

The HUMBOLDT Project: Development of a Framework for Data Harmonisation and Service Integration

Technical Whitepaper, 18. April 2007

Abstract

This whitepaper describes the aims and current status of HUMBOLDT project, which aims to facilitate the harmonisation of spatial data and metadata by automating the necessary processes as far as possible. The project commenced with a comprehensive state of the art analysis on related themes. The methods and tools for geodata and metadata management were investigated and evaluated. Suitable software architectures were described and basic user requirements documented. On this basis HUMBOLDT will undertake a process analysis which will show the steps necessary to harmonise data and metadata. Finally, a software framework and diverse tools will be developed and integrated into the ESDI to support spatial data and service providers in offering standardized spatial information. An essential element of the project is the development of scenarios in which the different components are applied and tested under realistic conditions..

Categories and Subject Descriptors: H.3.5: Online Information Services, H.3.7 Digital Libraries.

1. Introduction

Spatial information has been available for centuries in form of paper maps. During the last decades Geographic Information Systems (GIS) have been used more and more to acquire, maintain, analyse and visualise spatial objects and processes. For these systems, large quantities of analogue data have been digitised or recollected. During this transition, no transnational coordination was established, resulting in differently modelled spatial data, which hampers and partly prevents the exchange of spatial information between countries.

In a time where this exchange becomes more and more important as a base for transnational policy making, especially for environmental and security policy, this has become a priority topic in the European Union. With this in mind, the Global Monitoring for Environment and Security (GMES) – a joint initiative of the European Commission (EC) and the European Space Agency (ESA) – has been created. In addition, the EU commission has approved the INSPIRE directive which aims at creating the legislative and technical background for the creation of a European Spatial Data Infrastructure (ESDI) to support the GMES initiative.

Within the scope of contributing to an ESDI and supporting GMES, the HUMBOLDT project focuses

on the technical aspects and does not consider political and organisational aspects. The aim of HUMBOLDT is to support the harmonisation process in terms of data management and service integration.

The project is named after *Alexander von Humboldt*, a famous scholar of the 19th century. He integrated state-of-the-art knowledge of his time in order to get new insights. This is the parallel to our project, which aims at achieving a similar goal by using existing know-how on data harmonisation for supporting the harmonisation processes in an SDI context. This approach can be used for both putting relevant INSPIRE implementation specifications into practice and bringing spatial information into new fields of application.

In HUMBOLDT the usefulness, usability and compatibility of existing tools, standards and concepts for spatial data harmonisation is investigated. Based on these results the HUMBOLDT framework is built, offering integrated functionality to support data harmonisation processes for SDI development. To ensure the usability and usefulness of this framework, the framework itself and the results that can be achieved with it will be tested and evaluated within scenarios. Since these scenarios are close to real world applications, their results provide essential information for the further development of the framework as well as “how-to” guidelines and best-practise examples on how tools and standards could be used to create the

ESDI. So, these insights can also be taken into consideration for the INSPIRE implementation guidelines and rules.

Core Facts about HUMBOLDT

Starting Date:	01 st October 2006
Duration:	4 years
Coordinator:	Fraunhofer Institute for Computer Graphics Research
Consortium:	27 partners from 14 countries
Effort:	~13.5 M€ ~110 person years

This paper, which will give you an introduction to the various aspects of the project, describes briefly the motivation for the project (Chapter 2) and its main purposes (Chapter 3). Chapter 4 outlines the methodological approach applied in the project. The specific challenges in the project and – closely related – its research topics are described in the Chapters 5 and 6. Chapter 7 outlines the benefit of the project by achieving its results (Chapter 8). The last chapter summarises this paper and gives an outlook.

2. Motivation

The growing awareness that environmental problems and security goals require for trans-national measurements leads to an increasing need of cross-border spatial information provided by various European countries. Nonetheless, actually the exchange of spatial data and the cross-border usage of services are hampered by many factors, such as:

- non-compliant data formats and models (even in one application domain)
- missing or incomplete meta data
- different semantics, representations and terminology
- unambiguous, partly contradictory national legislation (e.g. official surveying)

Borders in the usage of spatial data exist not only between countries but also between proprietary systems, application domains, languages and different parts of an organisation. In order to achieve a cross-border exchange of data and cross-border usage of services, these deficiencies have to be overcome. Common rules have to be determined which are mandatory for all ESDI participants.

However, the process of adapting existing data and services to these rules and standards is crucial for ESDI participants, especially for those who offer data or services.

3. Project Aims

The need for adapting existing data and services is the reason why the HUMBOLDT project focuses on the harmonisation processes. Harmonisation processes are identified, investigated and described in order to find ways to support them and to create an appropriate framework for spatial data harmonisation and service integration.

3.1. Processes and the current environment

Harmonisation processes consist both of technical solutions and organisational aspects. Theoretically, harmonisation could be exclusively an organisational process without any technical support. Obviously, this approach would require a huge effort. The more technical solutions can be applied in the harmonisation process, the lower this organisational effort will be. This principle is not only valid for tools but for methods, standards and concepts as well, and it is thus our objective to identify those steps that can be automated efficiently and to develop the respective tools.

According to this main objective of the project, HUMBOLDT has to investigate several relevant aspects:

- Identification of user groups and their requirements with respect to the data harmonisation processes;
- Identification of business concerns, including the current and future processes to adapt given data and services to harmonised formats and schemata;
- Evaluation of accepted and applied standards, de-facto standards and tools for spatial data management, processing, modeling and storage;
- Identification of existing services and libraries and determination of the state of the art in SDI software architectures.

The information assembled by fulfilling these secondary objectives will be used as requirements both towards the framework architecture as a whole, but also towards individual modules and functionality.

3.2. Harmonisation on multiple levels

The key aspect in achieving a horizontal and vertical exchange of spatial data is interoperability of data, models, and services. Therefore, the main objective of the HUMBOLDT project includes guaranteeing inter-

operability in syntax, schema, and semantics to exchange data and data models, including metadata. Intrinsicly tied to this task is the overcoming of various hurdles towards a harmonisation process, which includes matching of conceptual schemas, differing geometric representations, lineage of spatial data and quality information of both the data and the transformations applied to it. Also, the approach to automate harmonisation processes as far as possible plays an important role. Furthermore, means to define the applicability and orchestration of services will be developed in the project.

3.3. User Involvement

The technical contributions of the HUMBOLDT project have to serve the specific users of an ESDI, which include both service users (end users) and spatial data managers (data and service providers). In order to develop useful and usable solutions, users are considered in:

- The dissemination and exploitation strategy of the project, as well as the training measures;
- The determination of user requirements for the architecture and functional definition of the HUMBOLDT software results;
- The user forum and developer community, which are two means addressing both service users and software developers to gather feedback and momentum.

The overall strategy for managing user involvement is an integral part of the project and is compiled in a user involvement report. This report also includes a classification into typical user groups with homogeneous needs to identify and better describe group-specific requirements.

3.4. Application Momentum and Sustainability

The scenarios provide use cases to enhance visibility of the project for users. Along with their purpose of user integration into the project, the scenarios use and evaluate the developed framework components in real-world conditions and are also a major component of the dissemination and exploitation plan of the project.

Since progress outside the project will be made during the 4-year project run, another aim is the integration of the project into its environment and the sustainability of the project results. In order to keep the project results up to date and to ensure their survival beyond the project end in 2010, regular updates

and an ongoing search for innovative insights and developments are planned. Furthermore, an intensive external information exchange with INSPIRE drafting teams, other GMES-related projects and registered Spatial Data Interest Communities (SDICs) has been established. HUMBOLDT-internally the regular feedback acquisition from the implementing teams guarantees that the recommended technical solutions (tools, standards) are useful and implementable.

3.5. Broad Applicability

Finally, HUMBOLDT aims to cover a wide range of both application domains and institutions concerned with spatial information. This goal is achieved by bringing together very heterogeneous project partners in terms of nationalities, application domains and kinds of institutions.

4. Methodology

To achieve the aims of HUMBOLDT project, a methodological approach has been established in the first 2 project months. It begins with the search for and evaluation of existing technical solutions supporting SDI implementations, focussing on the support of harmonisation processes. As a result, best practice solutions are identified to be used in the development of the project framework and to be tested in eight scenarios on their practical usefulness.

4.1. Technological Base

These are the most important steps in the project's workflow to determine the technological and methodological state of the art:

In order to acquire the user needs, existing studies are analysed, interviews are conducted, and a strategy for active user involvement is developed. Beginning with the user aspects enables us to orient the project work in general towards what users really need.

Best practice solutions are searched by considering other projects (e.g. Boss4GMES, RISE, MOTIIVE) and by executing state of the art analyses in terms of tools, standards, methods, software architectures and harmonisation processes. SDI-relevant documents are searched, investigated, described and evaluated. Based on these results a Handbook of Standards is created to support the HUMBOLDT implementation teams in the development of the framework and the scenarios. In order to integrate feedback and to keep it up to date, the Handbook is updated regularly.

4.2. Framework Development

The HUMBOLDT framework will be the core software result of the project. This software framework is the hull for the various data harmonisation scenarios and provides the common functionality required by the scenarios.

This functionality addresses the core issues that need to be tackled when integrating heterogeneous existing data repositories and services into an ESDI of harmonised data. The framework is not an application, but a 'template' plus a toolbox with software components to be used by end-user applications. The proof for this approach will be carried out in HUMBOLDT adopting the framework to scenarios foreseen in the project. For the sustainability of the framework both application developers and harmonisation experts will be involved in the development. Application developers are required to adopt the framework for practical use and to further extend the framework. Harmonisation experts (usually in terms of data providers) are required for the actual mapping of services and data.

From a functional viewpoint the framework offers connectors to the commonly used data sources and formats in the geo-domain, ranging from spatial databases to web services. It fully supports the model-driven approach for data and metadata management. For data harmonisation and service integration a series of modules and applications are designed and implemented supporting data modeling and the generic creation of databases, consistency checks, security aspects etc.

The HUMBOLDT framework will be flexible and dynamic. This enables the implementation teams to integrate innovative solutions developed during the project run, for instance in the HUMBOLDT scenarios.

4.3. Evaluation by Scenarios

Besides offering a base for scenarios and project-external data harmonisation projects, the framework will also profit from this usage and the feedback that will inevitably be generated. Using these scenarios the framework will be evaluated, and it will be tested whether it is developer-friendly, addresses user's needs and matches the expectations and requirements.

Specifically, the scenarios that are used in the HUMBOLDT project are:

HS1: BorderSecurity – In this scenario, which revolves around supporting border police on the outer border of Europe, the focus is on the use of highly sensitive data, real-time sensor input and high availability of geodata from trans-border sources.

HS2: Urban Planning – This scenario addresses environmental, architectural, and social needs of all the stakeholders in urban planning by offering them integrated access and visualization of such different data as sociodemographic information and 3D city models, which makes this scenario a perfect test for data integration from different application domains.

HS3: Forest – In this scenario, which centres on the management of forests on both sides of the Czech-German border, geometric and semantic harmonisation of multiple representations and different sources of geodata are the aims.

HS4: Protected Areas – Another scenario in which highly different data sets need to be used together, from biodiversity information over land cover and dynamic input from tourist tracking to water networks.

HS5: ERiskA – The European Risk Atlas aims to integrate data from different domains and countries to build up a cross-border application in emergency management.

HS6: Water – The Water scenario is an application of the SDIGER project, which manages transboundary catchments and evaluates effects of water consumption or contamination using the HUMBOLDT framework.

HS7: Ocean – Being the largest scenario in HUMBOLDT, this project will focus on cross-border, multi-language data, with high amounts of satellite data playing an important role. However, distributed processing and 4D visualizations are used for the simulation of oil spills and other disasters.

HS8: Galileo – A scenario that will make use of the new GNSS Galileo to collect and distribute atmospheric data. These are required from several domains in a range from macroscopic to very small-scale level.

These scenarios are important drivers for the whole software development process in HUMBOLDT. To provide realistic test conditions covering a wide range of GMES topics the scenarios have been developed with a focus on heterogeneity of domains and processes. For each scenario, harmonisation is required since they have been designed to include borders of nations, application domains and formats.

4.4. Integration into the Project Environment

Furthermore, the project works together with other projects and initiatives, from the GMES area but also with other IT projects, to avoid redundant work and to extend existing or find additional test cases. Among the projects with which a close cooperation has already been established are BOSS4GMES, CASCADOSS, RISE and MOTIIVE. The first of these two projects mainly concentrates on sustainability issues of an ESDI, especially in the GMES context, while the latter two are technology-oriented and provide information on data harmonisation in a marine context as well as other valuable results.

The sustainability of the HUMBOLDT project itself is also supported by these co-operations, but there are additional activities to assure the sustainability of HUMBOLDT results. For a view on the HUMBOLDT project environment, please consult Figure 1 below.

5. Challenges

The cooperation of so many partners provides a lot of knowledge and enables us to realise the project on a very wide base. But with the number of partners the risk of an overly large portion of organisational work increases and this costs time without contributing to the project's contents. Furthermore, tracking of individual contributions and surveying project progress is more complicated and challenging than in minor projects. The project coordinator, executive board and the work packages leader are asked for an accurate management job.

Finding a common basis needs compromises, such as the definition of a common spatial geometry schema. If all available geometry types of all GIS (more than 150) are considered, there would be too much to implement preventing full interoperability. On the other side, if only a small subset is defined, several applications would fail because of the lack of a specific geometry type. Therefore, it is an essential challenge to find "ideally" scaled solutions which are neither over-boarding nor too small.

Harmonisation is not only a technical and organisational challenge of integrating data sets. Moreover, the semantics of spatial objects should be considered. For instance, a fire brigade base in Germany has a partly different function than an Austrian one. Whereas in Germany emergency physicians are part

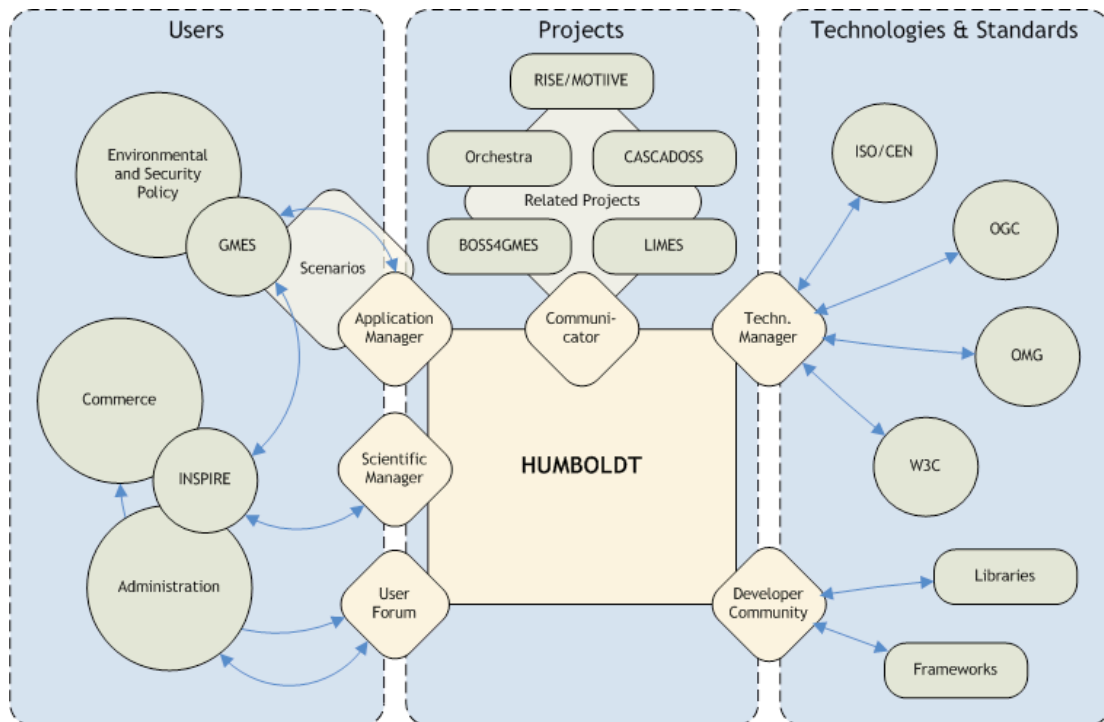


Figure 1: The HUMBOLDT Project Environment including the project's major integration interfaces

of the fire brigade, they are in Austria assigned to the Red Cross Organisation. Thus, the function of a fire brigade base differs, which has to be taken into account in the emergency response. Similar challenges can be stated in terms of multilingualism.

To achieve usable, useful and sustainable results that meet the users' requirements as far as possible is another challenge of this project. Several measures have been taken and are described in Chapter 3.

A project-internal transfer of knowledge is essential. Know-how which has been gained for the description and evaluation of tools has to be provided to the implementation teams. Since tool evaluators and implementers are not the same persons, knowledge must be transferred. Various actions (creation of concise Handbook, establishment of e-learning platform etc.) are taken to cope with this challenge.

Knowledge transfer focuses especially on the scenarios as they are a proof of concept for the development of the HUMBOLDT framework. Each scenario will utilise the harmonised data created within the Humboldt framework. In this "Humboldt Model", the scenarios then form test cases for the methodology and approaches identified in the previous project phases including WP3 State of the Art Analysis, further specified in WP5 Framework Interfaces, Models and Architecture. These interconnections of the Humboldt framework and the scenarios are established from the project inception throughout the project. Feedback between the framework WPs and the scenarios will be undertaken in a two-way process assisting in the conceptual definition of the framework model and the scenarios.

To get useful project results, the interoperability of the scenarios must be guaranteed. This challenge is met by compliance to the standards and following the guidelines and implementing rules, defined in the WP3 Handbook of Standards and further specified in WP5 Framework Interfaces, Models and Architecture. Standards from the Standards Handbook will be used within the scenarios, but this does not imply that the scenarios will follow a "single highway". Methods and a platform for feedback acquisition are developed.

From the beginning of the project, the aim is to get several applications which show the quality of the research results in HUMBOLDT and the usefulness of the ESDI for those application areas. These will act as seeds towards the creation of actual productive applications after the HUMBOLDT project will be completed. This is a primary goal, since success in this

area will lead to a rich variety of experiences, application components and commitment.

6. Research Topics

As a research project, HUMBOLDT aims to develop new solutions, which will be implemented in the framework. The following list outlines some main research topics which we expect to occur in the project development:

1. Finding and describing of harmonisation processes in order to support these processes by appropriate and usable tools. The more steps in the harmonisation process can be executed in an automated way; the lower is the effort in the management and on the organisational level;
2. Creation of data profiles for the geoinformation required in the scenarios based on the common data models provided by INSPIRE;
3. Achieve full interoperability in terms of data models and formats, which is a pre-condition for an ESDI implementation;
4. Easily understandable visualizations for complex data, especially for the complex relationships between data models from different repositories, to enable domain experts to perform a mapping;
5. Automatic transformation of geoinformation and metadata using semantic mappings that have been created by domain experts. Additionally, an approach should be developed to measure the quality of the semantic mapping;
6. Development of methodologies to maintain consistency between multiple representations from different sources, based on individual rules;
7. Orchestration of Geoservices, especially finding a way on how to orchestrate over different types of Web Service interfaces such as SOAP/WSDL, OGC-WS or REST-style web services.

7. Benefits

The HUMBOLDT framework for the harmonisation of spatial data will enable a mapping and conversion between different metadata thesauri and between different informational classes, or ontologies, thus bringing benefits to the geo-information community of users and developers for geographic services across the European Community.

Scientific and strategic impact of the HUMBOLDT project are closely bound to the more challenging sides of the project itself; well managed challenges

and solutions provided to internal problems can turn into benefits not only for the project environment and results, but also for the entire community of geo-information users, becoming a successful example of how to overcome difficulties pertained to:

- Relationships and interactions between the implementation phase of HUMBOLDT framework and the application momentum of HUMBOLDT Scenarios;
- Efficiency of the framework for data harmonisation, gained through best-fitted solutions, neither over-boarding nor too restricted for target purposes;
- Overcoming of gaps in semantic and multi-lingual issues;
- Cogency of project orientation on actual user's requirements about the implemented framework;
- Management and coordination of the pan-European dimension and heterogeneity of the project consortium.

Through the solutions of the difficulties and nodes listed above, the proposal of the HUMBOLDT framework will affect the implementation of a European Spatial Data Infrastructure (ESDI) and its community of users, ranging from institutional and political users, to enterprises working in the fields of spatial information, to private citizens and groups, to research communities in geo-spatial data issues.

In particular, the resulting harmonisation of spatial data and services, gained with the HUMBOLDT implemented framework, will enable or at least make easier geographic applications that cross:

- National borders between European Community member states, but not only;
- Application domains, affecting scientific fields of analysis not only in directly related geosciences, but bringing a wide benefit also to socio-economic studies, statistical analysis, civil protection and security, medical and epidemiological issues;
- Limitations inhered in spatial data availability, from incompatible data formats to semantic gaps related to lacking data and metadata models.

Moreover, HUMBOLDT has the role of putting a part of the INSPIRE principles and implementation specifications into practice to make sure that guidelines given by INSPIRE are actually implement-

able. The synergy will result in the reduction of implementing efforts for the future ESDI, together with an abatement of costs related to ESDI realisation, thanks to data harmonisation capabilities of the HUMBOLDT framework.

Once implemented, the HUMBOLDT framework will provide interoperability between spatial information systems, thus bringing huge benefits for the user community, i.e.:

- Enable access to geospatial services not available or not usable at this very moment, using current technological solutions, because of inconsistencies in data definitions and formats or lacking of data documentation and modelling;
- Creation of new information through the access to additional data and services, affecting the decision-making process and making it more comprehensive (in the fields of social security, environmental issues and infrastructure planning, for instance);
- Enhancement and facilitation of data and services access and distribution, thus making ESDI creation efforts more attractive for commercial and industrial partners, with a sharing of costs and resources.

The choice of Open Source solutions during the project will result in benefits and support for spatial data users, for the implementation work is made more manageable for two reasons: the integration of existing knowledge and tools, characterised by an open access to the public (especially to non-experts), and with linked reduction of costs not only for the implementation phase carried on by the HUMBOLDT consortium, but above all for the further development of the framework after the project conclusion, thanks to an open source developer community.

Finally, HUMBOLDT will be connected to standardisation bodies (OGC, ISO, CEN), through project partners already involved in OGC committees; during the implementation of the framework, international standards and technical specifications will be taken into account and a fruitful cooperation between the HUMBOLDT team and standardisation committees will bring not only to the exploitation of existing standards, but above all to HUMBOLDT contributions to current standard amendments and future standard definitions

8. Expected Results

Summarising the last chapters, there are several dimensions of results that are expected as the outcome

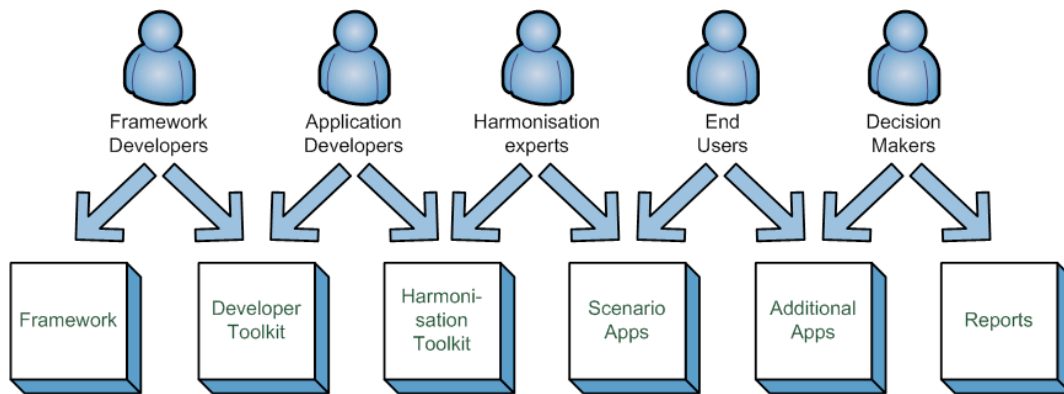


Figure 2: Main Project Results and their target groups

of this project. One of these is the infrastructure dimension, most visible in the HUMBOLDT framework, while another one are usable services and applications based on these. The next dimension is the creation of developer and end-user communities. Finally, the project also aims at influencing its environment by contributing to standardisation and by generally laying foundations for an all-around usage of spatial data.

8.1. Open Source Framework

One of the most relevant results will be the software framework and the accompanying tools, as they will be released under an open source license and thus be usable by a wide a range of organisations. The framework will be released in four versions, starting with a basic environment around June 2008 and ending with a final version in May of 2010.

8.2. HUMBOLDT Scenarios and Applications

However, the framework is something not tangible for many typical users of geoinformation. For these, the applications created on the basis of the framework will be the most visible part. The applications are created as part of each scenario, and since the scenarios cover the GMES themes, many users will be able to reflect their tasks in the functionality demonstrated by these scenario applications. The final scenario applications will be released at the end of the project, but a first version of each one will be available around March 2009.

8.3. HUMBOLDT Developer Community

An important goal of this project is the sustainability of the project results. Regarding the software results, we thus aim at creating a community of developers that will maintain, support and improve the

software, especially the framework components. To support the creation of this community, the HUMBOLDT project will create an online platform containing all the necessary tools of collaboration and information that are necessary for such a distributed development from the environment the project uses itself. The creation of the community will start with the release of the first framework version around June 2008.

8.4. HUMBOLDT User Forum

As opposed to the Developer Community, the User Forum is a place for experts and decision makers from the various GMES application fields, but also for others interested in the ESDI implementation. The User Forum should not be considered as an online web-forum; instead, this group will be supported by providing regular updates to the project, offering training and seminars, and by hosting HUMBOLDT public conferences. Two of these conferences are currently planned, one around December 2008, the other around June 2010. All in all this User Community plays an important role in giving feedback to the Developer Community and in motivating their organisations to use HUMBOLDT-based harmonisation services.

9. Summary & Outlook

This paper has described the motivations, aims, methodology, challenges and benefits of the HUMBOLDT project, giving a rationale for the HUMBOLDT framework capabilities and functionality in the context of the implementation of an ESDI.

With the approval of the INSPIRE directive, the European Parliament has set the milestone for permitting a wide use of spatial information, opening the path leading to a European Spatial Data Infrastructure. Due to the traditional heterogeneity of spatial

data throughout Europe, the challenge of creating a trans-national SDI has to face the topics of data harmonisation and service integration. In order to achieve consistency between cross-border datasets and applications, HUMBOLDT will implement a framework for the harmonisation of spatial data which will overcome deficiencies in interoperability and semantic gaps, as well as supports a vast range of application domains, data models and processes.

The major aim of HUMBOLDT is the implementation of efficient, cost-effective, reliable, generic, interoperable and sustainable solutions for the issue of spatial data harmonisation and integration of geographic services in the framework. This objective is to be reached putting INSPIRE principles into practice, applying international standards and using as core reference the users' requirements and needs, finally establishing a community of users and developers, composed by research partners and public institutions and private companies, which ensures the endurance sustainability of the HUMBOLDT framework well after the formal end of the project in 2010.

The methodology of the HUMBOLDT development is based on a dual approach, comprising both a technological and an application side, and on an iterative process of implementation, during which the solutions found are tested and validated with the cooperation of an application momentum, composed of scenarios which cover topics of utmost importance in GMES.

The HUMBOLDT project shows challenges both to geosciences research, covering topics in data harmonisation at a continental scale, and to economic and political management of such a large and heterogeneously composed consortium of partners. Nonetheless, the more relevant the challenges to face, the better the benefits which will surge from their solutions: benefits for specialised and non specialised users of spatial data, for policy-makers, planners and managers, for European citizens and their organisations, at a level which varies from local to regional to European.

HUMBOLDT results, and the subsequent ESDI implementation, will affect a broad range of application and scientific domains, thus contributing to a future development of the European Community in political integration, social welfare and economic growth.

References

- [TL05] K. TOTH, V. NUNES DE LIMA; *Data Quality and Scale in the Context of European Spatial Data Harmonisation*; 11th EC-GI & GIS Workshop, Alghero (Italy), 29th June-1st July 2005
- [SC07] P. C. SMITS, A. FRIIS-CHRISTENSEN; *Resource Discovery in a European Spatial Data Infrastructure*; IEEE Transactions on Knowledge and Data Engineering, vol. 19, no. 1, pp. 85-95, January 2007
- [AS03] A. ANNONI, P. SMITS; *Main Problems in Building European Environmental Spatial Data*; International Journal of Remote Sensing, vol. 24, no. 20, pp.3887-3902, October 2003
- [BC05] L. BERNARD, M. CRAGLIA; *SDI – From Spatial Data Infrastructure to Service Driven Infrastructure*; 1st Research Workshop on Cross-learning on Spatial Data Infrastructures (SDI) and Information Infrastructures (II), 31st March-1st April, 2005
- [BKA*05] L. BERNARD, I. KANELLOPOULOS, A. ANNONI, P. SMITS; *The European Geoportal – One Step Towards the Establishment of a European Spatial Data Infrastructure*; Computers, Environment and Urban Systems, vol. 29, pp. 15-31, 2005
- [RHL*06] T. REITZ, D. HOLWEG, D. LUDLOW ET AL.; *HUMBOLDT – Development of a framework for data harmonisation and service integration – Description of Work*; Annex I of the HUMBOLDT project contract, October 2006

Contact

The HUMBOLDT project is hosting an on-line information center under the following address:

<http://www.esdi-humboldt.eu>

Furthermore, you can direct all your inquiries to the HUMBOLDT Project Office:

zeitform Internet Dienste OHG
Fraunhoferstraße 5
64283 Darmstadt
Germany

Phone: +49 6151 155 637

Fax: +49 6151 155 634

E-Mail: po@esdi-humboldt.eu