REQUIREMENTS REPORT

SOFTWARE REQUIREMENTS AND RECOMMENDATIONS FOR DEMONSTRATORS, SPATIAL DATA USE, TRAINING AND PROMOTION

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Requirements Report

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PREFACE

With the development of Galileo, a European Global Navigation Satellite System (GNSS), the European GNSS Supervisory Authority (GSA) aims to move Europe forward in the location based technology and stimulate innovation and new business. In order to examine potential uses and to prepare likely users for applications using the Galileo infrastructure and services, the GSA has initiated projects addressing various user communities.

This report has been prepared in the frame of the FieldFact project. The aim of FieldFact is the introduction and promotion of GNSS within the agricultural user community. The project is managed by the GSA and funded under the 6th Framework Programme. There are six consortium partners participating in the project - Alterra, Vexcel and PPO from the Netherlands, University of Warmia and Mazury (UWM) from Poland, Ekotoxa from the Czech Republic and the European Commission's Joint Research Centre.

The present report is the result of the requirements specification activity in the FieldFact project. It was renamed from the original "Specification Report" to the "Requirements report". The concept of requirement describes better the level of detail that is captured by this deliverable. Specifications of the demonstrators (being more detailed and more aimed to the specific demonstrators to be built) will be described in the deliverables D3.3 and D3.5 of WP3 - Application Development.

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EXECUTIVE SUMMARY

The Requirements Report has been prepared within the WP2 of the FieldFact project and represents a follow-up to the Critical Analysis Report (CAR). The purpose of the report is to serve as an input for the project's downstream Work Packages dealing with the development of demonstrators, testing, training and promotion. For these Work Packages, the report is defining:

- Requirements applying to two demonstrators to be developed within the project (input for WP3);
- Requirements concerning the use of spatial data (input for WP4);
- Recommendations for promotion and training campaigns (inputs for WP5 & WP6).

First, the selected method for requirements capturing is described. Functional requirements (FRQ) are expressed in the form of user stories, while non-functional requirements (NFR) are expressed as quality attributes in the framework of the extended ISO model for software quality.

The description of the work carried out in the frame of the FieldFact project covers the initial concept proposed by the consortium, critical analysis and selection of priority applications, analysis of European regulatory requirements, analysis of stakeholder expectations and requirements, development of requirements and recommendations, and finally development of database for recording requirements and recommendations which is the core part of the report.

The following chapter describes obtained results: functional and non-functional requirements related to the development of demonstrators, recommendations for the promotion and training campaigns and specific requirements concerning the use of spatial data. Requirements/ recommendations are included in the database table. In total 62 records (19 functional requirements, 33 non-functional requirements and 10 recommendations) are listed in the database. Each requirement/ recommendation is described and rationalized. In addition, the origin (document or person/ group originating the requirement) and the value of the requirement to the users is mentioned as well. Priority given to each requirement/ recommendation by the team of authors represents the initial value that should be further evaluated and possibly adjusted in the frame of WPs 3-6.

The report is concluded with the main conclusions and recommendations for further development within the FieldFact project.

The Requirements Report is designed primarily as a document creating a basis for further development of demonstrators (WP 3-4) and preparation of training and promotion campaigns (WP 5-6) and it is intended for project partners working in WPs 3-6.

1 INTRODUCTION

1.1 Purpose and scope

As one of its initial steps, the FieldFact project carried out a critical analysis examining the current scenario of GNSS use in agricultural user community. The critical analysis is described in a Critical Analysis Report (CAR, FieldFact DEL-2.2), which identifies major GNSS applications within the agricultural community and assesses them against a range of indicators. From among the identified applications, priority applications were selected to be developed into demonstrators and used in promotion and training during the implementation phase of the FieldFact project.

This Requirements Report was prepared within the WP2 of the FieldFact project and represents a follow-up to the CAR. The purpose of the report is to serve as an input for the project's downstream Work Packages dealing with the development of demonstrators, testing, training and promotion. For these Work Packages, the report is defining:

- Requirements applying to two demonstrators to be developed within the project (input for WP3);
- Requirements concerning the use of spatial data (input for WP4);
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First, the selected method for requirements capturing is described. Functional requirements (FRQ) are expressed in the form of user stories, while non-functional requirements (NFR) are expressed as quality attributes in the framework of the extended ISO model for software quality.

The description of the work carried out in the frame of the FieldFact project covers the initial concept proposed by the consortium, critical analysis and selection of priority applications, analysis of European regulatory requirements, analysis of stakeholder expectations and requirements, development of requirements and recommendations, and finally development of database for recording requirements and recommendations which is the core part of the report.

The following chapter describes obtained results: functional and non-functional requirements related to the development of demonstrators, recommendations for the promotion and training campaigns and specific requirements concerning the use of spatial data.

The report is concluded with the main conclusions and recommendations for further development within the FieldFact project.

The database containing specific requirements and recommendations is attached in the form of digital Excel table in Appendix 2.

1.2 Intended audience / Classification

The Requirements Report is designed primarily as a document creating a basis for further development of demonstrators (WP 3-4) and preparation of training and promotion campaigns (WP 5-6) and it is intended for project partners working in WPs 3-6.

1.3 Associated documentation and references

Following inputs were used as a main source of information for preparation of below mentioned requirements and recommendations:

- Statement of Work. GALILEO Research and Development Activities, Second Call, Area 1A, GNSS for Special User Community. Ref.: GJU/04/2412-SOW/MM/fk, Issue 1, 26/05/2004. Galileo Joint Undertaking, Brussels;
- FieldFact Proposal. Technical Tender. Version 1.0.1. 20/07/2006. FieldFact consortium;
- FieldFact Proposal. Financial, Management and Administrative Tender. Version 1.0.1. 20/07/2006. FieldFact consortium;
- Critical Analysis Report (final). The State and Future of GNSS in Agriculture. Ref.: FIELDFACT-WP2-EKOTOXA-DEL-2.2, version 1.0, 19/12/2007;
- Requirement Identification and Priority Report. Ref.: FIELDFACT-WP1-JRC-DEL-1.3, Issue 1.3., 22/05/2007.

The FieldFact proposal contains initial concepts proposed by the consortium as an answer to the requirements mentioned in the Statement of Work. The Critical Analysis Report (first output from WP2), which makes a complex inventory of the state of GNSS use in agriculture, is concluded by the selection of priority applications that will be used for development of demonstrators. The Requirement Identification and Priority Report (output from WP1) deals with the verification and prioritisation of user requirements through an inventory of relevant EU legislation and analysis of stakeholders' views on GNSS use in agriculture.

Other already available project reports contain useful information and concepts concerning the application development, spatial data issues, testing, training and promotion:

- Conceptual model as a basis for application development. Ref.: FIELDFACT-WP3-ALTERRA-DEL-3.1, Version 1.0;
- Geo-Spatial Data Issues. Integrated Report. Ref.: FIELDFACT-WP4-MICROSOFT-DEL-4.1-4.2-4.3, Version 1.0;
- Methods and Procedures for Testing of GNSS Equipment / Receivers - Techniques of measurements and training of operators. Ref.: FIELDFACT-WP5-UWM-DEL-5.1, Version 1.0;
- Promotion Plan (draft). Ref.: FIELDFACT-WP6-PPO-DEL-6.1, Version 1.0.

Other references are indicated directly in the text and are listed in the section "References" at the end of the report.

1.4 Acronyms and Abbreviations

CAP	Common Agricultural Policy
CAR	Critical Analysis Report
CEOP	Coordinated Enhanced Observing Period
ETRS	European Terrestrial Reference System
EU	European Union
FGDC	Federal Geographic Data Committee
FRQ	Functional Requirement
GIS	Geographic Information System
GML	Geography Markup Language
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSA	European GNSS Supervisory Authority
GUI	Graphical User Interface
INSPIRE	Infrastructure for Spatial Information in the European Union
ISO	International Organization for Standardization
LCC	Lambert Conformal Conic Coordinate Reference System
LPIS	Land Parcel Identification System
NFR	Non-functional Requirement
OGC	Open Geospatial Consortium
RAVI	Dutch Network for Geoinformation
REC	Recommendation
VHR	Very High Resolution
VRA	Variable Rate Application
WGS	World Geodetic System
WP	Workpackage
XML	Extensible Mark-up Language
XP	Extreme Programming

1.5 Definitions

In this section we discuss and explain several specific terms that are used in this document. Some of these terms have multiple definitions. In this section the definitions are given as used in the project.

1.5.1 Requirement

The term requirement is referring to a condition or capability demanded by a stakeholder that must be met or possessed by the demonstrators that will be developed in the project. This follows the generic definition of a (software) requirement [1].

During requirements capturing a Requirement is often stated as a condition or capability needed by a user to solve a problem or achieve an objective. This contextualizes a requirement.

1.5.2 Functional Requirement

A Functional Requirement is a requirement describing the behaviour of a software product in terms of function, services or tasks the software product is required to perform. It describes what a software product will do.

1.5.3 Non-Functional Requirement

A Non-Functional Requirement is a requirement describing the behaviour of a software product, not being functionality.

1.5.4 Specification

The term specification is reserved for a description of an intended requirement, behaviour or other characteristic of a product or service. A specification should be complete, precise and verifiable, preferably including the procedures to determining whether the provision has been satisfied.

In this project we see a specification as an evolution of a requirement that is measurable and testable.

1.5.5 Software Quality Attribute

A property of a software product by which its quality will be judged by a stakeholder. In general a quality attribute is an individually meaningful abstraction of a set of characteristics accompanied with indicators and methods for evaluating them as to assess the quality of the software.

In this project, we are adhering to the software product quality approach as opposed to the software process quality approach. Software quality attributes have a significant influence on the architecture of a system and therefore play an important role in requirements elicitation.

1.5.6 User Story

A user story is a piece of user-valued functionality that can be developed and delivered [2]. User stories are short descriptions of functionality — told from the perspective of a user — that are valuable to either a user of the software or the customer of the software. User Stories are written by the customers as things that the system needs to do for them. They are in the format of about three sentences of text written by the customer in the customers terminology without techno-syntax.

The concept of user stories was introduced by Extreme programming (XP) [3] as the practice of expressing requirements. The amount of functionality required in a user-story is not specified in the definition, just as the length of an iteration is not specified in its definition.

The main difference between user stories and a standard requirements document is a focus on user needs. Details of specific technology, data base layout, and algorithms should be avoided. Stories should be focused on user needs and benefits as opposed to specifying GUI layouts.

2 DESCRIPTION OF SELECTED METHOD

2.1 Requirements capturing

The process of software development typically runs through a series of phases (analysis, design, implementation). In these phases the expectations of users, but also the market and business expectations are translated to and implemented into a software product. A crucial aspect of software development is the requirements capturing from users; registering and expressing what a software product is expected to do.

In the FieldFact project we are developing demonstrators for the purpose of introduction and promotion of satellite navigation in agriculture, in particular with reference to the added value benefits of Galileo and EGNOS.

As we are not dealing with a specific one customer or customer group the collection of requirements is not straight forward. This is especially true when trying to develop software products with characteristics that should reflect a future system, as which is the case with Galileo. There is not a clearly identified, current user that can decide on the required functionality and behaviour of the software product.

Based on previous experience we have chosen for a stepwise refinement strategy: we collected requirements at a descriptive level which we refined and filled in gradually during the process of requirements elicitation and specification. This approach is also reflected in Figure 1.

The first step in this process is the assessment of requirements, derived from the expectations of various stakeholders. From these requirements, subsequently the specifications of the product can be derived, basically by prioritizing (selecting) the important requirements and evolving them into specifications. These specifications are input to the design phase, which in turn leads to the implementation phase. After implementation the products can again be used in testing (is the product according to specifications) and to verify compliancy with the requirements (does the product meet the requirements).

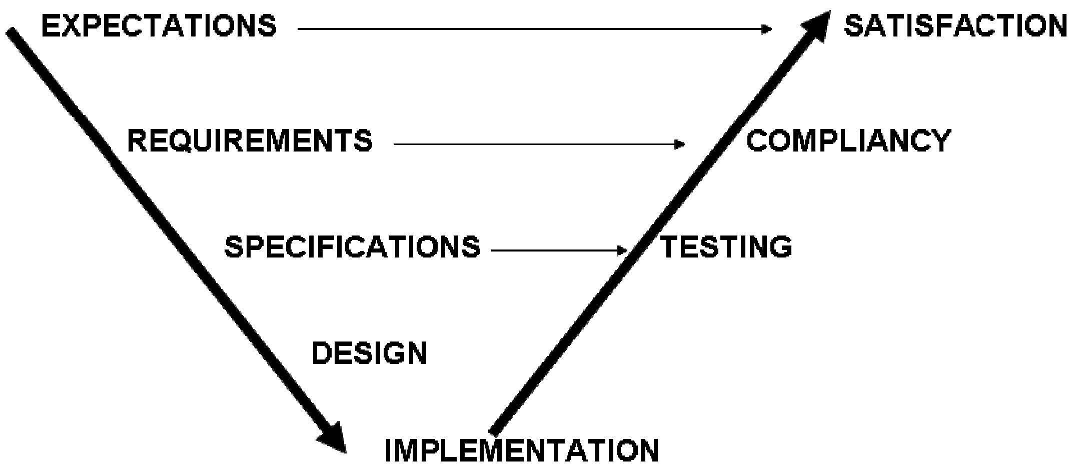

Figure 1 – Translation of expectations to software

As graphically depicted in Figure 1, requirements play an important role in elicitation of users expectations into formal, testable characteristics of a software product. This figure represents the often applied “V” shaped model, where each definition phase (left side) has a corresponding validation phase (right side). Expectations are measured during in-use validation and are expressed as satisfaction. Expectations and hence satisfaction are rather qualitative attributes of a software product. Therefore Expectations are translated into Requirements as being conditions or capabilities a software product must possess or meet. During validation the compliancy to these requirements is measured. Adding indicators to these Requirements that have a measurable aspect can facilitate this.

In this project we are developing demonstrators to introduce and promote key advantages of Galileo and EGNOS in the use of satellite navigation in the agricultural user community. Thus the demonstrators are also used to fulfil the projects goals in demonstrating the added value of Galileo and EGNOS.

2.2 Functional Requirements

Functional Requirements reflect the functions of a software product, in other words those things a software product needs to do. In our project we have selected the user stories method for the description of functional requirements.

The concept of user stories was introduced by Extreme programming (XP) [3] as the practice of expressing requirements. User stories are short descriptions of functionality — told from the perspective of a user — that are valuable to either the user or the customer of the software. Or, in short, a user story is a piece of user-valued functionality than can be developed and delivered. User Stories are expressed by stakeholders as things that the software product needs to do for them. They are in the format of about three sentences of text written by the customer in the customers terminology without techno-syntax.

In the XP methodology, a user story reflects a function that can be developed and delivered in one release iteration. If necessary, a user story can be split into two user stories to reduce complexity and hence the risk of not being able to complete the development in one cycle.

User stories also drive the creation of the acceptance tests. One or more automated acceptance tests must be created to verify the user story has been correctly implemented.

The amount of functionality required in a user-story is not specified in the definition, just as the length of an iteration is not specified in its definition. It is a project specific. Developers estimate how long the stories might take to implement. Too large stories need to be split, too short stories need to be aggregated. The latter implies that the descriptions are too detailed.

User stories are user-centered descriptions of product functionality. Details of specific technology, data base layout, and algorithms should be left out. User stories should focus on user needs and benefits as opposed to specifying GUI layouts.

2.3 Non-Functional Requirements

The expectations of a software product include a lot of unmentioned, implicit quality characteristics of that product. In the development of user stories, like most requirements engineering processes, the focus is on the functional requirements. In other words, specifying the functions that a software product must be able to perform. However, user satisfaction is for long time not only determined by functional requirements or expectations. It is also largely determined by the behaviour of the system in non-functional domains, such as the systems performance (respondability), robustness and maintainability.

The requirements elicitation also needs to define these non-functional requirements as they often have an enormous impact on the architecture and design of a system. In order to make sure all aspects are covered, the software engineering industry makes use of so-called software (product) quality models. Quality has a lot of different “dimensions” and aspects. It is therefore hardly possible to assess the quality aspects without a strictly defined framework. In ISO 9126 such a framework is described as a set of well defined software quality characteristics and sub-characteristics. This set has been extended with some extra characteristics in the Extended ISO Model [4]. The model covers a whole range of quality attributes that are relevant for software quality (Figure 2). Each attribute has been strictly defined in order to avoid misinterpretation (see Appendix 1). It can thus be used as a guideline as well as a checklist in the requirements analysis. It ensures that the requirements analyst covers the whole area of quality and interprets the quality attributes in a valid manner. In each analysis however, the significance of specific attributes must be assessed as not always all attributes are impacting the intended scope or usage of a software product.

In this report, the non-functional requirements for the FieldFact demonstrators are listed describing the characteristics of the demonstrators to be built in order to satisfy the expectations of the stakeholders. Thus, essentially, the requirements describe the quality of the demonstrator derived from a stakeholder perspective and directed towards a detailed specification and design of the demonstrators.

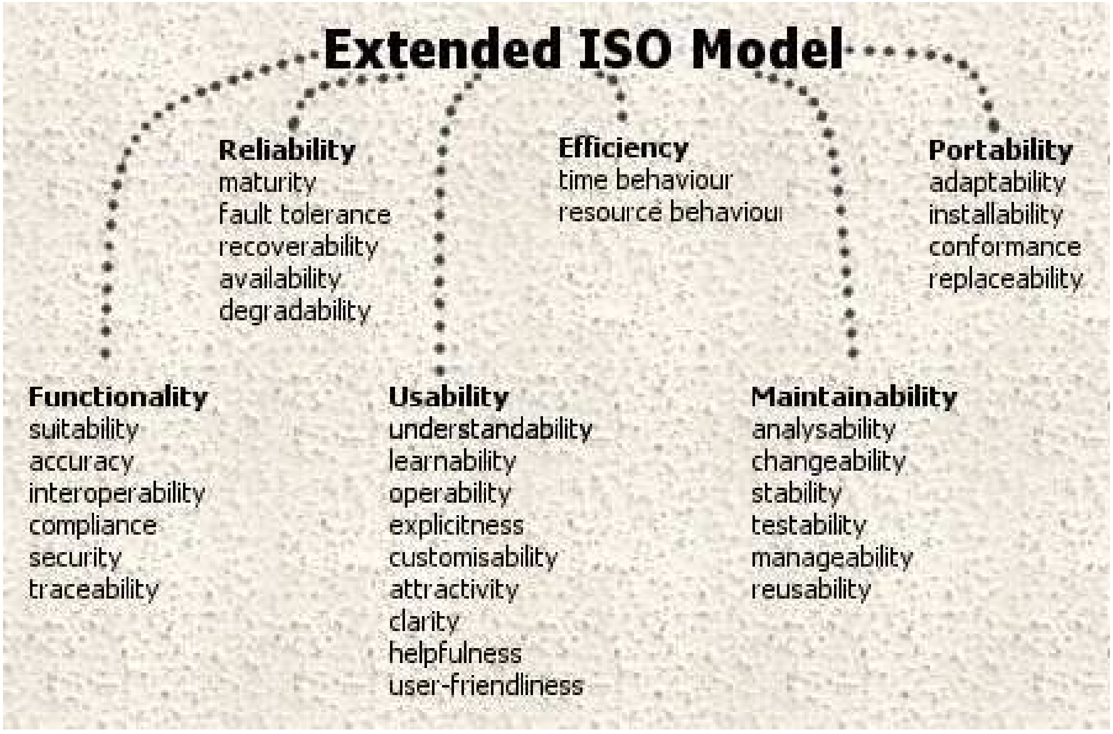

Figure 2 – The extended ISO model for software quality

3 DESCRIPTION OF THE WORK CARRIED OUT

3.1 Initial concept proposed by the consortium

The initial concept proposed by the Consortium envisaged the development of two different demonstrators:

- **Low-End demonstrator:** an application of mass-market (handheld) receivers to reach the larger part of the user community;
- **High-End demonstrator:** an application of dedicated receiver integrated with sensors and machine monitors. This application will serve a smaller market segment but has a “formula 1” attractiveness to farmers.

The objectives concerning the above demonstrators were defined in the following way [5]:

The main objective of the ***Low-End demonstrator*** *is to create awareness within the user community about the circumstances and conditions under which the GNSS signal can be used on farm and field level. The audience the FieldFact consortium aims at is formed by the European farmers. The consortium expects as a result to create acceptance for the new technology and a ‘pull’ for innovative applications. The demonstrator will underline the added value of the EGNOS/ Galileo concerning signal in relation to traceability.*

The main objective of the ***High-End demonstrator*** *is to show the advantages of creating geo-information by combining an accurate, reliable position signal (EGNOS/ Galileo) with relevant data sources on farm and field level. Another objective is to demonstrate advantages of communication between agricultural user community partners based on (parcel) geometry and location. For this type of demonstrator the added value of integrity and guarantee of the EGNOS/ Galileo signal is crucial.*

Implementation of promotion and training campaigns around demonstrators showing the integration of GNSS and geographic data has been proposed in the project proposal as well. Preparation and implementation of major promotional events (special „GNSS in Agriculture“ events) in different EU-regions (North-West, East and South) is anticipated as a part of awarenes campaign introducing demonstrators developed in the frame of the project.

3.2 Critical analysis and selection of priority applications

The Critical analysis of the state and future of GNSS in agriculture was concluded by the selection of priority applications to be developed into demonstrators and used in promotion and training campaigns during the Implementation phase of the FieldFact project. The selection method is based on the set of specific questions derived from initial proposed characteristics of both low and high end demonstrators and is described in the Critical Analysis Report (CAR) [6].

Based on the results of critical analysis it was proposed to integrate the following two identified priority applications in the low-end demonstrator:

- Sampling location (see Chapter 4.5 of the CAR) and
- Parcel measurement (see Chapter 4.13 of the CAR) including the following specific functionality:
    - Parcel area measurement

- LPIS data collection and updates

In order to demonstrate the links between various operations involved in precision farming it was proposed to integrate the following three identified priority applications in the high-end demonstrator:

- Harvest monitoring (see Chapter 4.3 of the CAR)
- Biomass monitoring (see Chapter 4.4 of the CAR)
- Variable rate application (see Chapter 4.6 of the CAR)

During the Critical Analysis meeting held in Opava, Czech Republic, from 14 to 15 February 2007 the above listed priority applications were confirmed by the project consortium members as the basis for further development [7]. The demonstrators will include only selected functionality that will first of all attract the intended audience (mainly farmers) and clearly demonstrate the added value of Galileo and EGNOS services.

3.3 Analysis of European regulatory requirements

Detailed inventory of EU legislation related to EU Common Agricultural Policy (CAP), that potentially impacts requirements and specifications of FieldFact demonstrators has been carried out in the frame of WP1 – Stakeholder platform. The results are presented in the Requirements Identification and Priority Report [8].

3.4 Analysis of stakeholder expectations and requirements

The analysis of stakeholder expectations and requirements is based on results obtained during a series of consultations and events organized by the FieldFact consortium until the end of April 2007 (first eight months of the project duration). Stakeholders addressed both technical issues and the strategy for promotional activities [9].

3.5 The process of requirements development

The consortium has already produced some first requirements for the proposed demonstrators during project definition phase. These requirements arose from the previously gained experience of consortium partners in the field of applying satellite navigation in agriculture.

The study on critical analysis of existing and future GNSS applications in agriculture also contains requirements towards our demonstrators. Most of these requirements are also requirements towards the described applications. The report DEL-2.2 obviously served as a main input.

During the meetings and discussions with stakeholders many other requirements were mentioned, sometimes explicit, sometimes implicit. The report DEL-1.3 served as main input, but also other communications were taken into account.

Requirements were gathered, described and sorted (categorised). Functional requirements are expressed as user-stories, non-functional requirements as quality attributes.

Not necessarily all identified requirements are either useful or feasible to be implemented in demonstrators. Therefore the whole list will be subjected to a final selection and prioritizing process.

In this report, we restrict ourselves in describing the requirements gathered from different sources. The evolution of requirements into specifications will take place later. This will be elaborated in terms of the consequences for software architecture in the Functional/ non-functional analysis report (DEL-3.3).

3.6 Development of database for recording requirements

A simple database (Excel spreadsheet) was created to manage and trace the requirements. This database has the following structure:

NAME	DESCRIPTION	CODE_LIST	TYPE
REQ_TYPE	Requirement type	FRQ - functional requirement; NFR - non-functional requirement; REC - recommendation.	Text
REQ_AREA	Requirement area	LED - low-end demonstrator; HED - high-end demonstrator; DEM - both demonstrators; PRO - promotional/ training activity.	Text
REQ_NR	Requirement number (within one type)		AutoNumber
UID	Unique identifier (complex string)		Text
DESCRIPTION	User story (in case of FRQs and RECs) or quality indicator (in case of NFRs)		Text
RATIONALE	Rationale of the desired requirement		Text
ORIGIN	Document or person/ group originating the requirement		Text
USER_VALUE	The value of the requirement to the users		Text
PRIORITY	Priority given to it by the FieldFact team	[1 = high; 5 = low]	Integer [1, 5]
HISTORY	As appropriate, the history of the requirement		Text
NOTE	Note or corresponding quality attribute in case of NFRs		Text

Table 1 – Structure of the Requirements database

The Excel table in a digital format is attached to this report (Appendix 2) and contains the following four sheets:

- FRQ – list of functional requirements;
- NFR – list of non-functional requirements;
- REC – recommendation for promotional and training activities;
- DB structure – database structure.

4 RESULTS OF THE WORK CARRIED OUT

4.1 Functional requirements

Functional requirements described in the form of user stories (see chapter 2.2) are listed in the database (the FRQ sheet). In total 19 functional requirements concerning the development of demonstrators have been included. Each requirement is completed with the rationale and contains reference to its origin. The description of requirements and proposed priority represents the initial value set up by the authors of this report. We suppose that this proposal will be further evaluated and possibly adjusted within the FieldFact project in the frame of WPs 3-6.

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4.2 Non-functional requirements

As explained in chapter 2.3, the non-functional requirements applying to the demonstrators are defined here using the extended ISO model. However, not all attributes defined in this model are particularly relevant for the demonstrators being developed under the FieldFact project. This is in part due to the fact that the extended ISO model is designed primarily for software while we are using its framework to define the qualities of the demonstrator. The other factor taken into account when defining the qualities of the demonstrators is that the goal of the FieldFact project is to develop demonstrators related to GNSS use in agriculture rather than full-fledged applications that could be readily marketed to a large number of users.

The records listed in the database (sheet NFR) cover all attributes specified in the extended ISO model. In total 33 non-functional requirements have been specified. Attributes where no indicators have been defined for reasons given above are included as well and those particular cases are explained and justified. Non-functional requirements listed in the database are not prioritized because we would like to cover the whole selected quality model.

4.3 Recommendation for the promotion and training campaigns

Recommendations for the promotion and training campaigns are listed in the database as well (sheet REC). In total 10 specific recommendations have been included. Contrary to the functional and non-functional requirements related to the development of demonstrators the list of recommendations is not exhaustive. Its role is mainly to complete the description of training and demonstration activities mentioned in the project proposal and in the draft Promotion Plan by specific recommendations resulted mainly from the stakeholder consultations and previous experience with the setup and organization of similar demonstration events.

5 SPECIFIC REQUIREMENTS CONCERNING THE USE OF SPATIAL DATA

5.1 Standardization

Within the proposed demonstrations it is envisaged that spatial data from various sources and formats will have to be combined and integrated. If one wants to do a demonstration on the use of Galileo for parcel measurement, one can use an ortho-photo in combination with a digital topographic map and/or pre-existing vector data of parcel boundaries. Also the output data of the demonstrations (parcel boundary map, recommendation and application maps) will have a data format and projection.

Data like aerial or satellite orthoimages, vector data of field boundaries, and digital topographic maps come in a variety of “flavours” depending on data vendor, country, (satellite) sensor, local regulations, etc. Most prominently the data from various sources will come in various formats (geotiff, img, hdf, etc) and projections (lat/lon, UTM, RD, GK, etc).

The following spatial data available in the EU Member States are essential and will be used with the demonstrators:

- Aerial or VHR satellite digital ortho-images – raster data to be viewed in the background; official data sets used by national/ regional administrations are preferable;
- Digital topographic map including a road map – raster or vector data helping in orientation and navigation;
- Digital LPIS data – official vector data of reference parcels used for administration and control of area based subsidies (CAP), in some countries complemented with other data layers (e.g. rural landscape features);
- Recommendation and application maps for selected VRA based on variable soil characteristics, multi-spectral remote sensed data, etc. (relevant only to high-end demonstrator).

Optionally other data could be used, for instance:

- Digital cadastral data showing the ownership of land;
- Soil sampling data from previous sampling campaigns;
- Additional up-to-date satellite images.

The main requirement for the use of spatial data in the various demonstrations is standardisation. Spatial data should be standardised in a way that is compliant with INSPIRE principles in the European context. The INSPIRE (INfrastructure for SPatial InfoRmation in the European Union) programme has explicitly been cited in the project document as a working platform for standardization, quality and availability issues. The purpose of the INSPIRE Directive is to lay down general rules aimed at the establishment of the Infrastructure for Spatial Information in the European Community (hereinafter referred to as "INSPIRE"), for the purposes of Community environmental policies or activities which may have an impact on the environment. INSPIRE shall build upon infrastructures for spatial information established and operated by the Member States [10].

The INSPIRE directive addresses various rules for standards and protocols on various aspects of spatial data like metadata, interoperability, network services and data sharing. The most important aspects relating to the FieldFact requirements on the use of spatial data are addressed in the sections below on metadata standard (ISO 19115), data format as supported by the Open Geospatial Consortium (Geography Markup Language - GML; ISO 19139), and projection issues.

5.2 Metadata

It is felt necessary to put into place a suitable metadata collection methodology in the context of the project. The advantages of such a metadata collection effort are:

- Standardization of the description of spatial data sets;
- An assessment of the quality of the spatial data sets;
- Contribution to an overview of the existence and availability of spatial data sets;
- To allow users to search for spatial data sets and possibly, retrieve them e.g. through internet availability.

The commonly adhered standard for geospatial metadata is the ISO 19115 (2003) standard [11]. This standard exactly defines what information should be stored as metadata and the linked ISO 19139 standard (see next paragraph) stipulates how this information should be stored in an xml standard. Other metadata standards which are still being used are the “Dublin Core” [12] (not primarily designed for geographic data) and for the U.S. the FGDC (Federal Geographic Data Committee) standard [13].

ISO 19115 has identified “core” elements which are mandatory, e.g. the title of the data set or the geographic extent. A European profile has been defined which has some additional “core” elements and a Dutch profile has been defined which includes not only the European profile but again some additional core elements.

The current situation is described below:

Standardization

The ISO19115 standard is subject to updates and an important development is the definition of a standard for imagery and gridded data. This is known as ISO 19115-2 and is still under discussion by the International Standards Organization. It is important to follow developments as satellite imagery will be an important input in the project.

Moreover the CEOP (Coordinated Enhanced Observing Period) refines satellite imagery with in-situ, but the ISO-19115 standard does not meet all requirements in integrating satellite imagery, in-situ observation data and 4D model simulation results as collected in CEOP.

Compatibility

A major problem of every single metadata editor is that the XML produced by any other package or tool cannot be read. This means that the editors are not fully compliant with the ISO standards which should be adopted.

On-line access

Another problem of the freeware editors is that there is no web cataloguing service to provide an on-line search facility for the spatial data sets for which metadata have been prepared. This is a major disadvantage in the context of this international project.

The latter problem has been acknowledged by De Rink (RAVI = Dutch Network for Geoinformation) and is due to the fact that there is no ISO standard yet for geospatial services [14].

Selection of specific metadata editor

For the FieldFact project it is proposed to use the CatMDEdit metadata edit tool to enter and edit the metadata for the spatial datasets covering the FieldFact demonstration test sites.

5.3 Data format

The Open Geospatial Consortium, Inc.® (OGC) is a non-profit, international, voluntary consensus standards organization that is leading the development of standards for geospatial and location based services [15]. One of these standards is the use of GML data format.

This part of the ISO 191** Family of Standards provides a spatial metadata XML (**s**patial **m**etadata e**X**tensible **M**ark-up **L**anguage (smXML)) encoding, an XML schema implementation derived from ISO 19115, Geographic information – Metadata. The metadata includes information about the identification, constraint, extent, quality, spatial and temporal reference, distribution, lineage, and maintenance of the digital geographic dataset. ISO TS 19139 is designed to provide a common XML specification for describing, validating and exchanging geographic metadata. It is intended to promote interoperability, and exploit ISO 19115's advantages in a concrete implementation specification [16].

The Geography Markup Language (GML) is an XML encoding for the representation and exchange of geographic information, including both the spatial and non-spatial properties of geographic features. This specification defines the XML Schema syntax, mechanisms, and conventions that

- provide an open, vendor-neutral framework for the definition of geospatial application schemas and objects;
- allow profiles that support proper subsets of GML framework descriptive capabilities;
- support the description of geospatial application schemas for specialized domains and information communities;
- enable the creation and maintenance of linked geographic application schemas and datasets;
- support the storage and transport of application schemas and data sets;
- increase the ability of organizations to share geographic application schemas and the information they describe.

Implementers may decide to express geographic application schemas and information in GML, or they may decide to convert from some other format on demand and use GML only for schema and data transport.

GML was developed with a number of explicit design goals, a few of which overlap the objectives of XML itself. These are to:

- provide a means of encoding spatial information for both data transport and data storage, especially in a wide-area Internet context;
- be sufficiently extensible to support a wide variety of spatial tasks, from portrayal to analysis;
- establish the foundation for Internet GIS in an incremental and modular fashion;
- allow for the efficient encoding of geo-spatial geometry (e.g. data compression);

- provide easy-to-understand encodings of spatial information and spatial relationships, including those defined by the OGC Simple Features model;
- be able to separate spatial and non-spatial content from data presentation (graphic or otherwise);
- permit the easy integration of spatial and non-spatial data, especially for cases in which the non-spatial data is XML-encoded;
- be able to readily link spatial (geometric) elements to other spatial or non-spatial elements.
- provide a set common geographic modelling objects to enable interoperability of independently developed applications [17].

Conversion of spatial data into GML format

The data used in the FieldFact demonstrations will be exchanged using the GML format as far as possible, and will hence be compliant with the OGC standard.

5.4 Projection system

Besides format and metadata description, another important prerequisite to allow for data interoperability is the geographic projection of the various datasets. Many countries (within the European Union) have their own projection system. To allow for data viewing, searching and downloading from a common portal within the FieldFact project, the data should be re-projected to a single European-wide projection, covering all demonstration sites. This is in fact in line with the INSPIRE directive on “network services”.

There is an initiative from the JRC (Joint Research Centre of the European Commission) to come to a suitable map projection for spatial data for use by the Commission in its activities. The result is a proposal of the ETRS89 (European Terrestrial Reference System) Lambert Conformal Conic Coordinate Reference System (ETRS-LCC). This is based on the GRS80 ellipsoid and is the basis for a coordinate reference system using ellipsoidal coordinates [18].

Most GNSS (GPS) receivers nowadays are working with WGS84 as datum, and are usually set to work in a Geodetic projection (Latitude/Longitude).

Selection of projection system for spatial data

For the FieldFact project it is proposed to use the Geodetic/WGS84 projection as it is for the moment the most widely used common projection system that can be used on a European scale. It is envisaged however to comply with the ETRS-LCC system in the near-future.

6 CONCLUSIONS & RECOMMENDATIONS

Requirements concerning the development of demonstrators and recommendations for promotion and training have been prepared and included in the database table. In total 62 records (19 functional requirements, 33 non-functional requirements and 10 recommendations) are listed in the database. Each requirement/ recommendation is described and rationalized. In addition, the origin (document or person/ group originating the requirement) and the value of the requirement to the users is mentioned as well. Priority given to each requirement/ recommendation by the team of authors represents the initial value that can be further verified and possibly adjusted. In addition specific requirements concerning the use of spatial data are included in the separate chapter.

The draft version of the report together with the requirements database was presented and discussed within the FieldFact team during the Mid-term review meeting held in Olsztyn from 25 to 26 September 2007. It is intended that the report is used as a basis for further development of demonstrators specifications and the content of promotion and training events.

It is suggested that the partners responsible for WP 3 use the database as one of the main inputs for functional and non-functional analysis and user interface design of both FieldFact demonstrators. It is also suggested that they perform a cross-reference between the requirements stated in this Requirements Report and the functional and non-functional specifications for both the low-end and the high-end demonstrators (DEL-3.3 and DEL-3.5).

Recommendations for promotion and training should be taken into consideration during the preparation and implementation of FieldFact promotional and training activities.

APPENDIX 1. EXTENDED ISO MODEL: QUALITY ATTRIBUTES

Functionality

A set of attributes that bear on the existence of a set of functions and their specified properties. The functions are those that satisfy stated or implied needs.

Suitability

Attribute of software that bears on the presence and appropriateness of a set of functions for specified tasks.

Accuracy

Attributes of software that bear on the provision of right or agreed results or effects.

Interoperability

Attributes of software that bear on its ability to interact with specified systems.

Compliance

Attributes of software that make the software adhere to application related standards, conventions or regulations in laws and similar prescriptions.

Security

Attributes of software that bear on its ability to prevent unauthorised access, whether accidental or deliberate, to programs and data.

Traceability

Attributes of software that bear on the effort needed to verify correctness of data processing on required points.

Reliability

A set of attributes that bear on the capability of software to maintain its level of performance under stated conditions for a stated period.

Maturity

Attributes of software that bear on the frequency of failure by faults in the software.

Fault tolerance

Attributes of software that bear on its ability to maintain a specified level of performance in cases of software faults or of infringement of its specified interface.

Recoverability

Attributes of software that bear on the capability to re-establish its level of performance and recover the data directly affected in case of a failure and on the time and effort needed for it.

Availability

Attributes of software that bear on the amount of time the product is available to the user at the time it is needed.

Degradability

Attributes of software that bear on the effort needed to re-establish the essential functionality after a breakdown.

Usability

A set of attributes that bear on the effort needed for use, and on the individual assessment of such use, by a stated or implied set of users.

Understandability

Attributes of software that bear on the users' effort for recognising the logical concept and its applicability.

Learnability

Attributes of software that bear on the users' effort for learning its application (for example, control, input, output).

Operability

Attributes of software that bear on the users' effort for operation and operation control.

Explicitness

Attributes that bear on the clarity of the software product with regard to its status (progression bars, etc.).

Customisability

Attributes of software that enable the software to be customised by the user to reduce the effort required for use and increase satisfaction with the software.

Attractivity

Attributes of software that bear on the satisfaction of latent user desires and preferences, through services, behaviour and presentation beyond actual demand.

Clarity

Attributes of software that bear on the clarity of making the user aware of the functions it can perform.

Helpfulness

Attributes of software that bear on the availability of instructions for the user on how to interact with it.

User-friendliness

Attributes of software that bear on the users' satisfaction.

Efficiency

A set of attributes that bear on the relationship between the level of performance of the software and the amount of resources used, under stated conditions.

Time behaviour

Attributes of software that bear on response and processing times and on throughput rates in performing its function.

Resource behaviour

Attributes of software that bear on the amount of resources used and the duration of such use in performing its function.

Maintainability

A set of attributes that bear on the effort needed to make specified modifications.

Analysability

Attributes of software that bear on the effort needed for diagnosis of deficiencies or causes of failures, or for identification of parts to be modified.

Changeability

Attributes of software that bear on the effort needed for modification, fault removal or for environmental change.

Stability

Attributes of software that bear on the risk of unexpected effect of modifications.

Testability

Attributes of software that bear on the effort needed for validating the modified software.

Manageability

Attributes of software that bear on the effort needed to (re)establish its running status.

Reusability

Attributes of software that bear on its potential for complete or partial reuse in another software product.

Portability

A set of attributes that bear on the ability of software to be transferred from one environment to another

Adaptability

Attributes of software that bear on the opportunity for its adaptation to different specified environments without applying other actions or means than those provided for this purpose for the software in question.

Installability

Attributes of software that bear on the effort needed to install the software in a specified environment.

Conformance

Attributes of software that make the software adhere to standards or conventions relating to portability.

Replaceability

Attributes of software that bear on the opportunity and effort of using it in the place of specified other software in the environment of that software.

APPENDIX 2. REQUIREMENTS DATABASE

The Excel table in a digital format is attached to this report and contains the following four sheets:

- FRQ – list of functional requirements;
- NFR – list of non-functional requirements;
- REC – recommendation for promotional and training activities;
- DB structure – database structure.

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