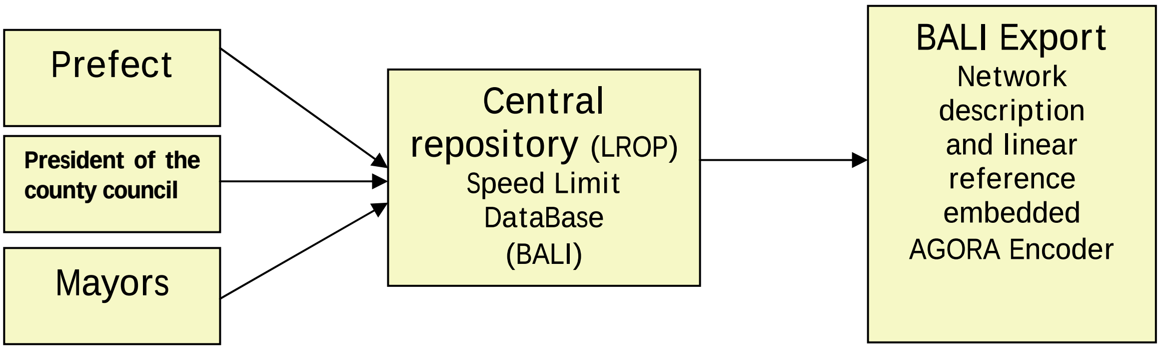
	Number of Kilometres	**AADT (Vehicle / day)**
Motorways	129	63 251
National roads	161	34 212
County roads	1517	5 533
Communal roads	8400	(unknown)

Table 12 - Road network and traffic

4.3.2.1.2 Involved administrative levels in collecting the data

In a county like Yvelines, there are three organisational levels:

- The prefect for the national road network (motorway & national roads)
- The President of the county's General Council for the county roads
- The mayors in built-up areas and communal roads



BALI Data flow

Figure 10 - Components and data flows of the Bali test site

4.3.2.1.3 Timescale of the test

The test period is fixed to a 6-8 month period starting end of 2009, exchanging static data and testing the update chain.
During this period it is foreseen to test the specific BALI developments.
ROSATTE tools and complements will then be added and tested in parallel on a mirror-database to avoid interferences on the first experience but with the same data. It seems possible to make some test with dummy data.
The first draft of the assessment report of BALI project will be available mid- 2010
The complete document will be available three month later.

4.3.2.2 Aspects of architecture to be validated

Figure 11 gives an overview of the BALI test sites architecture. It can be seen, that data from different entities like field surveyors or police authorities are acquired for the BALI database. This data is then made available to the general public as well as to equipment manufacturers.

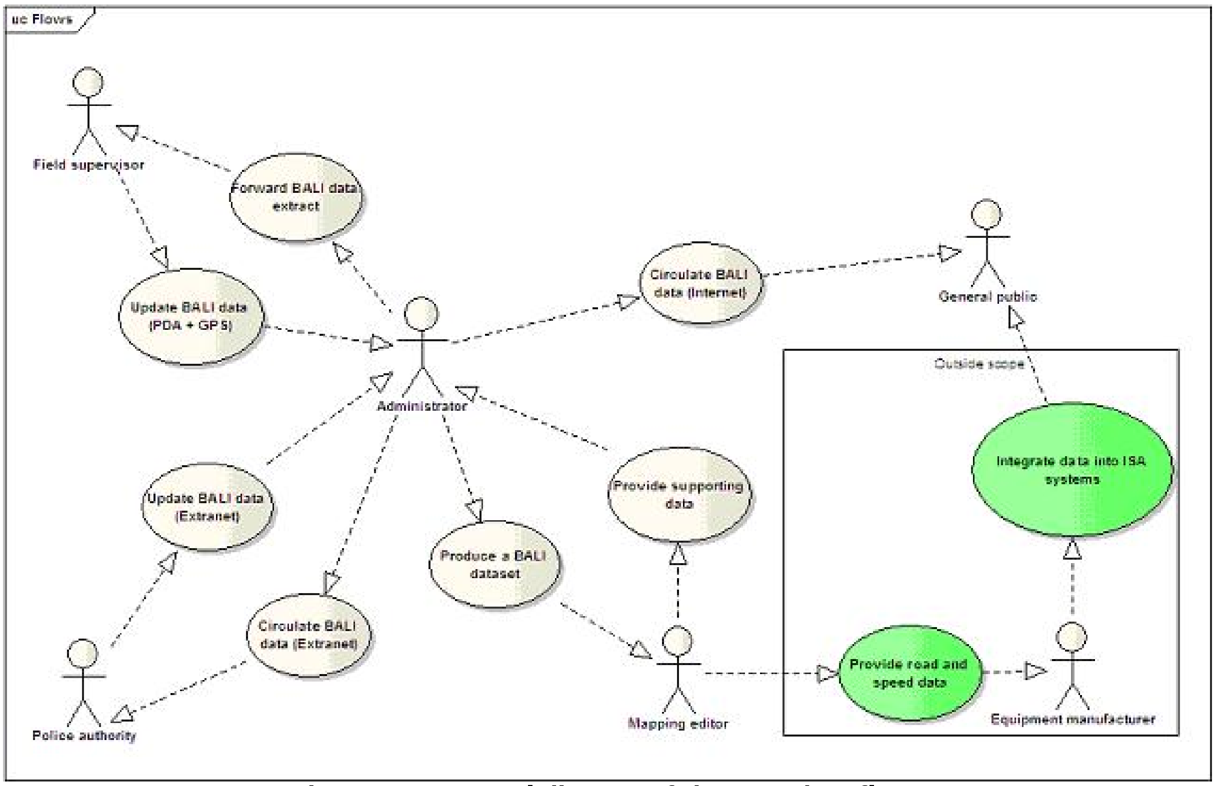


Figure 11 - General diagram of the BALI data flows

4.3.2.3 Test site specific assessment objectives

The objectives are to:

- Evaluate the feasibility to build a national database of speed limits
  How to organize county and national levels?
  To define a technical solution to create, maintain, produce and disseminate a SLs
  And to have Common specifications for this DB on all the road network and urban area
- A limited-scale trial
  To collect data and update the created DB
  To evaluate the needs in terms of human, technical and financial means in order to deploy such a DB at the national level

In the ROSATTE project, we want to:

- test methods and tools developed in the ROSATTE project with the BALI DB including a translator between both formats;
- test the data exchange between Public Authorities and Map Providers (data chain)
- improve consistency and understanding of road signs regarding the infrastructure
- harmonise speed regulations (common frame)
- benefit from the European partners' experience

4.3.3 Test site Bavaria

4.3.3.1 Test site overview

In the test site Bavaria the central repository will be based on the INTREST system. The Georeferencing system and database INTREST is currently running and being operated by the public-private-partnership of the Traffic Information Agency Bavaria (VIB). The system can provide data in different formats such IDF (INTREST data format), shape, MapInfo. Also Specific INTREST content has been converted into EuroRoadS and FeedMAP formats. The database is filled with basic content from NAVTEQ that has been enhanced by additional content, e.g. intermodal information like public transport lines and stops, but also an initial supply for safety relevant attributes. Speed limit information is currently available for the Bavarian highways, the EuroRoadS testsite of Ansbach and the city of Munich. The speed limits are represented as linear features on the road network and also as point objects for the sign. In addition an initial supply from NAVTEQ is available for all Bavaria.

A complete initial supply of speed limits is planned to be executed within other projects. The permanent data supply from the local authorities is up to now not organized.

There are no special tools for updating available yet, so the development of these tools will be the main goal of ROSATTE from the point of view of the Bavarian Road Administration. The special aim of the testsite Bavaria is also to cover the complete data chain from the data delivery by the local authority until data use in a final application.

The testsite partners consist of the Bavarian road authority OBB that will be responsible for conception, organization of data supply and coordination of the partners in the testbed, the local authorities in the model regions, PTV who will take the tasks of software development, data integration and supply of a mobile client for testing and the University of Stuttgart, responsible for quality measurement and assurance as well as for the identification of quality lacks. The commercial mapmakers shall be integrated into the testsite for initial data supply to the central repository, integration of data and use of data in applications and to supply feedback on data usability.

4.3.3.1.1 Covered area

The Testsite in Bavaria shall cover the complete state of Bavaria, but there shall be four model regions for the testing in ROSATTE:

- Ansbach: the former EuroRoads testsite covers all kinds of road types in Bavaria and has rural and urban aspects. A data supply out of EuroRoadS is available there.
- City of Munich in this urban region data from the FeedMAP project is available.
- Berchtesgadener Land: this alpine region has various specialities regarding topography and thus also road signing.
- Cham: this rural region close to the Bavarian forest is very densely populated and has only few signs compared to other regions.

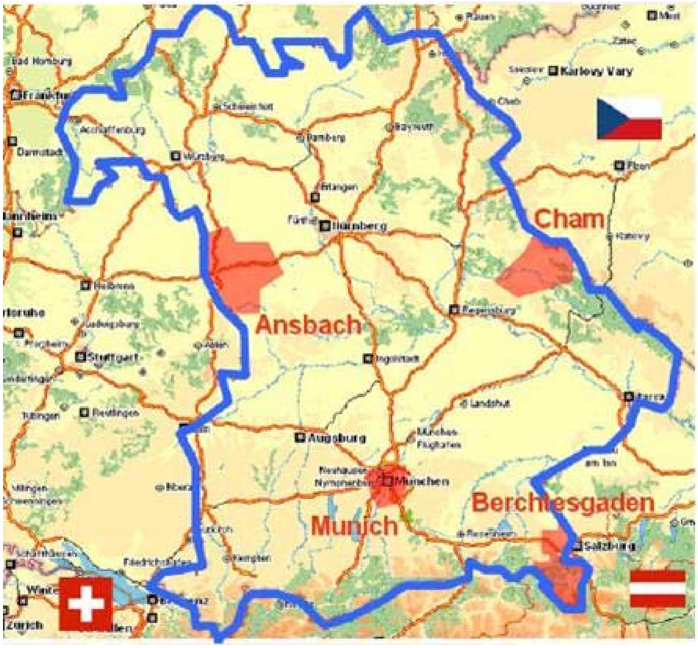


Figure 12 – The Bavarian test site area

4.3.3.1.2 *Involved administrative levels in collecting the data*

Beyond the Bavarian Board of Building (OBB), the highest road authority in the state of Bavaria, the two highways agencies will be involved. In the four model regions it is planned to integrate

- the local road authorities of the State
- district administrations
- district-free cities with an own right for traffic ordering
- at least one major community

4.3.3.1.3 *Timescale of the test*

The exact timescale of the Bavarian test site will have to be defined among the partners, but the tests will be executed within the timeframe defined in the workplan.

4.3.3.2 Aspects of architecture to be validated

The architecture of the Bavarian test site foresees to build up a tool that enables the local authorities to update the central repository due to their administrative orders as soon as they have received the installation feedback from the road maintenance offices on the local level. The central repository has been supplied with an initial dataset coming from implicit regulation of the NAVTEQ map (50 built-up areas, 100 outside built-up areas, 130 recommended ob highways), lists from the Bavarian highway administration, the ZEB field survey of the Bavarian road administrations, and a supply of data from the subordinate road network at least in the model regions.

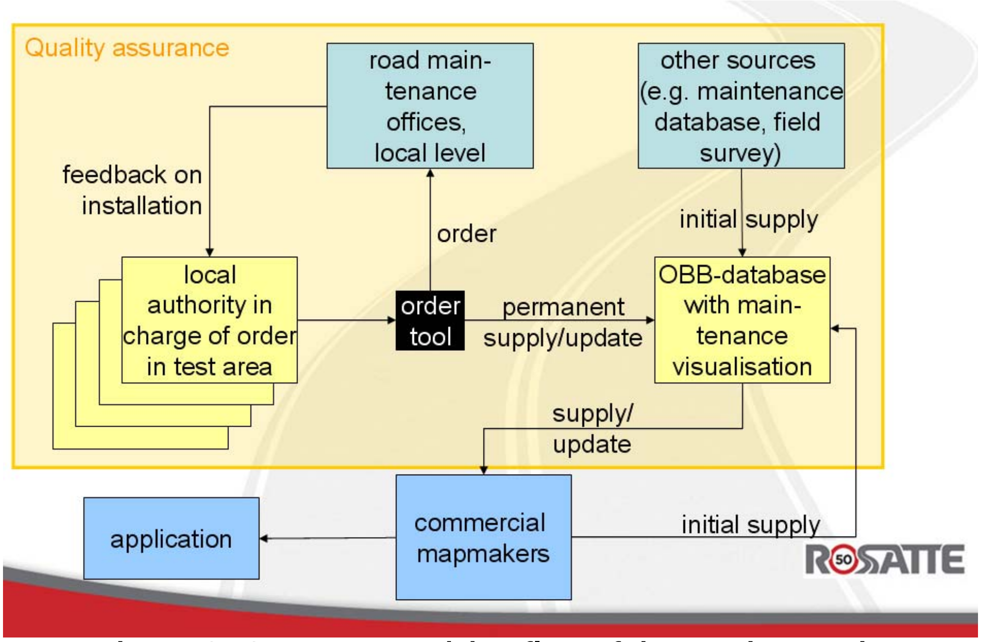


Figure 13 - Components and data flows of the test site Bavaria

The initial data supply will consist of the evaluation of the data from the highway administration, ZEB database and the local level. The information will be collected within standardized forms and then be entered into the developed editing tool for data entering by the Center for Traffic Management (ZVM) together with the local authorities in the model regions.

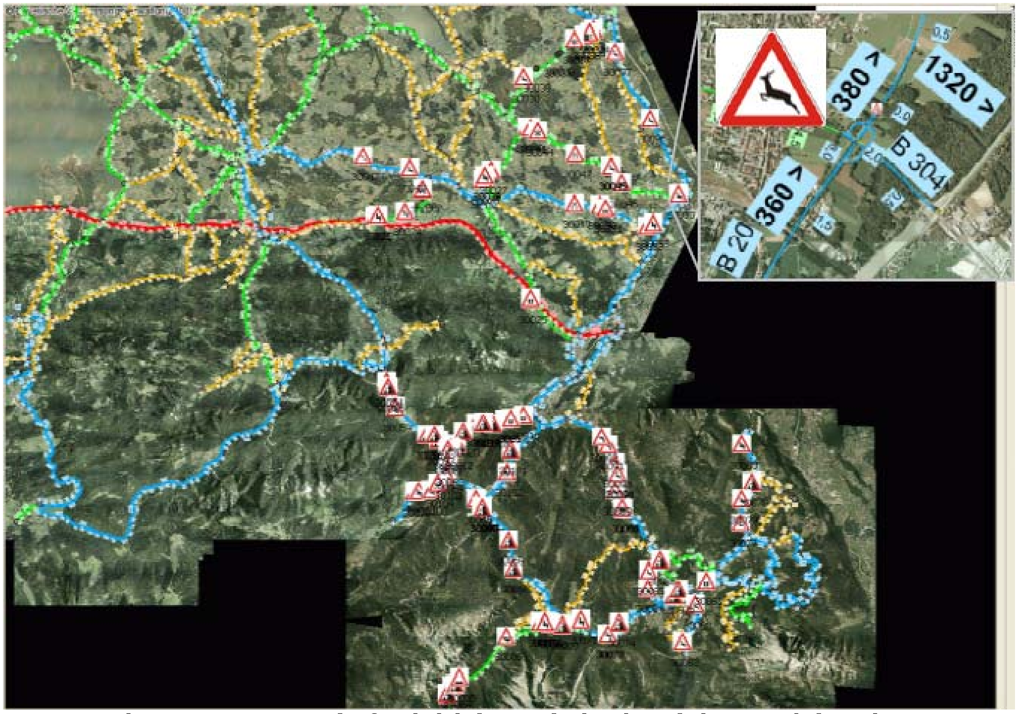


Figure 14 - Example for initial supply in the alpine model region

4.3.3.3 Test site specific assessment objectives

The overall aims for the testing can be summed up like this:

- Enable supply and maintenance of safety attributes in the whole test region. The road attributes addressed in the test site shall be first of all speed limit information but also warning signs like curvy road or rock fall (in the alpine model region) and overtaking bans.
- The quality of the data supply will be tested with the help of additional field surveys in selected areas.
- Test successful workflow from new regulation ordering to central repository and successful integration into map provider data in the model regions
- Test the feedback in case of problems in integration the data into commercial database

Beyond the supply and maintenance of the data, also a visualization of data for administrative purposes is foreseen.

4.3.4 Test site Flanders

4.3.4.1 Test site overview

The Agency Roads and Traffic (AWV) of the Flemish government is building a database of all traffic signs along their highways, main roads and regional roads (about 6500km). Parallel to this inventory, the department Mobility and Public Works (MOW) of the Flemish government is making an inventory of the traffic signs along the other roads in Flanders, mainly local and secondary roads maintained by the provinces or the municipalities and cities (about 54000km).
This AWV database partly exists already. It will be completed by the end of 2010. The AWV database will be kept up to date by integrating the process of the updating of the database in the workflows of the AWV districts.
The inventory of the traffic signs along the municipal roads started in Q4 of 2008 and will be completed by the end of 2010. The municipal traffic sign database will be kept up to date by using the workflow of the ‘additional regulations’ regarding local restrictions that autonomously can be put in place by cities and municipalities.

The existence of both databases creates the opportunity to test the data chain from the road authorities up to the map providers for the exchange of static safety attributes.

4.3.4.1.1 Covered area

The Flemish testsite will be located in the Antwerp region. A closed trajectory of about 30km was selected containing highways, main roads, regional roads and roads under the jurisdiction of the city of Antwerp. By involving the city of Antwerp in the tests, the ROSATTE infrastructure can be tested at 2 organisational levels in Flanders.

Figure 15 - Preliminary map indicating the road network considered in the testsite

The closed trajectory consists of the following roads:
Binnensingel R10 → Plantin en Moretuslei N184 → Betogingstraat → 's-Herenstraat → Blijde-Inkomstraat → Turnhoutsebaan N12 → Carnotstraat → Congresstraat → Constitutiestraat → Regentstraat → Wetstraat → Kerkstraat → Pastorijstraat → Lange Van Bloerstraat → Sint-Willibrordusstraat → Lange Beeldekenstraat → Perenstraat → Duinstraat → Herderstraat → Handelsstraat → Korte Zavelstraat → Gasstraat → Van Kerckhovenstraat → Viséstraat → Trapstraat → Sint-Jobstraat → Essenstraat → Dambrugstraat → Oranjestraat → Lange Dijkstraat → Fuggerstraat → Ellermanstraat → Italëlei N1 → U-turn on Napelsstraat → Italliëlei N1 → Ankerrui → Waaslandtunnel → Halewijnlaan → Blancefloerlaan → Verbrandendijk/Dorpoost/Dorpwest/Beversebaan N70 → Krijgsbaan N419 → E17 (Kruibeke) → R1 → Kennedytunnel → R1 → Gerard Legrellelaan → Binnensingel R10

4.3.4.1.2 Involved administrative levels in collecting the data

Following authorities will be involved in the ROSATTE test site in Flanders:

- Flemish Government = regional authority in Belgium
  - Agency Roads and Traffic
  - Department Mobility and Public Works
- City of Antwerp = municipal authority in Flanders

4.3.4.1.3 Timescale of the test

The test period is fixed to a 3 month period starting in Q2 of 2010, exchanging static data and testing the update chain.

4.3.4.2 Aspects of architecture to be validated

The Central Repository contains all of the traffic signs located along the Flemish road netwerk. The AWV (Agency for Roads and Traffic) database contains the traffic signs along the regional roads and highways, while the municipal database provides information of all the other (lower category) roads. To fill the Rosatte Repository, an extraction of the traffic signs in the testsite area was made (datasets of the city of Antwerp and Zwijndrecht, together with a dataset for the regional roads in the area). The Rosatte Tool

uses the Rosatte Repository to simulate some changes, and to extract incremental updates, in order to provide them to both map makers. Figure 16 gives an overview.

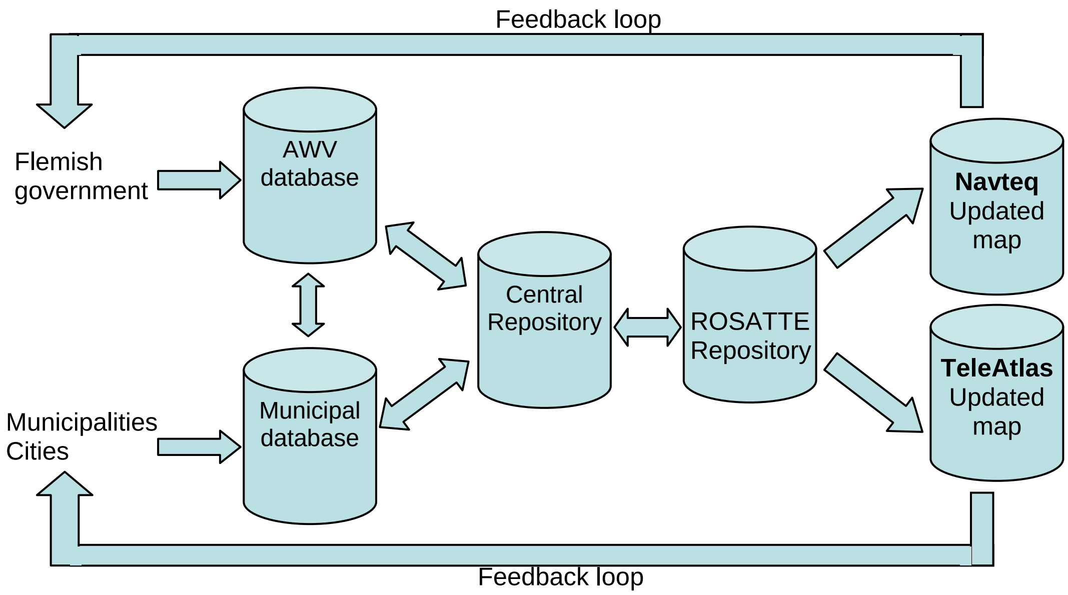


Figure 16 - Components and data flows of the Flanders test site

4.3.4.3 Test site specific assessment objectives

The aim of the test site is to demonstrate agreed working methods, and test the instruments and data exchange mechanisms that will be elaborated. Parties on different level will perform updates in their own system, and the resulting data should be properly propagated, integrated (for assuring a coherent traffic management) and forwarded to the map makers. All authorities will receive access to the integrated information in digital map format at an appropriate level, in order to view and validate all updates performed.
In fact this means that following aspects of the data chain will be tested:

1. change of traffic sign along regional road
   → central repository should be updated
   → ROSATTE repository should be updated
   → the same update should appear in the maps of the map makers
2. change of traffic sign along a road of the city of Antwerp
   → traffic sign database of city of Antwerp should be updated
   → central repository should be updated
   → ROSATTE repository should be updated
   → the same update should appear in the maps of the map makers
3. introduce an error in the database of AWV
   → test if this error is detected by ROSATTE repository or by the map maker
4. introduce an error in the database of the city of Antwerp
   → test if this error is detected by ROSATTE repository or by the map maker
5. test of the update frequency: perform an update in the traffic sign database of AWV
   → check the update frequency of the map makers
6. communication/data exchange between the database of AWV and the database of the city of Antwerp should be tested

Table 13- Supported attributes on Flanders test site

Function (use case)	Objective (requirement)	Validation indicator	Evaluation method
1. Change of traffic sign along regional road	a. Test if central repository is updated accordingly. b. Test if ROSATTE repository is updated accordingly c. Test if update appears in the maps of the map makers	Data change/import success rate	Check whether each update request ends up with a successful change/import
2. Change of traffic sign along a road of the city of Antwerp	a. Test if traffic sign database of city of Antwerp is updated b. Test if central repository is updated c. Test if ROSATTE repository is updated accordingly d. Test if update appears in the maps of the map makers	Data change/import success rate	Check whether each update request ends up with a successful change/import
3. Introduction of error in the database of AWV	a. Test if this error is detected by ROSATTE repository b. Test if error is detected by the map maker	Success rate of the feedback loop	Check the feedback loop from the ROSATTE repository /map maker to the road authority works successfully
4. Introduction of an error in the database of the city of Antwerp	a. Test if this error is detected by ROSATTE repository b. Test if error is detected by the map maker	Success rate of the feedback loop	Check the feedback loop from the ROSATTE repository /map maker to the road authority works successfully
5. Perform an update in the traffic sign database of AWV	Test the update frequency of the maps of map makers	Time necessary for updates.	Measure the time between the change in the AWV database and the corresponding change in the map of the map makers
6. Communication/ data exchange between the database of AWV and the database of the city of Antwerp.	Test if communication and data exchange work fine	Communication/data exchange success rate	Check whether safety attributes are correctly exchanged

4.3.5 Test site Norway / Sweden

4.3.5.1 Test site overview

National Road databases are established in Sweden and Norway. Sweden will also introduce a system where input to the road database will come from legal traffic regulations

available on the Internet. The data chain in the Norwegian-Swedish test site will therefore be a unique test of what we foresee as possible future scenario in several countries in Europe.

The scope of the Norwegian Swedish test site is to:

- Test the whole data exchange chain from public authorities to map providers using methods and tools developed in the project. The road data exchange will be done incrementally and fully compliant with the methods specified in WP3.
- Test data exchange both with line attributes as speed limits and with point attributes like height restriction.
- Test feed back loop from Map providers to PA:s
- Use cross border data Norway-Sweden

4.3.5.1.1 Covered area

The following test areas will be used:

- E6 Lillehammer to Göteborg via the border at Svinesund.
- All roads in the municipalities of Fredrikstad and Halden in Norway (close to the Swedish border).
- All roads in the municipality of Strömstad in Sweden (close to the Norwegian border).
- An area around Trondheim defined by NPRA/Sintef.

The aim to use these test areas are to test the result of the data exchange chain in existing applications that are running in these particular areas.

The focus on the tests will be on quality not on quantity. It is important to test with both point attributes and line attributes.

Figure 17 - Overview of the test site area (Test areas marked with red)

4.3.5.1.2 Involved administrative levels in collecting the data

The data collection will involve both national and local authorities in the two countries.

The updated datasets will be documented and propagated all the way from local authorities or municipalities via Norwegian Public Roads Administration (NPRA) and Swedish Road Administration (SRA) to Navteq and Tele Atlas to be used in some test applications.

Triona will act as a software provider to both SRA and NPRA.

4.3.5.1.3 Supported attributes

The test activities will focus on **speed limits**, **specific traffic regulations (**height restriction, direction to be followed, Obligation to stop) and **warning signs** (moose crossing, sharp curve).

Conditions like time dependency will be applied for some attributes like speed limits. Along with static attributes, temporary attributes like speed limits at road constructions will be used. Temporary attributes will be handled in the same way as static attributes.

Most of the attributes used in the Norwegian-Swedish test site will be based on legal decisions.

4.3.5.1.4 Timescale of the test

Milestone	Description	Date
M1	Requirements compiled	August -09
M2	Test site specified	November -09
M3	Test site established	January -10
M4	All updates transferred to Map Providers	March -10
M5	Test site results evaluated	May -10

Table 14 - Timescale of Norway and Sweden test site

4.3.5.2 Aspects of architecture to be validated

Both NPRA and SRA have a road data base. Sweden does also have a national data base for traffic regulations operating from 2009. Transport Network Engine (TNE in Norway and TNE in Sweden) may be defined as part of the ROSATTE Infrastructure, although in the test site there is no need for any common central ROSATTE software as long as we have common and agreed descriptions for metadata, standard formats and interfaces. Anyway, the ROSATTE data store as defined in the project is implemented in the TNE-platform.

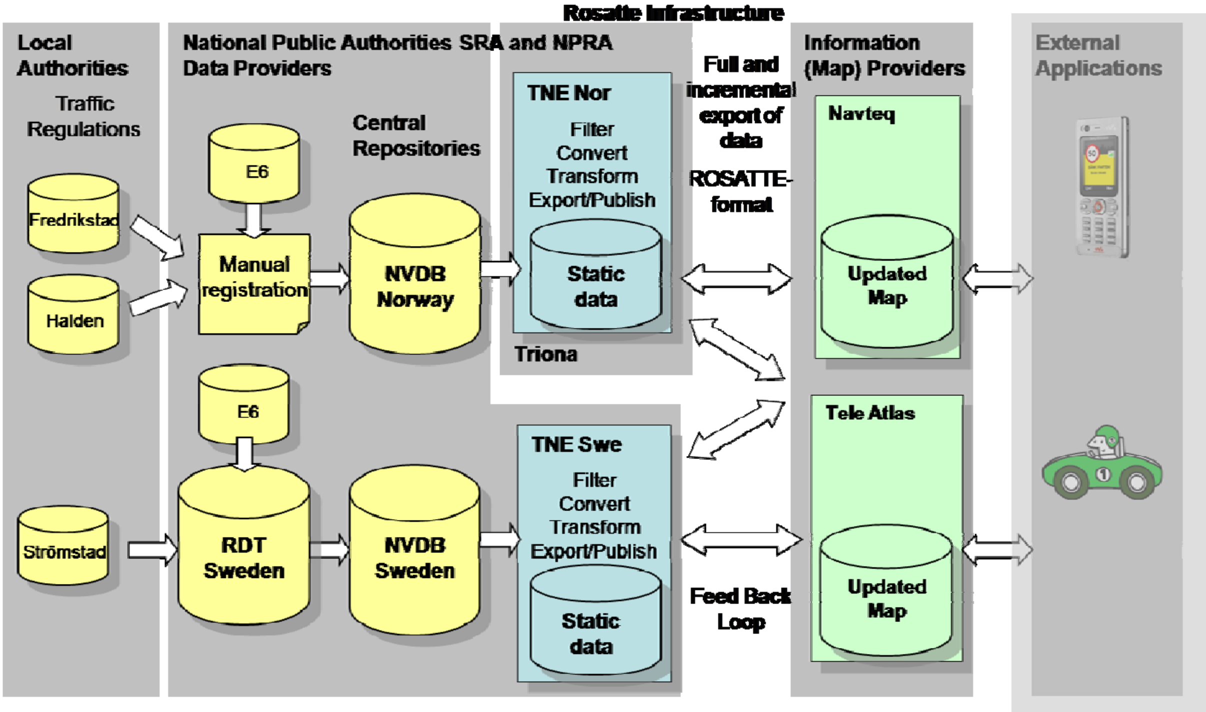


Figure 18 - Overview of the architecture

TNE©, Transport Network Engine© is an ArcGIS extension that enables an organization to set up a state-of-the-art Road Data Base in a cost and time efficient way.
TNE© helps employees re-use existing data and enter new inventoried data into the RDB. Once stored in the RDB the data complies with an information model that is based on international standards.

An add-on to TNE will be developed inside the project and used for formatting and publishing data according to the format specified in D3.1 [5]. TNE will then be used in the data exchange PA2MapProvider. Download-services as specified in D3.1 [5] will be developed that Map Providers can use to get updates from.

4.3.5.3 Test site specific assessment objectives

The objective of the Swedish-Norwegian test site is to evaluate:

- if the attribute values remain intact in every step in the data chain(s)
- the result - efficiency and accuracy - of the chosen method of location referencing, (encoding linear and point locations from a Public Authority road network and decoding the locations on a Map Provider road network is extremely interesting to evaluate)
- the efficiency of different parts of the data exchange chain(s)
- the value of the feedback loop from map providers to NPRA and SRA
- if the data exchange chain can handle attributes from the two countries in the same way – the same specification from source to map
- if the established data exchange chain(s) is suitable for use in production lines in Europe in the coming years

4.3.6 Test site London (TfL)

4.3.6.1 Test site overview

Transport for London (TfL) as an organisation is responsible for implementing the Mayor of London's Transport Strategy and managing transport services across the city, working in partnership with the 33 boroughs which make up London.

TfL has sole responsibility for management along the Transport for London Road Network (TLRN) and works in conjunction with individual boroughs to manage all borough roads along with Highways Agency (HA) to manage highways. Through the Intelligent Speed Adaptation (ISA) project resources have been committed to survey and collect all the physical speed limit signs within the Greater London area for the purpose of creating a Digital Speed Limit Map (DSLM), with the initial collection having been completed.

Both terminal and repeater signs are collected, along with the attributes to distinguish which direction signs are facing (two-sided signs) and the posted speed limits, where available the Traffic Regulation (legal) Order (TRO) is also recorded. An updating process is in place, based on the notification of legal orders and site surveys.

As far as ROSATTE is concerned TfL is extremely interested in data collection techniques and methods as well as facilitating data exchange.

4.3.6.1.1 Covered area

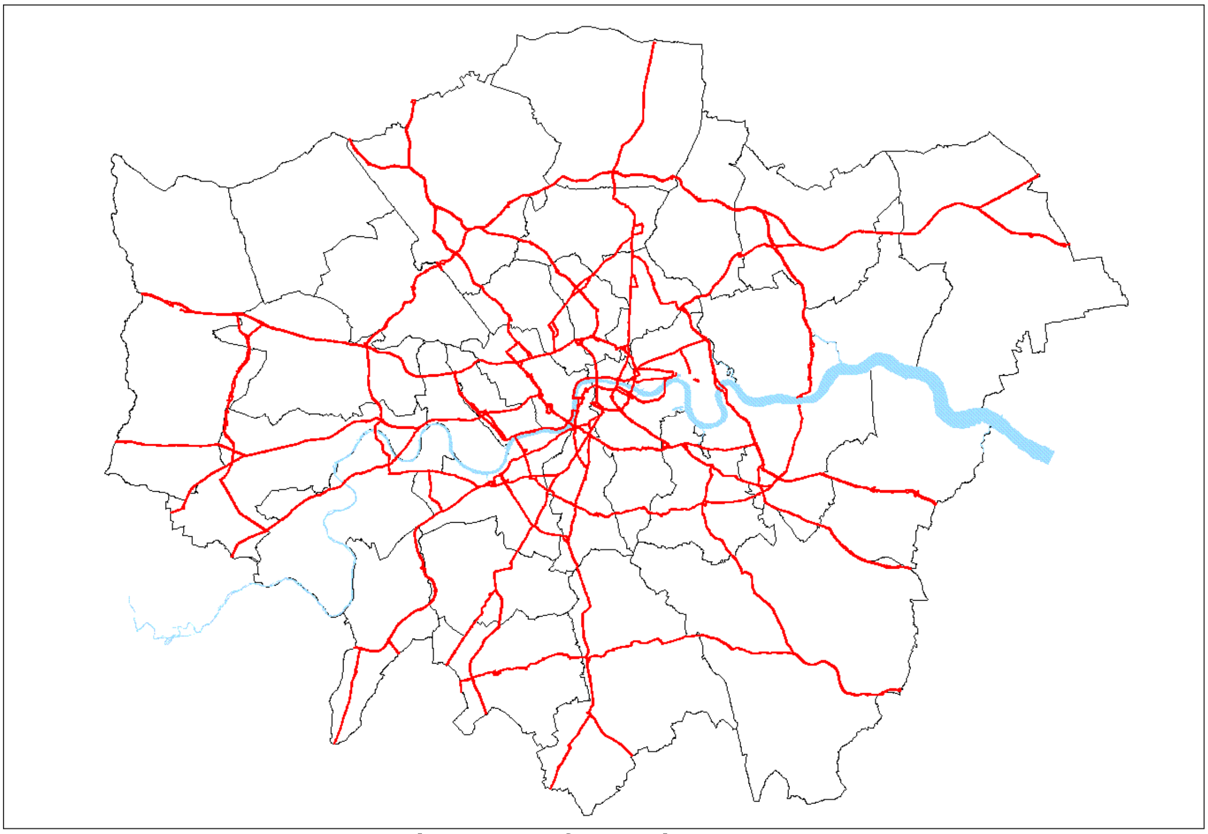


Figure 19 - TfL test site coverage

Although Transport for London only has direct responsibility for some 580km of the London road network, the entire network covers over 14,000 km and in many places is highly complex and dense. It is the larger inclusive road network which will be used for the ROSATTE project.
Each London Boroughs has at least one, and generally several town centres which serve as commercial and recreational hubs, and consequently transport hubs.
Each London Borough has the authority to alter the speed limits on the road for which they have direct responsibility, in many cases without any requirement to notify or consult TfL.

4.3.6.1.2 Involved administrative levels in collecting the data

The data collection will involve both Transport for London, as the principle driver of the data collection, as well as all 33 Boroughs within Greater London.

Transport for London (TfL) is responsible for collecting the speed limit data for the whole of Greater London on all roads managed both by TfL and those roads managed by the respective boroughs. For local expertise the boroughs will provide assistance in resolving speed limit queries and signing issues.

TfL will provide speed limit map updates to the boroughs, primarily in MapInfo tables.

4.3.6.1.3 Timescale of the test

The exact timescale of the tests will be agreed with other ROSATTE partners. All tests will be completed within the timescales agreed and according to the proposed work plan.

4.3.6.2 Aspects of architecture to be validated

The following diagram (Figure 20 below) represents the data chain from collection to the provision to the map authority. It includes the feedback loop and web service providing both 'push' and 'pull' data exchange capabilities. It is a high level UML diagram for the process followed in collecting, maintaining and supplying ROSATTE data.

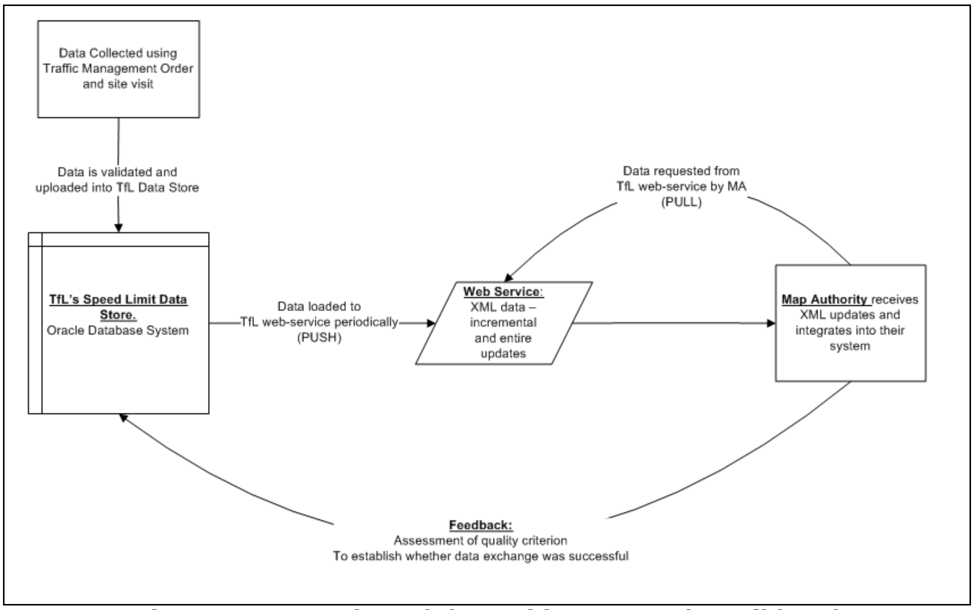


Figure 20 - Overview of the architecture to be validated

4.3.6.3 Test site specific assessment objectives

TfL will, across London, validate the process of supply and maintenance of ROSATTE compliant information to map providers with a view to promoting the ROSATTE processes as best practice.

In particular TfL are aware that with many different bodies with the authority to alter speed limit information, the feedback processes required will need to be robust and comprehensive.

It is the quality issues and quality control which TfL will have significant interest in developing with our ROSATTE partners.

Specifically:

- Enable the supply and maintenance of Safety Attributes across the whole London region and across highway authorities

- Test the process from new regulation to the inclusion of the data in the central repository

- Test the feedback mechanism for cases when there is ambiguity.

5 Summary

The main concern of this document is the compilation of a test and validation plan exactly fitting the ROSATTE objectives. Descriptions of processes for verifying and validating the implemented tools and procedures on each test site involved in the project are developed and presented. Other topics which are examined are related to quality aspects as well as indicators for user and system requirements. The test and validation plan established in this document contains general guidelines to be applied in each test site as well as a compilation of test procedures and suitable evaluation methods. It also includes answers on how the test procedures should be carried out and what kind of attributes will be supported on the test sites.

Dealing with assessment objectives, one has to distinguish the approach and methods between the verification and validation phase. Thereby verification concentrates on testing if the implementations actually fulfil the functional and non-functional requirements derived from the user requirements. And validation determines if user requirements are met with the developed ROSATTE framework and to what extend they achieve the purpose.

Issues that also have to be considered in this context are the assessment of data quality along the data processing chain, the safety attributes exchange and integration process as well as the publishing and feedback processes. Consistency between chosen formats and data should be retained.

The final assessment at test sites chapter gives details about how the verification and validation is to be conducted at the different test sites. The specifics for each test site are discussed separately.

From the beginning it is taking into particular account that a quality management concept has to apply for the entire data chain. In that way, the demand of delivering quality assured safety-relevant attributes that meet the data user requirements can be fulfilled. That is the demand and the aim which is to be achieved. At the end the test and validation plan should enable to confirm the aspired goal.

Annex A: Definition of quality characteristics

A.1 Introduction

The ROSATTE quality management is a vital part of the project. As for any other product, the user or customer of geodata has certain expectations or even requirements on the quality of the purchased product. Therefore the customer is the starting point also for the ROSATTE quality management. Since we are dealing not only with private customers but also with safety relevant applications as advanced driver assistance systems (ADAS) the quality issue becomes even more important.
In order to be able to formulate and describe these quality requirements one needs to define certain quality parameters. These parameters then are really measurable and comparable and the data quality really becomes concrete.
If it is now possible to measure and describe the quality of the product, one can use several methods for testing and evaluating the data quality. Comparing the test results with the previously defined quality requirements one can determine whether those requirements are fulfilled or not. In the latter case, one has to have a look at the production processes, these are the data capturing, data exchange and data integration for the ROSATTE project. The process analysis will show where the processes have to be changed, or new processes have to be implemented in order to improve the end-product quality. This phase of comparing the present quality situation with the target state is called quality assurance. It helps the producer to keep the quality of his product on a defined level or even to improve the quality. The quality assurance phase is to be repeated regularly. The detailed approach is described in the following.

A.2 Description of data quality

A base model to describe data quality in geoinformation processes was developed at the University of Stuttgart, Germany. This model was developed and used within the framework of many different projects. It was also used and applied in the EuroRoadS project [3]. The EuroRoadS project has laid the ground for a pan-European standardized, seamless, updated, and quality assured digital road data infrastructure by defining a specification framework for the exchange of road data. Since this is very similar to what is to be done within this project, it is also intended to use the University of Stuttgart quality base model within ROSATTE. Of course, the model has to be applied to the special needs of the project. In contrast to many previous projects, the quality management in ROSATTE not only focuses on the description of data quality but also puts special strength on the processes of data production and maintenance and their influence on the data quality. Therefore the existing quality base model has to be extended and further developed within ROSATTE. The results will be presented in deliverable D5.2 “Report on data quality management concept”.

The model is based on norms and international standards in the field of geoinformation quality and also on an investigation of user needs. As quality is defined in ISO 9000 (2000) as „degree to which a set of inherent characteristics fulfils requirements“, the main objective was to define such a set of inherent quality characteristics. All quality phenomena, meaning the quality of all geoinformation data, can be described by these characteristics. They always stay the same, therefore the model can be applied to all possible problems and always ensures that all quality aspects are covered. But in order to really get measurable values, the model has to be concretized on the individual problem. This is to be done using the so-called quality parameters. As can be seen in figure 4, the quality parameters are quantified by values that can be measured using evaluation methods. These quality parameter values are also used to formulate the quality

requirements. Figure 4 shows the six quality characteristics and their interrelations to the phenomenon to be described as well as to the quality requirements and the evaluation methods.

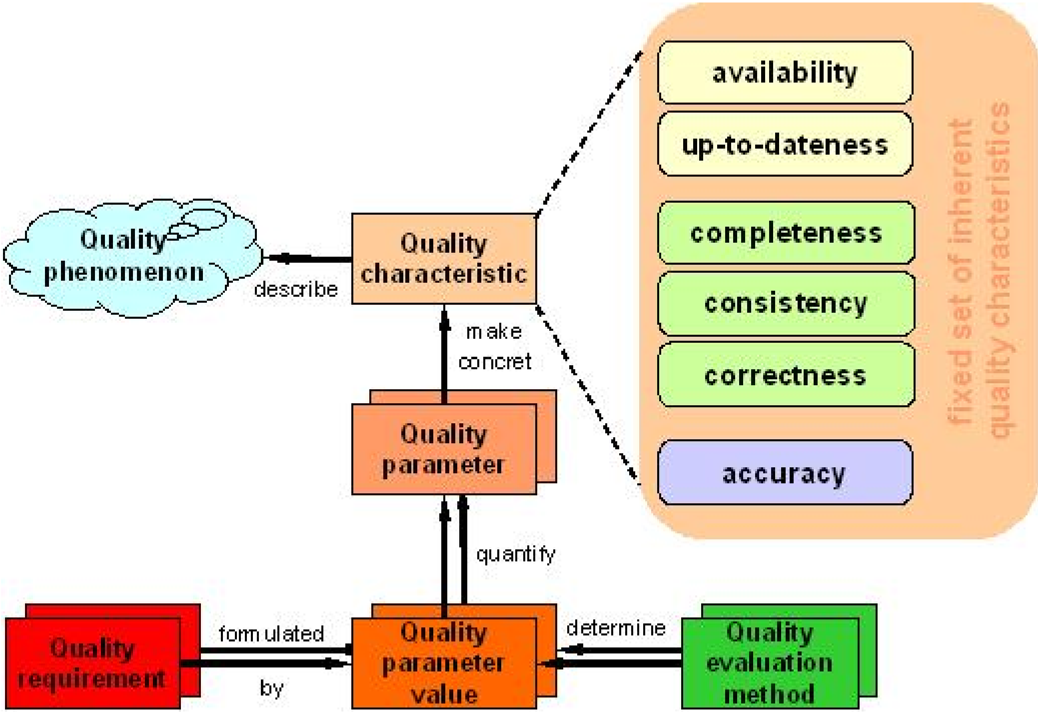


Figure 21 - Quality model [3]

The quality characteristics and their definitions are shown in table 2. The EuroRoadS D2.2 Report on quality frame for information [1] gives a detailed description of the six quality characteristics and examples for possible quality parameters. It is very important for all partners involved in the test and validation activities to have a common knowledge of the quality base model. Therefore the following subsections summarize the EuroRoadS document in order to give a sound understanding. For more detailed information please refer to the corresponding EuroRoadS document.

Table 15 - Definition of quality characteristics and quality parameters for EuroRoadS quality model for assurance in geoinformation processes [3]

groups of quality characteristics	quality characteristics	Definition	possible quality parameter
dependability	availability	degree to which geographic data are available at a certain place and at a defined time	failure rate
			…
	up-to-dateness	degree of adherence of geographic data to the time changing universe of discourse	last update
			rate of change
			temporal lapse
			…
integrity	completeness	degree of adherence of the entirety of geographic data (features, their attributes and relationships) to the entirety of the universe of discourse	omission
			commission
			…
	correctness	degree of adherence of existence of geographic data (feature(s), attributes, functions, relationships) to corresponding elements of the universe of discourse, up-to-dateness being presumed	geometric correctness
			topological correctness
			thematic correctness
			…
	consistency	degree of adherence of geographic data (data structure, their features, attributes and relationships) to the models and schemas (conceptual model, conceptual schema, application schema and data model)	geometric consistency
			topological consistency
			thematic consistency
			…
accuracy	accuracy	degree of adherence of geographic data to the most plausible resp. true value.	absolute position accuracy
			relative position accuracy
			quantitative attribute accuracy
			temporal accuracy of time measurement
			…

The quality characteristics are also defined as non-functional project requirements in D1.2 [3]. A more detailed description can be found in the following paragraph.

A.3 Quality characteristics

Availability

The availability is only fulfilled if the geographic data are available at a required place in time. In addition to the time factor, the place is also of fundamental importance. It is not sufficient that geographic data does exist, the geographic data must also be available at the required place and time. Therefore the availability can be defined as "degree to which geographic data are available at a certain place and at a defined time". For example, if in case of a WebGIS-application the geographic data is available in the intranet, but due to a communication error cannot be transferred to the internet to external user, availability is not given. I.e. if the system or a part of it has a failure, availability is not given.

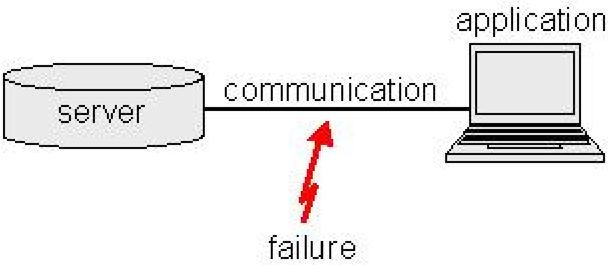


Figure 22 - Example for availability

Up-to-dateness

The up-to-dateness describes the degree of adherence of geographic data to the time changing universe of discourse. This is depending on the dynamic of reality and the rate of update. For example, flow regulation at a junction was changed at 12th August 2001 from traffic sign to traffic light. But the regulation of the junction was not changed in the geographic dataset till now. As a result of changes in the course of time the information does not represent the reality correctly.

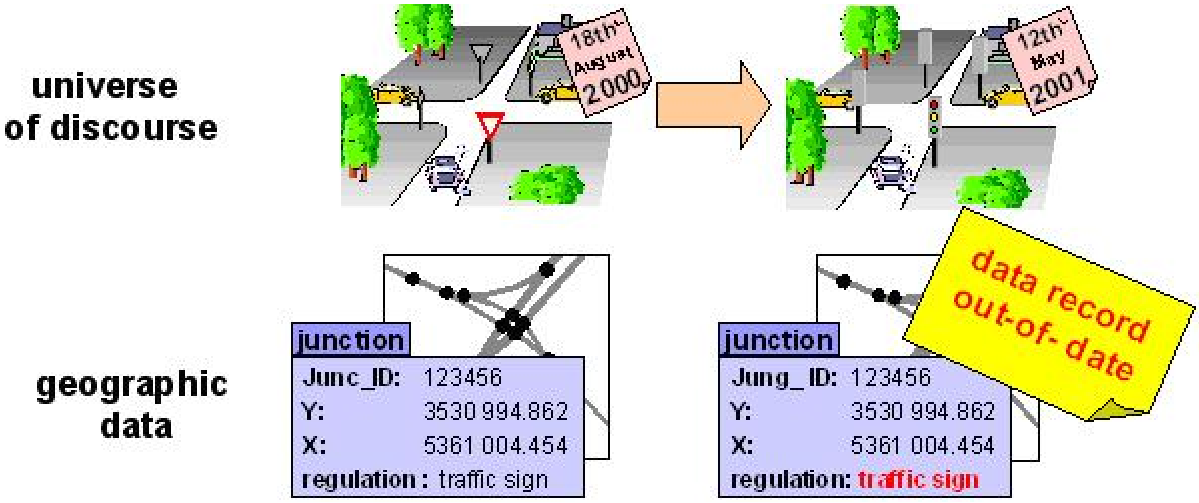


Figure 23 - Example for up-to-dateness

Completeness

The completeness is only fulfilled if all required features, attributes and relationships of the universe of discourse are in the geographic dataset. For example if the feature “Point of Interest” has an Y-value but no X-value the dataset is incomplete, i.e. data is absent from a dataset (`*omission*`). On the other hand, excessive data can be present in a dataset (`*commission*`).

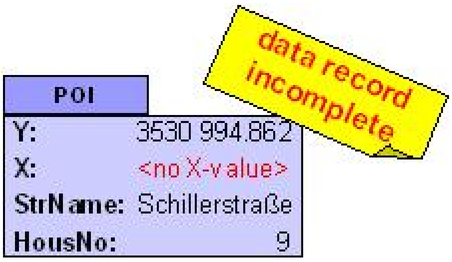


Figure 24 - Example for completeness

Consistency

Consistency is necessary for the connection between geographic data and schemas, which are the basis for the information storage. It is the precondition for a contraction-free data base. Consistency can only be described by boolean values, i.e. a feature, attribute or rule is either consistent or not. The consequence of consistency errors are incorrectness and missing availability. In practise consistency has to be checked for a rule, a feature or an attribute.

Correctness

The correctness means the extent of conformity of geographic data in relation to the universe of discourse. The gross and systematic errors will be considered. These errors are depending on the required accuracy. Possibilities are pictured in figure 8: Example (I) shows an incompleteness. Example (II) is incorrect as result of inaccurate digitising, i.e. the digitized street is outside the given accuracy. Example (III) is correct, because the digitized street is inside the given accuracy. The given accuracy of digitising using a digitising table depends on the accuracy of the original manuscript, pointing, and the device. I.e. the cause of non-correctness is digitalisation outside the buffer given by accuracy for the geometry of the road.

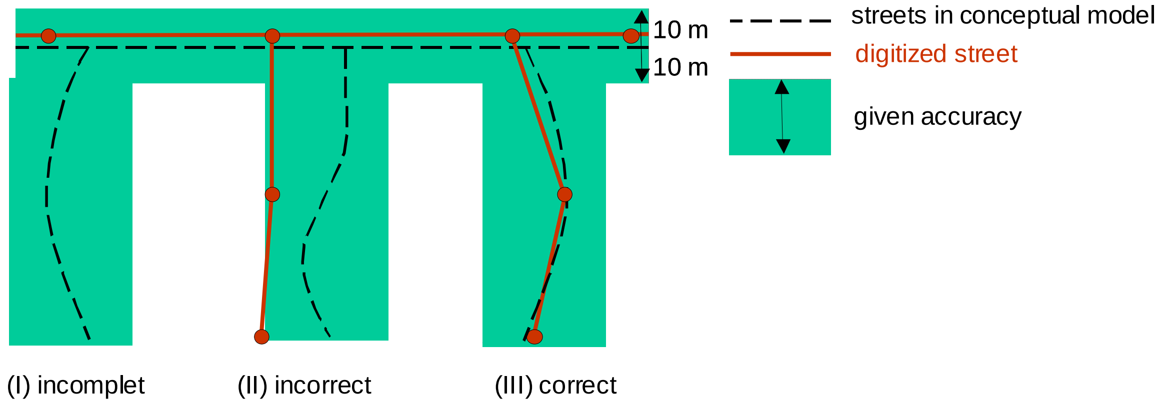


Figure 25 - Example for correctness

Accuracy

The aim of the quality concept is, that one quality phenomenon is described by one quality characteristic. Therefore the phenomenon “how accurate are the data” is described by the quality characteristic “accuracy”. I.e. the same quality characteristics should be used for all *data types* (temporal, thematic, geometric). For example one could imagine a street segment A (including geometry, street classification and temporal constraints) and another street segment B (including only geometry and street classification). For the quality model in the geographic data processes only one quality characteristic should describe the accuracy. This is necessary as ISO 9000 postulated that one quality phenomenon (e.g. how accurate are the data ?) should be described non-ambiguously by one quality characteristic (e.g. accuracy). Consequently the concretisation of the general quality characteristic “accuracy” happens at the level of the quality parameter.