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BESTSDI – Western Balkans Academic Education Evolution and Professional's Sustainable Training for Spatial Data Infrastructures

With the support of the Erasmus+ program:

Higher Education – International Capacity Building
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Task Report

Task T1.4: Project Curriculum on Spatial Data Infrastructures

Version 1.0

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Work Package / Task:

WP1 – Preparation / Task 1.4 – Specification of Project Curriculum

References:

Project Management Plan / Work Package 1 Work Plan / Task Group 1.4 Project Curriculum

Short Description:

This report is a deliverable of Task Group 1.4 – Specification of Project Curriculum. It defines and designs a project or baseline curriculum on Spatial Data Infrastructures based on the analysis of the outcomes of T1.1, T1.2 and T1.3.

Keywords:

Report, SDI, Needs analysis, Competences, INSPIRE

Revision History:

Revision	Date	Author(s)	Status	Description
V0.1	24/04/2017	D. Vandenbroucke	Draft	First outline and method
V0.2	20/08/2017	D. Vandenbroucke	Draft	Lessons learned from D1.1, D1.2 and D1.3
V0.3	08/09/2017	D. Vandenbroucke	Draft	Describing the main building blocks of the project curriculum based on discussions within Task Group 1.4
V0.4	03/11/2017	D. Vandenbroucke	Draft	Details for each building block of the project curriculum based on feedback received during the Nikšić meetings
V0.5	22/11/2017	D. Vandenbroucke	Draft	Finalizing the building blocks details based on feedback received during the Mostar meetings
V0.6	07/12/2017	D. Vandenbroucke	Draft	Method for the adaptation of the curriculum
V0.7	26/12/2017	D. Vandenbroucke	Final Draft	Consolidation
V0.8	28/12/2017	D. Vandenbroucke	Final Draft	Final review
V0.9	10/01/2018	D. Vandenbroucke	Final Draft	Add conclusions and references

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1. Introduction

The specific BESTSDI project objectives are to develop, test and adapt new curricula, courses, learning material and tools within the field of SDI. By the incorporation of SDI and other modern concepts based on spatial data and information, students of the new courses will provide efficiently spatial data and services to SDI users when entering the job market. In parallel, the project also introduces SDI and related concepts in undergraduate and graduate study programs of academic institutions which professional profiles are well recognized as SDI users, raising awareness among the students and professionals about the relevance of SDI and advantages of well-organized, harmonized and accessible spatial data.

In this context, the specific objective of the project is to develop appropriate curricula, courses and their content for both target groups (SDI providers and SDI users) of academic institutions, as well as for vocational LLL training initiatives. This includes the development of:

- SDI compulsory course for undergraduate study programs in geodesy;
- SDI modules for graduate study programs in geodesy and geo-informatics;
- SDI user course components (not necessary full courses) for undergraduate study programs of partner faculties;
- SDI elective courses for graduate study program of partner faculties (SDI users);
- Development of sustainable training courses (life-long education) of broad scope of professionals.

The goal of **Work Package 1 (WP1): Preparation** is to specify the content of the curricula to be developed (project curriculum and adapted curricula). The project curriculum is a general curriculum addressing the needs of the consortium as a whole (it is a sort of baseline curriculum based on existing Best Practices). Each partner university may then select appropriate parts of the project curriculum and include it in their own adapted curricula.

The WP1 is subdivided into five tasks:

Task 1.1 – Current curriculum status
Task 1.2 – Current learning material status
Task 1.3 – Requirements analysis
Task 1.4 – Specification of project curriculum
Task 1.5 – Curriculum adaptation specification

The initial activities as part of T1.1 and T1.2 focused on the collection of information on the current curriculum status in the partner countries (D1.1) and current learning material available in the program countries (D1.2). The collected material from these two initial tasks and a detailed requirement analysis (T1.3) guide and adapt, together with developments on European level, the specifications of the project curriculum (T1.4).

Due to the fact that substantial differences exist among the current curricula of partner universities/faculties and due to the different national conditions in which SDI is developed certain adaptation to the national conditions are necessary (T1.5). With the intention that this adaptation process is kept limited and well organized, so that the essence of the developed project curriculum remains the same or similar in all partner study programs, the specification for curriculum adaptation are developed.

Milestones for WP1 are:

- Project Kick-off meeting held, foreseen documents approved (M1)
- Project dissemination tool implemented (web site) (M3)
- Stakeholder survey in order to identify key requirements for the development of curricula (M6)
- Regular PMP meeting held, foreseen documents approved (M6, M12)
- Summer school executed (M7)
- Regular evaluation and reporting established (M6, M12)

In task **T1.4 – Specification of project curriculum,** the partners from the program countries and from the partner countries develop a method, and design the outline and contents of a project curriculum on SDI. This is a sort of baseline curriculum that describes the major building blocks that cover all aspects of SDI's, both from the technological as the non-technological point of view. The project curriculum describes the structure, the learning outcomes and the topics to be covered, as well as the teaching level(s), the efforts required and references to existing learning materials. The resulting design is the starting point for the activities of T1.5 Curriculum adaptation specification and the sub-sequent tasks of WP2 in which the curricula will be developed. In order to achieve this Task T1.4 members and representatives from the Task Group held regular TelCo meetings to discuss ideas and monitor progress.

The persons dealing with the execution of this task T1.4 are the task leader, the task deputy leader and all partners contributing to the deliverable. The contact information of these persons are as follows:

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TABLE 1: TASK LEADER, DEPUTY TASK LEADER AND CONTRIBUTORS OF TASK GROUP 1.4

The report is structured as follows. Section 2 briefly introduces the relevant task deliverables and associated indicators while section 3 is about the communication within the task activities. In section 4 the methodology is described. Section 5 provides a summary of the 'lessons learned' from *"D1.1 - Specification of current SDI status at partner universities"*, *"D1.2 - Specification of SDI learning material at program universities and external open sources"* and *"D1.3 - Requirements analysis"*, as well as from the first Summer School held in Split in July 2017. In section 6, the building blocks of a full SDI project curriculum are described including a brief description of their content, the topics covered, the related learning objectives, etc. This section forms the main part of the report. In section 7 the first ideas are outlined on how the project curriculum could/should be applied and adapted to local needs. The report ends with a series of conclusions (Section 8).

2. Indicators and deliverables

The task produced the following deliverables (the planned delivery dates were revised during the Split Summer School:

Number	Title	Date of delivery	Planned Date
R1.4-1	Draft outline of the report on the Project curriculum specifications	24.04.2017	08.03.2017
R1.4-2	Concept note on the method for defining the project curriculum: definitions, different types of SDI curricula	24.04.2017	08.03.2017
R1.4-3	Analysis of existing curricula and learning materials, and the requirements analysis from the project SDI curriculum description	31.05.2017	30.04.2017
R1.4.4	Draft report on Project curriculum specifications	15.10.2017	31.05.2017
R1.4-5	Final report on Project curriculum specifications	19.02.2018	15.07.2017

TABLE 2: PLANNED DELIVERABLES FOR T1.4

The task is monitored and evaluated by the following indicators and targets.

Number	Indicator	Assessment method	Target value
1	I1.4	Number of learning units in project curriculum (expressed in ECTS for academic education and number of hours for life-long learning training)	20 EQTS
			Between xx and xx hours

TABLE 3: INDICATOR(S) FOR T1.4

The target values relate to the maximum number in case all the building blocks are integrated or developed. While originally a full Master programme was envisaged (120 EQTS), the objective has been revised towards a more realistic target (20 ECTS).

3. Communication within the work package

For the purpose of internal communication between the workshops, the Project Office (PO) established a Moodle platform for communication on, and implementation and monitoring of tasks including information and data on submissions, implementation of surveys and working documents exchange.

Initial data and information collection was conducted through surveys about the existing curricula and courses at the partner institutions, through the analysis of existing studies, SDI curricula and courses in other countries, etc. (T1.1 and T1.2), and through the analysis of the requirements based on a survey among stakeholders (T1.3). All The surveys were fully web based and the results were gathered through the Moodle platform. The results of those tasks were used as a basis for the design of the project curriculum in T1.4.

Task leaders and TG members (contributors) of T1.4 communicated in following manner:

- Regular communication – via e-mail messages and through the Moodle platform;
- Information delivery and discussion notes – via e-mail and the Moodle platform;
- Initial discussions were held in the workshops in Subotica (13-15/03/2017) and Skopje (27-29/03/2017);
- Follow-up discussions were organised during the Summer School in Split (3-7/07/2017);
- Skype meetings were conducted on a regular basis in the course of July-August 2017;
- The proposed method and building blocks were discussed in more detail in Nikšić (14-15/09/2017) and Mostar (6-8/11/2017);
- The final draft was discussed by the TG1.4 members and feedback was collected from all partners early 2018;
- The final draft version of the report is submitted to the SDI stakeholder community in view of improving it for the design of the LLL activities (D4.2);
- The project coordinator/manager approved the report and close TG activities in a week after Report submission and the report will be endorsed during the PMB of 22/02/2018.

The report is complemented with a structured description of the project curriculum in the GI-N2K CDTool which will be accessible by all partners.

4. Methodology

For Task 1.4, no separate survey was organized since all the necessary information was collected in three main deliverables resulting from the activities of T1.1, T1.2 and T1.3. Therefore, those deliverables formed the basis for the analysis:

Deliverable	Question answered	Content of the analysis
D1.1 - Specification of current SDI status at partner universities + Metadata description of 221 existing courses in partner countries	Which are the existing courses in the partner countries that can 'host' SDI topics? Are there any SDI topics already covered? Do there exist specific SDI courses?	Title course Course description Structure (learning units) and topics covered Learning outcomes Language
D1.2 - Specification of SDI learning material at program universities and external open sources + Metadata description of 43 existing courses in program countries + Description of courses elsewhere in Europe (websites …)	Which are the existing courses in the program countries that can deliver course material on SDI topics? Can those existing courses be considered as Good Practice and provide a starting point for the design of the project curriculum?	Title course Course description Topics covered Learning outcomes Language
D1.3 - Requirements analysis + Survey data from 186 respondents	Which learning outcomes or competencies are considered key for SDI education and training? What is the current status of knowledge on SDI (and INSPIRE) Which Knowledge Areas of the Body of Knowledge for GI S&T are mostly related to SDI? What are other general requirements?	Knowledge Areas Topics Learning outcomes Priorities Level of teaching

TABLE 4: METHDOLOGY FRO USING THE DELIVERABLES D1.1, D1.2 AND D1.3

The analysis of the deliverables was performed in the form of 'lessons learned from …' of which the result is summarized in section 5.

It was deemed that it is difficult and makes little sense to define one big, monolithic curriculum that fits all requirements. It was decided after discussions during the Subotica and Skopje meetings (March 2017) that TG1.4 should try to design several curricula including: 1) a 'core' curriculum that all partners might offer; 2) an advanced SDI curriculum including innovative topics and 3) specific thematic curricula. As a result, the project curriculum would consist of different building blocks offered to, but not necessary integrated in all participating faculties (see also section 7).

Based on the analysis, the major structure of the project curriculum was outlined in the form of a graph (see section 6). It was decided to describe the different building blocks in detail in D1.4 (main parts and structure of the project curriculum) and to describe them using the Curriculum Design Tool of the Erasmus project Geographic Information Need To Know (GI-N2K) in a later stage. This tool is illustrated in figure 1.

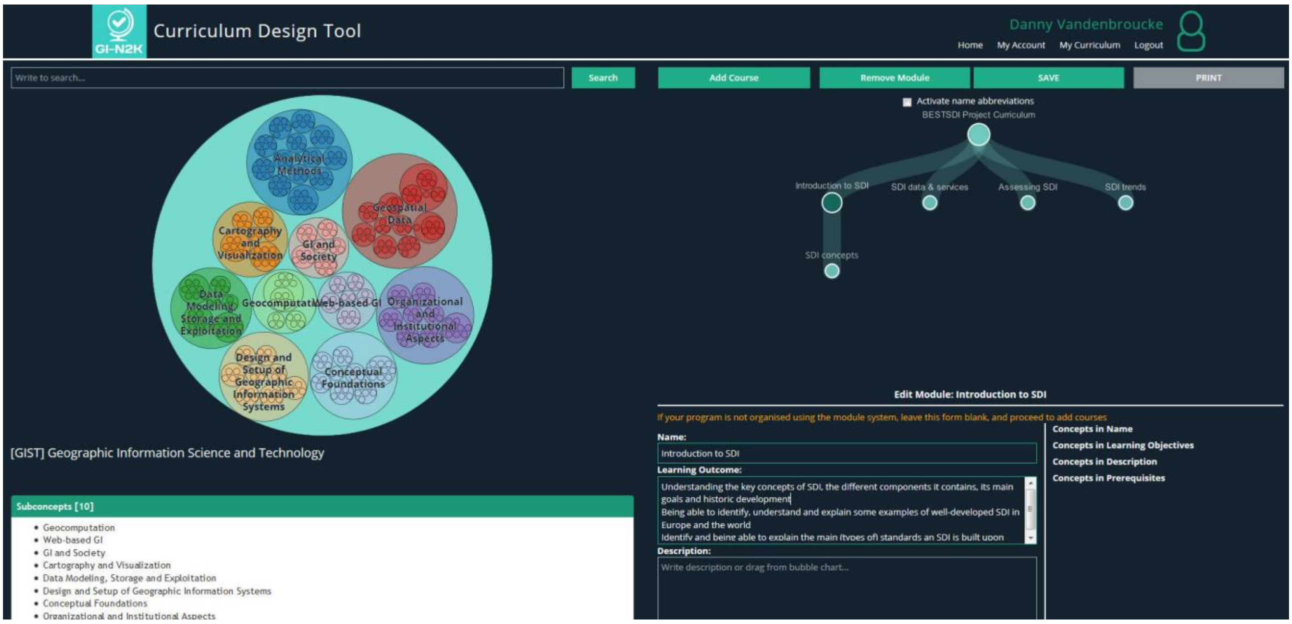

FIGURE 1: THE CURRICULUM DESIGN TOOL OF GI-N2K, USED TO DOCUMENT THE PROJECT CURRICULUM BUILDING BLOCKS

Following elements must be covered in the curriculum design phase:

N°	Curriculum Design Element	Notes
1	Structure with 4 possible levels (programme, modules, courses and lectures/assignments)	The structure is here designed at a high level, not (yet) at the lowest level(s)
2	Concepts/topics to be covered (might be a theory, a method, a technology ...)	Based on key-words, if possible borrowed from the BoK for GI S&T
3	Content description (in the form of an abstract)	Descriptive text of maximum half a page
4	Learning objectives or outcomes (in terms of what one should know or be able to do)	Described at the higher level, i.e. the building blocks (~ to programmes) and modules they consist of

N°	Curriculum Design Element	Notes
5	Pre- and post-requisites (if applicable)	Many SDI topics require prior knowledge and skills on basic GI S&T topics (e.g. what are Coordinate Reference Systems)
6	Required efforts in terms of EQTS and/or number of learning hours	Including all efforts: F2F lectures, e-learning, exercises, own efforts ...
7	Level at which the education and/or training is provided (based on EQF)	For the sake of simplicity it was decided to simplify the EQF levels to three major levels: introduction, advanced and expert (topics can be included in Bsc or Msc
8	The assessment method(s)	Dropped for the time being
9	Reference materials	In this stage of the project only at the higher level, i.e. refering to existing training modules

TABLE 5: CURRICULUM DESIGN ELEMENTS

The method and first outline of the project curriculum was presented and discussed in plenary during the workshops in Subotica (13-14/03/2017) and Skopje (27-29/03/2017). During the Summer School in Split, a follow-up discussion was organised and some potential interesting lectures/assignments took place (in the form of 'train-the-trainer') to give the partners a flavour of SDI content and how it could eventually become part of their own curricula. In the course of July and August several TelCo's were organised with TG1.4 members to further discuss the development of the project curriculum. The major building blocks were described and presented during a dedicated session in Nikšić. The final discussions with all the partners took place during the Mostar workshop after which the final project curriculum was drafted and finalized (early 2018).

5. Lessons learned from D1.1, D1.2, D1.3 and the first Summer School

This section summarizes the lessons learned from the analysis performed in Task 1.1, i.e. the existing courses in partner countries, Task 1.2, the existing training material in program countries and Task 1.3, the requirements expressed by GI/SDI stakeholders in partner countries. Moreover, the Summer School brought some additional lessons learned based on the practical experience from the different training sessions.

5.1. Existing courses in partner countries

The repository of existing GI and SDI courses in the Balkan region (only from the partners involved in the project) is quite rich: 221 courses were described in detail through their metadata. Courses cover various sub-fields such as: (Engineering) Geodesy, Cartography, Geographic Information Systems (GIS), Photogrammetry, etc. Figure 2 shows the tag cloud of terms/words used in the course names/titles.

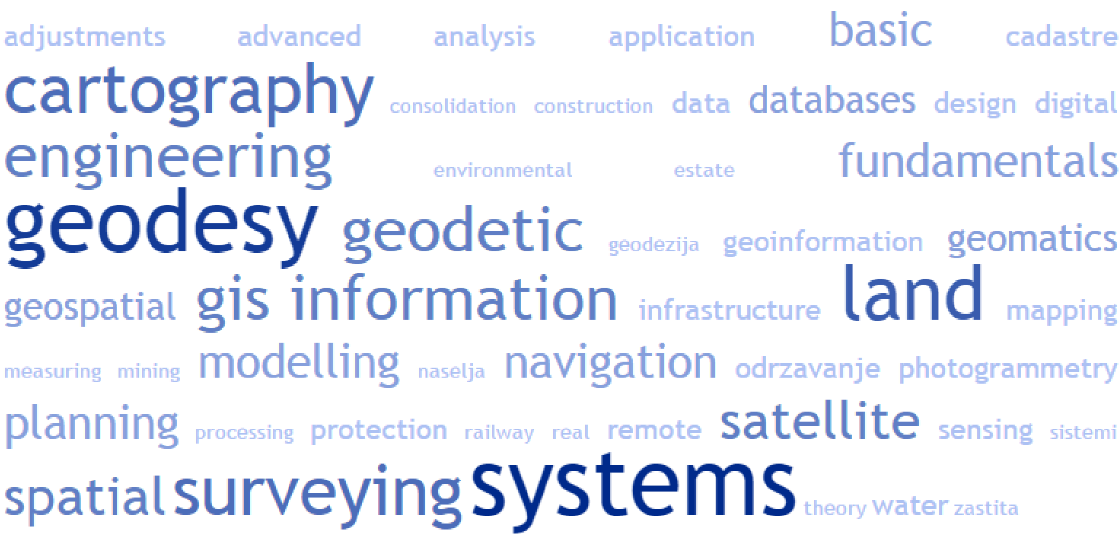

FIGURE 2: TAG CLOUD OF TERMS/WORDS THAT APPEAR IN COURSE NAMES (TUTIĆ, 2017)

The courses are from all partners, although the numbers vary strongly among partners. As can be seen in figure 2, the content/focus of the courses vary as well. Also the level and intensity of the courses vary in terms of ECTS or the required number of hours students have to dedicate to them: from 3 to 7,5 ECTS, and between 30 and 90h of learning efforts in the form of lectures, exercises and work.

There exist many courses in which SDI topics can be integrated: geodetic related courses; courses on GIS (often including topics related to data models and modelling); thematic or application oriented courses (e.g. "Land Information Systems"; "Agricultural Information Systems"; "Application of GIS in Agro-Ecological Zoning") and even a few courses on SDI (e.g. Geospatial Data Infrastructure) or

SDI related topics (e.g. Web cartography). Examples of courses in which SDI-related topics exist, are provided in table 6:

Name of the course	SDI topics	Partner	Country	ECTS
Modelling of geoinformation	Strategic design, UML, geo-standards	UniSa FCE	Bosnia And Herzegovina	5 30h lectures, 30h exercises
Geographic Information Systems	Databases and data models, INSPIRE data models	UniMo FSE	Bosnia And Herzegovina	4 30h lectures, 30h exercises
Geoinformatics	Modelling spatial entities, standardisation (ISO TC 211), 3D space modelling	UniNS FTS	Serbia	4
Geospatial Data Infrastructure	Geospatial data models, metadata, distributed architectures, standards, organisational aspects of SDI, portals	UniNS FTS	Serbia	6
GIS application	Use of geoinformation, data modelling, re-formatting, transformation, quality control	UniPz	Kosovo	6 30h lectures, 30h lab work, 10h practical work
Geospatial databases and data integration	Data modelling and representation, from 2D to 3D, catalogues and data sources	UniPz	Kosovo	6 30h lectures
Modelling and GIS	Spatial modelling, geology and mining	PUT FGM	Albania	7,5
Legislation in Albanian and EU geoinformation, standarts and INSPIRE	Albanian legislation, INSPIRE Directive, SDI concepts, EUREF	PUT FCE	Albania	5 20h lectures, 24h seminar 5h project

TABLE 6: EXAMPLES OF COURSES OF PARTNERS OF THE BESTSDI CONSORTIUM

In many of the above mentioned courses, there exist hooks for integrating SDI and SDI-related topics. SDI courses can 'easily' be modified/enhanced to host additional topics or to improve existing ones. Many of the GIS courses already contain SDI-related topics such as UML and data modelling. Also the thematic/application oriented courses can host specific SDI related topics.

In conclusion, it will certainly be possible to build further on existing courses without the need to change everything, but by integrating one or more SDI related topics.

5.2. Existing courses in program countries

A limited number of existing SDI related courses/modules and the supporting learning materials were identified and described by the partners of the program countries, 43 in total. Courses and modules are from HSB (Bochum), UniZg FoG and UniZg GTF (Zagreb), KU Leuven, UniSt FAGG (Split) and UKIM Sk FCE (Skopje). The materials cover both academic education and vocational training. Most of the material is in English although other languages are covered as well (Croatian, Dutch, German). The academic courses vary between 2.4 and 10 ECTS, distributed between Bachelor and Master courses. Only a few PhD courses are described as well. The courses and training modules are a mixture of lectures, practical training, workshops and self-training (e-learning).

The materials cover most of the SDI-related topics, but overlaps and also some gaps exist. Almost all courses and modules cover the technical aspects (39/43), but many also cover organisational (25/43) and policy aspects (33/43). Most of the SDI data topics as well as the usage aspects are covered. The envisaged competencies (see also Section 5.3) are also well covered, especially those related to SDI (Infrastructures and Platforms).

In conclusion, the existing training materials can most probably be re-used in the context of BESTSDI for academic as well as Lifelong Learning (LLL) initiatives (and Summer Schools). It is clear that most of the material should be re-tweaked, updated and enriched in view of the design of the BESTSDI project curriculum. Finally, the BESTSDI partnership is aware that more interesting SDI training material exist and that with little effort passed and ongoing initiatives/projects might be identified to obtain additional relevant material. In this context, the material from the LLP-LINKVIT project – *"Leveraging INspire Knowledge into Vocational Innovative Training"* - should be mentioned since only half of the modules have been described in the BESTSDI repository. The full list of 21 modules is provided in table 7. They focus not on SDI in general but rather on its European implementation called INSPIRE[1]. They are all available under a Creative Commons Attribution ShareAlike (CC BY-SA) license and therefore their re-use should not be too difficult.

Context knowledge for INSPIRE	Advanced technical modules
Introduction to INSPIRE	INSPIRE Advanced
European Geospatial Portals as SDI User Interfaces	Metadata and Catalogue Services
Basics of INSPIRE Data and Service Sharing	INSPIRE Network Services Advanced
Basic Concepts of XML and GML	Procedures for Data and Metadata Harmonisation

[1] Infrastructure for Spatial Information in Europe

Basics of INSPIRE Data Specifications	Examples of Data Transformation
Data Quality	Metadata and Data Validation for INSPIRE
Basics of INSPIRE Network Services	**Technological trends and innovative solutions**
Data Harmonisation	Introduction to Linked Data
Thematic modules	Linked Data Advanced
Nature Conservation & Natura 2000 Network	Introduction to Sensor Web Enablement
Nature Conservation and INSPIRE	
Risk Management	
Geological Data Harmonisation	

TABLE 7: OVERVIEW OF ALL THE LINKVIT MODULES

Part of the existing material has been re-used already for the first Summer School (Split, July 2017) as a kind of test-case in view of the 'train-the-trainers' actions of BESTSDI. It is proposed that, as part of WP2, all the documented modules and the ones from LINKVIT not (yet) described on the Moodle platform will be scrutinized in more detail.

5.3. Expressed requirements

In Task 1.3 an in-depth analysis was made of the stakeholders' requirements (including academia, public and private sector, non-governmental organisations) on GI/SDI education and training. The survey collected responses from 186 stakeholders spread over the partner countries, Croatia and the Republic of Macedonia. The respondents cover all the different participating countries, although important differences in response rates do exist (response rates vary between 5 and 55%) The survey did not only address the requirements with regard to education and training in SDI related topics, but addressed more broadly almost all aspects of the GI Science & Technology (GI S&T) field.

The core of the questionnaire focused on competence requirements, organised per GI S&T knowledge area (KA) (GI-N2K, 2017). Most of the listed competences were found to be somewhat to very necessary. In general, there appears to be more need for competences related to KA conceptual foundations, geospatial data, cartography and visualization, and society than the competences of the other KAs. The least needed competences refer to KAs analytical methods, design aspects, data modelling and data manipulation. The competences of remaining KAs infrastructures & platforms as well as organizational & institutional aspects are intermediaries. From the survey, the most needed single competences were found to be the following in decreasing order of necessity):

- *Working with land administration systems* (KA geospatial data)
- *Know about legal aspects* (KA society)
- *Being aware of relevant (national) legislations/regulations* (KA society)
- *Understand basic elements* (KA conceptual foundation)

- *Measure basic geometric properties* (KA analytical methods)
- *Assess data quality* (KA geospatial data)

(Crompvoets, 2017)

The above defined priorities and results of the survey generally confirm to a certain extend the lack of awareness about what SDI is/could do for different stakeholders. This became also clear through the survey specific questions regarding INSPIRE which gauged the extent of knowledge and understanding of INSPIRE which was found to be quite low. Moreover, the survey confirmed clearly that there is currently less interest in certain very specific SDI-related topics (e.g. Sensor Web Enablement). This could be expected, also because the survey was set-up more broadly and therefore reflects also the stakeholders' broader interest and current practices. But at the same time this also stresses the need to raise more awareness about SDI and INSPIRE among relevant stakeholders.

Considering the results of the survey from the perspective of what is needed to cover all SDI-related activities (so more from the SDI expert point of view), additional conclusions can be drawn. In the table below, relevant SDI-related topics in different KAs and the required competencies are listed. Some of these were found by the stakeholder to be less relevant/important, but might still be taken into account from the point of view of the experience in developing and using SDI's throughout Europe.

Knowledge Area	Competences
Conceptual Foundations	Understand the concepts of data ontology
	Understand the concepts of data sharing
Geospatial Data	None
Cartography and Visualization	Choosing adequate graphic representations (e.g. thematic mapping, web mapping and visualization, visualization of temporal geospatial data)
Analytical Methods	None
Design Aspects	Designing databases (e.g. Modeling tools, conceptual/logical/physical models)
	Designing system architectures (e.g. UML)
	Application design (e.g. user interfaces, workflow analysis and design)
	Implementing system (e.g. implementation planning, system testing and deployment)
Data Modelling	Understand database Management systems (relational DBMS, OO-DBMS)
	3D modelling (e.g. modelling three-dimensional (3D) entities, GML)
	Temporal phenomena (e.g. spatio-temporal GIS)
Data Manipulation	Transforming data representations (e.g. data model conversion, format conversion, coordinate transformations)

Knowledge Area	Competences
	Transaction management (e.g. database versioning/changings)
Infrastructure & Platforms	Being familiar with Spatial Data Infrastructure concepts (e.g. models, components, objectives)
	Being familiar with Spatial Data Infrastructure practices (e.g. existing practices, trends)
	Applying Spatial Data Infrastructure concepts into practice (e.g. case studies)
	Assessing Spatial data Infrastructures (e.g. existing approaches)
	Managing metadata (e.g. metadata standards, metadata description, metadata catalogues)
	Developing web portals and geoportals (e.g. setting up services, standards, architectures)
	Understanding relevant web platforms with SDI web services
	Understanding SDI service components
	Implementing discovery services (e.g. OGC WCS)
	Implementing view services (e.g. OGC WMS)
	Implementing download services (e.g. WFS)
	Implementing transformation services
	Implementing web processing services
	Being familiar with Sensor Web Enablement
	Being familiar with Linked Data (e.g. RDF, triples, Linked Open Data)
	Being familiar with key spatial data standards (ISO, OGC)
	Being familiar with exchange specifications and/or transport protocols
Society	Know about legal aspects (e.g. liability, privacy, contract law)
	Being familiar with relevant EU policies and EU development programs (e.g. INSPIRE Directive, PSI-Directive, Europe 2020, Digital Agenda for Europe, Digital Single Market, Copernicus)
	Being aware of relevant (national) legislations/regulations (e.g. Privacy, Re-use)
	Considering economic aspects (e.g. valuing and measuring benefits, models of benefits, measuring costs)
	Manage GI in the public sector (e.g. public participation GIS, E-Government, co-creation)
	Geographic Information as property (e.g. copyright issues, property regimes)
	Disseminate geospatial information (e.g. data sharing, partnerships, open (data) access, security)
	Applying use conditions (e.g. licensing (CC), charging)

Knowledge Area	Competences
Organizational & Institutional Aspects	Managing the GI System operations and infrastructure (e.g. system revision, Budgeting, Database administration)
	Set up organizational structures and procedures (e.g. organizational models, coordination structures)
	Develop workforce (e.g. Staff development, positions and qualifications, training and education)
	Connecting institutions (e.g. technology transfer, data sharing)
	Institutional and inter-institutional aspects (e.g. adoption of standards, technology transfer, openness, Inter-organizational and vendor GIS, balancing data access, security and privacy)
	Governing organizations (e.g. coordinating bodies, professional organizations, publications, geospatial community, geospatial industry)
	Being aware of crowdsourcing as an alternative way for geospatial data collection and its limitations (e.g. existing practices of crowdsourcing (OSM))

TABLE 8: SDI-RELEVANT KNOWLEDGE AREAS AND COMPETENCIES

It should be noticed that some of the competencies might belong to several Knowledge Areas. For example, in the Knowledge Areas „Society“ and „Organisational and Institutional Aspects“ some competencies relate also to important technological aspect (e.g. adoption of standards should certainly not only be viewed from the organizational or institutional perspective). Moreover, some of the other competencies in D1.3 are also relevant, but might be rather considered as 'pre-requisites' for courses/modules on SDI. Finally, the listed competencies were formulated at different levels: "Know about …"; "Being familiar with …"; "Understanding …"; "Being able to implement …" are all different things. Often different levels can be built in the curriculum by providing education/training at different levels, starting with the basic level and then drill-down further with e.g. more advanced exercises. All these observations should and will be taken into account when designing the project curriculum (Section 6).

5.4. Feedback from the Summer School (July 2017)

The first Summer School, organised from 3 to 7 July 2017 in Split, was set-up as a train-the-trainer activity during which staff from the partner countries could follow different SDI-related sessions. Those included, among others: "GIS as a starting point, historical development and accumulation of problems"; "Why do we need SDI? From data sharing to collaboration"; "Examples of good SDI's and geoportals"; "The use of SDI components"; "Necessary SDI components"; "Making your data discoverable"; etc. For many participants, professors and tutors from the participating faculties, it was the first experience with SDI-related topics.

The Summer School revealed the following:

- SDI is quite new for most, but relevant topics can be integrated in existing curricula;
- The technical as well as the non-technical aspects are important;

- The hands-on exercises on how to use and set-up SDI components are interesting and should become part of the curriculum;
- Standards are very important, technical and content-wise;
- Also future aspects and new developments should be taken into account (e.g. Linked Data)

6. Project curriculum design

The design of the project curriculum is organised in different steps: from high level, and then gradually to a more detailed design. We describe first the major building blocks required to cover all aspects of SDI based on experiences at different European universities and in other European projects (e.g. LINKVIT), and how these can be organised/used. Secondly we describe in more detail every building block in terms of content, topics covered, learning outcomes, etc. The more detailed descriptions, up to the level of separate lectures/assignments, will be done in a later stage (WP2).

6.1. Overview of the main building blocks

The building blocks have been designed on the basis of 'logic' steps in the SDI learning process. The idea is that students at participating faculties at least gain knowledge in what SDI's are, what they can do and what they consist of. Moreover, it is of utmost importance that this knowledge is not limited to some 'theories' and 'principles', but is also illustrated with examples and use cases on how a GI user can use SDI's. Then, depending on the possibilities/interest of the faculties and the 'room' available in existing courses (parts of) other building blocks can be added and focused on. The experience is that it is very difficult to host all aspects of SDI's in one course, or even in several courses. The span-width of SDI topics is too broad for doing that.

Based on these assumptions the curriculum is set-up as a series of building blocks, initial as well as specialized ones (see figures 3 and 4). Some of those building blocks are 'required' (blue), others are rather 'optional' (yellow), depending on the focus and interest of the faculty (e.g. more interested on data use versus more technology oriented), while the remaining ones are 'nice-to-have' (green).

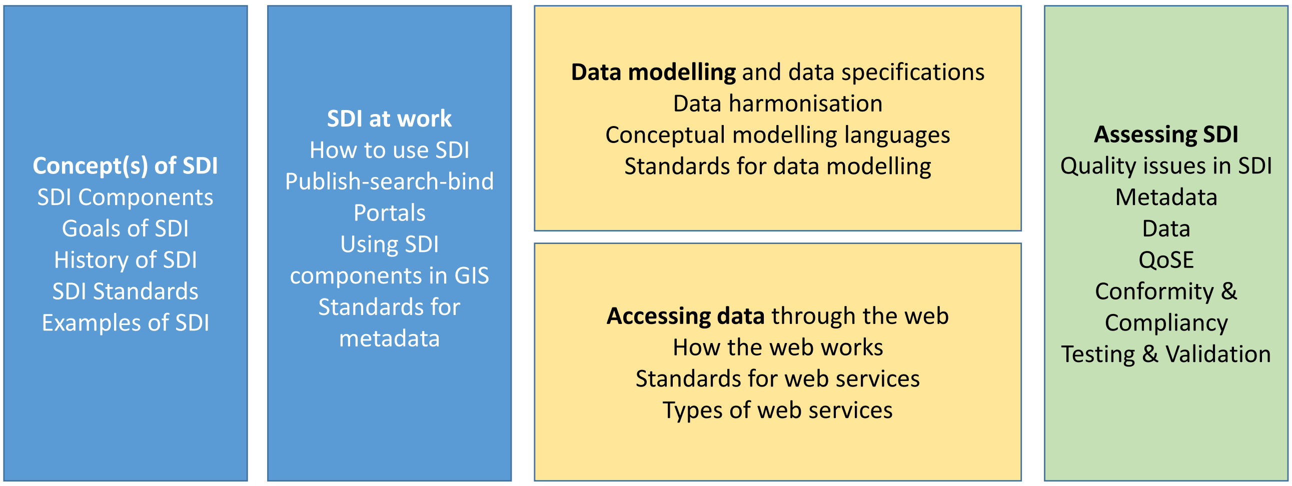

FIGURE 3: INITIAL SDI LEARNING BUILDING BLOCKS

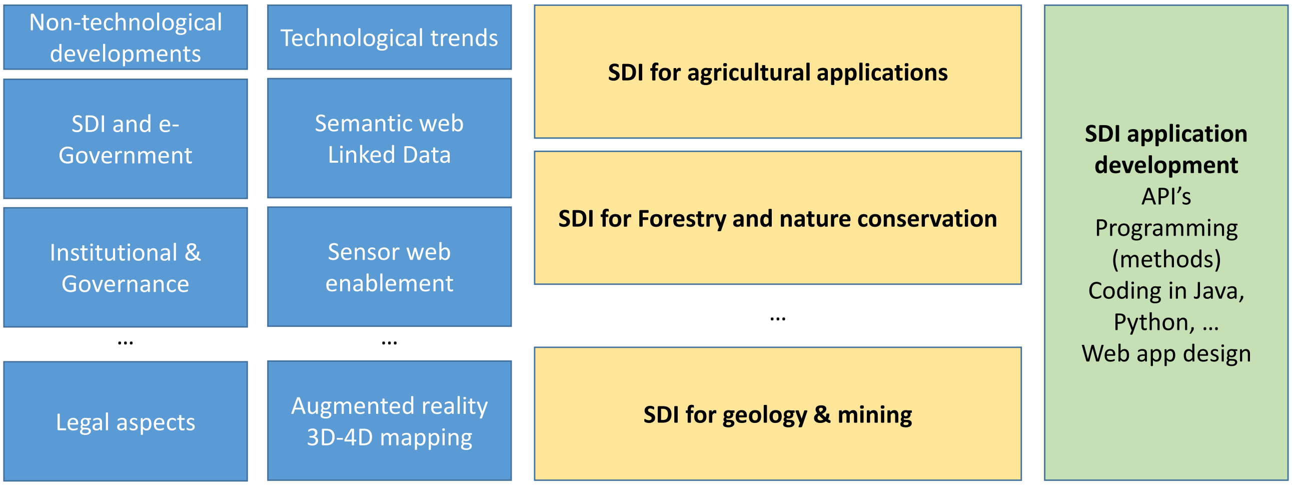

Figure 4: Specialized SDI Learning Building Blocks

The three colours provide also a logic from the sequence point of view: it is not possible to tackle the yellow building blocks without tackling first the blue ones, while it is also not possible to teach topics from the green building blocks without having treated the blue and (some of) the yellow ones.

Each building block requires a minimum number of teaching/learning hours. For example, to teach the concepts of SDI, the components they consist of and to provide some basic insights in the geospatial standards they rely on (including examples), a minimum of 1,5 h is needed, but ideally this would be 6h. This is similar for the second building block, the use of SDI's: a minimum is needed to introduce the topics, while ideally 12h are available especially for assigning extensive exercises. Altogether, the blue building blocks could be considered as core SDI education/training with a minimum of 6 hours required for the 4 blocks, in total.

It should also be noted that some of the topics listed in the yellow or green building blocks can be integrated in the blue building blocks, e.g. an example of an SDI implementation in a particular application field (agriculture, soil, water …) could be provided in the building blocks "SDI concepts" and/or "SDI at work". Some of the topics related to Quality Assurance can also easily be integrated in the same building blocks "SDI concepts" and/or "SDI at work".

6.2. Detailed description of the building blocks

In this sub-section we describe in more detail the building blocks: title, the topics covered, its content (in the form of an abstract), the structure, the major learning outcomes, pre- and post-requisites, the level(s) and formats, the required efforts in terms of learning hours and the 'value' as number of ECTS, and the available reference(s)/reference material.

6.2.1. SDI Concepts

Title: SDI concepts and principles

Topics covered: spatial data; data and service sharing; barriers to access and use, sharing and (re-)use of data; SDI objectives; SDI components; SDI standards; SDI examples; History of SDI and SDI typologies.

Abstract:

This building block focus on the basic concepts, definitions and principles which underpin Spatial Data Infrastructures (SDI). A Spatial Data Infrastructure can be defined as the collection of technological and non-technological components to facilitate and coordinate the exchange and sharing of spatial data. The concept infrastructure is used to promote the concept of a reliable, supporting environment, similar to a road or telecommunications network, that facilitates the access to and the use of spatial data. Data, metadata, access mechanisms and networks, standards, coordination, policies, funding, people and institutional frameworks are often considered among the key components of an SDI. SDIs have been developed in many countries worldwide at local, national and international levels. Often a distinction is made between a between the first generation SDIs that have data as their key driver and are based on a product oriented model and second generation SDIs in which user needs are the key driver that are based on a process or development model. Although SDI are by default distributed systems, involving many organisations, some SDI might be developed rather in an hierarchical way, while others are following a networked approach. This building block is rather theoretical, but it also pays attention to examples of SDI implementations and the use of harmonised data and services for various thematic applications.

Structure:

- The usage of spatial data in different application domains: examples of spatial data (sets) and applications;
- Existing barriers to access and use spatial data: non-harmonisation, licensing and pricing, restricted use, …;
- SDI's as answer to resolve those barriers: facilitating access, stimulating sharing and optimizing use;
- Different components of SDI: data, metadata, access mechanisms, standards, people and organisations, institutional and legal aspects …;
- Different types of SDI and different models: hierarchical or network based, connecting distributed resources;
- Main geospatial standards, the standardisation process and relevant standardisation bodies;
- Examples of existing SDI's, their evolvement over time and comparison worldwide.

Learning outcomes:

- Understand and being able to identify the objectives of SDI's, the different components of an SDI and the different types of SDI in place;
- Gaining insight in the geospatial standardisation process, the most important standardisation bodies and the different types of geospatial standards;
- Being able to identify existing Best Practice SDI implementations in the world.

Pre- and post-requisites:

Pre-requisite(s) – Geolocating data to earth, Fundamentals of Geographic Information, GI collection techniques, Relationships and GI, GI Storage and Management techniques.

Level(s) and formats:

- Basic – Lectures (and demonstrations)

Required efforts: between 1,5 and 6 hours

Value: 0,5 ECTS (if fully developed)

Reference material:

LINKVIT modules – Introduction to INSPIRE, Basics of INSPIRE Data and Service Sharing.

Some courses of the University of Zagreb are directly related to this building block: "Geoinformation Infrastructure" and "Open Geoinformation".

From KU Leuven, following courses can be used as reference material: "Spatial Data Infrastructures".

From Bochum University of Applied Sciences following courses can be used as reference material: "Normen und Standards" (in German) and "Geoinformatics".

From the Faculty of Civil Engineering of UKIM, Macedonia, following course can be used as reference material: "Web GIS".

6.2.2. SDI at work

Title: SDI at work

Topics covered: Publish-Search/Find-Bind paradigm, Geoportals and Open Data Portals, Metadata, Catalogues and Catalogue Services, Metadata Standards and Metadata Elements, Discovery and Evaluation of metadata (fit-for-use concept).

Abstract:

This building block is to introduce the users perspective of SDI's. How can users of geographic information find the information/data sets required for a particular application? SDI and other information infrastructures have defined the idea of single access points making use of the basic principles of the WWW to search for data and services, and to obtain information about the data and services (metadata) in order to understand the data (e.g. where does the data come from, what are the conditions or limitations of use, what is the area covered, the validity date, etc.). Users need to evaluate whether data and services are fit for (a particular) use. Metadata are stored in metadata catalogues and can be accessed through the catalogues services which are built on top of it. Good geoportals are simple to use and provide not only data about the data (and services), but also a mechanism to visualize and browse the spatial data to find more information about its content. Users should also be able to use the data in other applications by downloading the data on the own computer or by opening the data (layer(s)) in desktop applications. This is a building block with a series of exercises and can be extended with group work.

Structure:

- Introducing the publish-search/find-bind paradigm by using single points of access (portals) to distributed data and services;
- The role of metadata in SDI, the different types of metadata (discovery, evaluation and usage) and the standards they are built upon (ISO 19115, ISO 19119 and ISO 19139);
- The role of catalogues and catalogue services, and the concept of harvesting catalogues;
- How to evaluate whether a data set or a service is of the required quality and is fit for purpose (fit for intended use);
- Provide examples and 'simple' exercises to search for specific data sets and services, to correctly evaluate the content of the metadata record and to bind the data in a GIS desktop or other application;
- Providing examples of good geoportals and open data portals and discuss the characteristics of good portals (rich content, multiple providers, …).

Learning outcomes:

- Being able to identify the different functionalities and operations of geoportals and to identify the characteristics/criteria of/for good geoportals;
- Understand and being able to identify the standards for metadata and the mandatory metadata elements required for spatial data sets and services;
- Being able to search and find a specific spatial data set or service through a geo-portal, to evaluate the resource and to load it through a web service into an application (e.g. QGIS).

Pre- and post-requisites:

Pre-requisite(s) – Geolocating data to earth, Fundamentals of Geographic Information, GI collection techniques, Relationships and GI, GI Storage and Management techniques.

Pre-requisite(s) – "SDI Concepts and Principles"

Level(s) and formats:

- Basic – Lectures + exercises (and possibly group work)

Required efforts: between 1,5 and 12 hours

Value: 1 ECTS (if fully developed)

Reference material:

LINKVIT modules: European Geospatial Portals as SDI User Interfaces, Metadata and Catalogue Services, Basics of INSPIRE Data Specifications; Procedures for Data and Metadata Harmonisation.

Some courses of the University of Zagreb are directly related to this building block: "Geoinformation Infrastructure".

From KU Leuven, following courses can be used as reference material: "Spatial Data Infrastructures".

From Bochum University of Applied Sciences following courses can be used as reference material: "Sharpen your GIS skills" and "Geoinformatics".

6.2.3. SDI data

Title: SDI data modelling and data harmonization

Topics covered: spatial data; data models and data specifications; data harmonization and data interoperability; data transformation; standards for data modelling (ISO 19100 series); conceptual modelling languages; data exchange formats.

Abstract:

This building block deals with the representation of formalized spatial and spatio-temporal reality through data models and the translation of these data models into data structures that are capable of being implemented within a computational environment (i.e., within a GIS or more likely within a spatial data base). Data modelling is a crucial topic as it defines the content of a spatial database and the usefulness of this content (data) for certain applications. Data Modelling is performed using system neutral conceptual modelling languages like UML. These conceptual models have to be transferred to logical models (i.e. tables of a database). Data is stored in spatial data bases which are normally organized in an object relational way. For certain types of data specific data bases are used, like triple stores, NoSQL DBs, Array DBs etc. For data modelling quite a number of ISO standards are available for deriving the conceptual model as well as for rules for application schemas, spatial schemas, temporal schemas, quality principles, encoding, 3D modelling (CityGML) etc. Data models provide the means for formalizing the spatio-temporal conceptualizations. Data models also form the basis for using data together, e.g. in a cross-border context. Therefore they should be interoperable (semantically speaking). Data harmonization might be necessary by transforming data from one data model to a standard specification (following another but related data model), e.g. such as in INSPIRE. Extract Transform Load (ETL) processes might be required for doing so based on syntactic and semantic transformation rules.

Structure:

- Reading and using the UML conceptual modelling language (including how to read application schema's);
- Modelling our universe of discourse: spatial, temporal and other aspects;
- Difference between conceptual, logical and physical data models;
- ISO 19100 series of standards: reference model, spatial schema, temporal schema, rules for application schema, portrayal, data product specification, …;
- Encoding mechanisms and data exchange formats (including XML, GML and RDF);
- Explaining and analysing examples of product specifications and INSPIRE data specifications in particular (examples to be chosen depending on the field of interest);
- Data harmonisation and semantic interoperability;
- The role of ontologies and vocabularies;
- Comparing existing data sets or data models against specifications;
- Methods and steps for data transformation and the definition of syntactic and semantic transformation rules;
- Data quality and validation of transformed data.

Learning outcomes:

- Understanding the key concepts and principles of spatial data modelling and data modelling languages;
- Being able to identify, read and interpret the relevant International standards for defining such specifications;
- Obtaining the knowledge and basic skills in order to be able to harmonize existing data sets towards such specifications based on mapping, matching and ETL techniques.

Pre- and post-requisites:

Pre-requisite(s) – Geolocating data to earth, Fundamentals of Geographic Information, GI collection techniques, Relationships and GI, GI Storage and Management techniques.

Pre-requisite(s) – "SDI Concepts and Principles" and "SDI at work"

Level(s) and formats:

- Basic – Lectures (and demonstrations)
- Advanced – Lectures and exercises
- Expert (LLL) – Lectures, exercises and group/home/project work

Required efforts: between 6 and 36 hours

Value: 3 ECTS (if fully developed)

Reference material:

LINKVIT modules: Basic concepts of XML and GML; Basics of INSPIRE Data Specifications; Data Harmonisation; Procedures for Data and Metadata Harmonisation; Examples of Data Transformation.

Some courses of the University of Zagreb are directly related to this building block: "Geoinformation modelling"; "Spatial Databases" and "Geoinformation Infrastructure".

From KU Leuven, following courses can be used as reference material: "Advanced GIS concepts and applications"; "Spatial Databases" and "Spatial Data Infrastructures".

6.2.4. SDI access mechanisms

Title: SDI access mechanisms

Topics covered: WWW; Service Oriented Architecture (SOA); URI's, URL's and URN's; Servers and services; Data delivery through services; Standard interfaces; OGC Web Services; Service Capabilities and Operations; Service chaining and orchestration; SOAP and REST(full) Services.

Abstract:

This building block brings insight in the architecture, the technological solutions and standards used to access geospatial data through the web. The major architecture patterns are explained and the Service Oriented Architecture (SOA) is explained in more detail. Different types of web services exist, including SOAP and REST(full) services. In the most simplistic way a web service may be defined as "a Web accessible program code which performs a task of either processing or serving some data. Although there are many other definitions in the related literature, the one in W3C (2004) seems to be quite complete and referring to also lately popular REST style Web services. It states that "…We can identify two major classes of Web services: REST-compliant Web services, in which the primary purpose of the service is to manipulate XML representations of Web resources using a uniform set of "stateless" operations; and arbitrary Web services, in which the service may expose an arbitrary set of operations. The Open Geospatial Consortium has developed a whole suite of web services to operate on geospatial data. The most prominent, such as WMS/WMTS and WFS are explained in detail and exercises are available for setting-up such services. The Catalogue Web Service (CSW) explained from the usage perspective in building block "SDI at work" will be explained in detail as well and exercises are available for learning how to set-up a catalogues and CSW. Each service has specific capabilities and possible operations on geospatial data. An overview of other OGC web services is provided as well: e.g. Web Processing Services (WPS), Web Coverage Services (WCS) and Sensor Observation Services (SOS). Web services can be 'combined' by linking them to each other, by chaining them or through orchestration.

Structure:

- Fundamentals on how the WWW works, the technology stack and protocols used, its basic operations and the importance of URI's, URL's and URN's;
- Architecture patterns and overview of the Service Oriented Architectures used in most SDI's, based on at least three tiers: data, applications (clients) and services;
- Web services: what are they; what can they do; how do they work and what are different types of web services;
- OGC web service interfaces for accessing, discover, download, visualize, process … geospatial data;
- Detailed explanation and discussion on how WMS, WFS and CSW work, including examples from INSPIRE;
- Discussing the need for elaborating a good strategy for service implementation: how to implement portrayal, how to organise layers (in case of WMS); potential issues of performance; …
- Overview of support of OGC web services in popular GIS software;
- Exercises to set-up different type of OGC web services such as WMS/WMTS, WFS, CSW.

Learning outcomes:

- Being able to identify the main characteristics of the web and the importance of URI's, URL's and URN's and how they are composed, as well as the major components of a Service Oriented Architecture;
- Gaining knowledge and insight in the different types of OGC web services and how they work and the capabilities they have;
- Being able to set-up 'simple' web services to visualise, download and discover spatial data sets and services.

Pre- and post-requisites:

Pre-requisite(s) – Geolocating data to earth, Fundamentals of Geographic Information, GI collection techniques, Relationships and GI, GI Storage and Management techniques.

Pre-requisite(s) – "SDI Concepts and Principles" and "SDI at work"

Level(s) and formats:

- Basic – Lectures (and demonstrations)
- Advanced – Lectures and exercises
- Expert (LLL) – Lectures, exercises and group/home/project work

Required efforts: between 6 and 36 hours

Value: 3 ECTS (if fully developed)

Reference material:

LINKVIT: Basics of INSPIRE Network Services; Metadata and Catalogue Services; INSPIRE Network Services Advanced and Introduction to Sensor Web Enablement.

Some courses of the University of Zagreb are directly related to this building block: "Geoinformation Infrastructure", "Open Geoinformation" and "Programme Engineering in Geomatics".

From University of Split, following courses can be used as reference material: "Introduction to GIS with practical applications".

From KU Leuven, following courses can be used as reference material: "Spatial Data Infrastructures".

From Bochum University of Applied Sciences following courses can be used as reference material: "Sharpen your GIS skills", "Normen und Standards", "Web GIS" and "Geoinformatics".

From the Faculty of Civil Engineering of UKIM, Macedonia, following course can be used as reference material: "Web GIS", "Spatial Data Infrastructures" and "Geoinformation Systems".

6.2.5. SDI assessment

Title: SDI assessment and quality issues

Topics covered: Quality Assurance; Quality Control Process; QA of metadata, data and services; Quality and Experience of a Service; Conformity and compliancy; testing and validation; SDI assessments and benchmarking; impact assessment (value, C/B) and performance measurement.

Abstract:

This building block focusses on different aspects of 'quality' related to SDI (components). On the one hand it provides insight in Quality Assurance issues and the Quality Control process that should be put in place to assess the technological components of an SDI: the metadata, data and web services. High quality metadata are key for a good functioning SDI since it provides the first information about the data and services available, including information about their quality and conformity. The spatial datasets in an SDI should be harmonized in order to use them in a cross-border and cross-disciplinary context. QA of spatial data in SDI focus rather on whether the data are conform agreed specifications. This type of quality control is complementary (but does not replace) QA/QC of data production and individual data products. Data quality is the degree of data usability in relation to given objective and a particular application. The expectations to data vary between different applications. The key criteria in data quality are the amount of uncertainty in data as compared to the acceptable level of uncertainty. Appropriate metadata is inevitable for these judgements. Aspects of data quality include geometric and thematic accuracy, (in)consistencies, resolution, precision, usability and others. Assurance of data quality may be improved by following proper standards and SDI regulations for data collection and management. System of basic data quality measures for geospatial domain in the EN ISO 19157:2013 standard. Also for geospatial web services, quality and experience of usage are of utmost importance: service should be always available, perform well, even when used by many users at the same time. Quality aspects of an SDI also relates to how well the coordination and collaboration is set-up, and whether the SDI involves all relevant stakeholders and data/service providers, etc. From that perspective, SDI can be assessed and benchmarked, both from the technological and non-technological point of view.

Structure:

- What is Quality Assurance in the context of SDI's and how does the quality control process work?
- The difference between QA of spatial data production and data products (in terms of accuracy, completeness …) and QA of SDI components;
- The difference between QA and conformity/compliancy with standards and specifications in the context of SDI;
- Detailed QA and quality control issues related to metadata and catalogues: problems and issues that might occur, including examples and how to solve them;
- Quality and Experience of a Service: how well does a service work from a user perspective (the way it is organised and can be used, portrayal, …) and from a technological perspective, i.e. against standards or specifications (availability, capacity and performance);
- Methods for testing and validating harmonized data against data specifications including examples;
- Overview of tools and environments to perform testing and validation;
- SDI assessments: different methods to compare and benchmark SDI implementations;
- Exercise to explore different SDI's and evaluate them based on one or more methods and to compare results;
- Introducing aspects related to value, cost/benefits and performance management in the context of SDI's.

Learning outcomes:

- Being able to identify Quality Assurance issues and the Quality Control Process in the context of SDI for the major SDI technological components: metadata, data and web services;
- Obtain in depth knowledge and basic skills to assess metadata quality on data and services including the use of tools to check their contents and conformity;
- Being capable of assessing different SDI's based on the pre-defined set of criteria for evaluating and benchmarking SDI's.

Pre- and post-requisites:

Pre-requisite(s) – Geo-locating data to earth, Fundamentals of Geographic Information, GI collection techniques, Relationships and GI, GI Storage and Management techniques.

Pre-requisite(s) – "SDI Concepts and Principles", "SDI at work", "SDI data modelling and data harmonization" and "SDI access mechanisms"

Level(s) and formats:

- Basic – Lectures (and demonstrations)
- Advanced – Lectures and exercises
- Expert (LLL) – Lectures, exercises and group/home/project work

Required efforts: between 3 and 24 hours

Value: 1,5 ECTS (if fully developed)

Reference material:

LINKVIT: "Data Quality" and "Metadata and Data Validation for INSPIRE"

6.2.6. Non-technical developments

Title: Non-technological developments

Topics covered: Governance and e-Government; Institutional aspects; IPR and open licensing; PSI and re-use of data; open data; privacy, data protection and GDPR; citizens science and crowdsourcing

Abstract:

This building block is digging deeper into the non-technical aspects of SDI's and how they are currently evolving. The building block consists of a series of broader topics that can be developed as full building blocks themselves. This can especially be done when non-technical faculties are involved (law, social science). It is expected however that these topics will be covered together as part of an existing course in the form of an overview. One of the key aspects that is covered is how geospatial information and technology can be used to support decision making and e-Government processes in particular. SDI's can be and are used by private companies, but governments are using them mainly in e-Government processes to support G2C, G2B and G2G interactions, usually by providing location enabled e-Services (applications). A work or business process can be defined as a succession of structured and interconnected activities across time and space which, starting from one or more identifiable inputs, result in one or a set of defined outputs in the form of products or services. Business (work) processes can be modelled and we can identify where and how geospatial and related data can be used to support them. Typical work processes such as 'obtaining a building permit', 'evaluation of soil suitability', 'flood risk mapping', etc., are discussed and examples are given from different countries in Europe on how spatial data help solving questions/problems. A series of ongoing and upcoming developments are discussed which influence SDI implementation and how they can evolve over time: the protection of sensitive information while preserving data sharing (GDPR Directive); the handling of large amounts of (open) data; the involvement of citizens in collecting, assessing and improving geospatial information (crow sourcing); legislation that has an influence or is related to geospatial (PSI, Aarhus …), etc. The topics are well suited for developing group work.

Structure:

This building block might be composed of separate smaller building blocks covering specific non-technological trends and developments.

- Geospatial data and their integration with other data/information for different applications;

- E-Government processes and the location enablement their G2C, G2B and G2G interactions;
- Analysis of typical e-Government processes and modelling them using the BPMN (standard) language;
- Detailed overview and comparison of relevant European (and national) legislation with regard to GI and other public sector information: INSPIRE, PSI, Aarhus & Access, …;
- How to share spatial data to a maximum degree, while protecting sensitive information (such as personal information);
- Overview of different license and business models for the distribution of spatial data (including the Creative Commons framework);
- The Open Data movement and the application of Open Data principles in the context of SDI in different countries of Europe;
- Authoritative spatial data and official registries and/versus volunteered geographic information and crowdsourcing.

Learning outcomes:

- Being able to identify the major non-technological trends;
- In-depth understanding on e-Government processes and their G2C, G2B and G2G interactions and gaining basic skills to model a business process;
- Being able to distinguish the differences and commonalities between the for the geospatial sector relevant European Directives, and between authoritative and open data.

Pre- and post-requisites:

Pre-requisite(s) – "SDI Concepts and Principles"

Level(s) and formats

- Basic – Lectures (and demonstrations)
- Advanced – Lectures, exercises and group work

Required efforts: 1,5 – 12h

Value: 1 ECTS (when fully developed)

Reference material

LINKVIT: "INSPIRE and e-Government"; "INSPIRE maintenance approach" and "Geospatial Trends" (combined in the training package "INSPIRE Advanced").

6.2.7. Technological trends

Title: Technological trends

Topics covered: Semantic Web and Linked & Open Data; Geospatial Data on the Web; 3D/4D and Augmented Reality; Indoor mapping and BIM; UAV's; Big data and cloud computing; Secure access mechanisms.

Abstract:

This building block, similar to the building block "Non-technological developments", provides an overview of the main technological trends in the geospatial field or trends that influence the geospatial field. As is the case for "Non-technological developments", the number of topics is vast, so the building block aims to provide an insight/overview, rather than an in-depth elaboration of each of the topics (they can be developed as building blocks on their own if needed). The most important developments and trends are covered. One of the key topics is how spatial data are published and used on the web. The traditional way of searching for spatial data is based on the publish-find-bind paradigm. Currently developments use semantic web approaches based on Linked Data technology to enhance the linking and integration of disparate web sources. Currently, more and more geospatial API's are being developed to allow developers to build applications on top of SDI components. Another major field of development related to the shift from 2D geospatial data to 3D and even 4D data (including the time aspect). In that context, there is more and more demand to integrate traditional GIS with BIM models used to design and manage information on buildings. These developments also include Indoor Positioning. Collection of this type of detailed data, e.g. in the form of point clouds, is possible due to the development of more advanced UAV's and other technologies to gather information about our environment (which is by default 3D/4D) such as image-based mobile mapping. Other topics that might be covered are: Internet of Things and Sensor Web Enablement; Modelling, simulation and prediction and GI; big data analytics and artificial intelligence and the technical aspects of crowd sourcing. This building block is conceived as a dynamic repository and choices of topics can be influenced by specific interests of the faculty that includes them.

Structure:

- Overview of the major developments and trends as defined by UN-GGIM and OGC (with focus on technological trends);
- New ways of data acquisition and new data sources: UAV's; Image-based Mobile Mapping, Laser scanning, Crowd Sourcing and VGI; etc.
- Major programmes to support better and more data, more accessible and easy to use: Copernicus and GNSS, Galileo, …
- The influence of huge amounts of data on the way we work (big data): cloud computing; workflow and provenance; big data analytics; big data coming from social networks/media; etc.
- 3D/4D geospatial data: space and time including the provision of examples on: moving objects in space (eye-tracking), agent-based modelling (indoor/outdoor); augmented reality (looking to the past and into the future); etc.
- New ways to publish and use geospatial data on the web by making use of semantic web technology such as linked data: examples and small exercises on usage and implementation;
- SDI to improve sharing and exchanging data, but taking into account sensitive information by using secure access mechanisms and protection of (spatial) features.

Learning outcomes:

- Being able to identify the major technological trends;
- Being able to analyse a 3D geospatial data model and recognise ways of exploiting 3D in the context of a GIS;
- Understand and gain basic knowledge and skills on the semantic web and how Linked Data technology is used to publish, link and use spatial data on the web.

Pre- and post-requisites:

Pre-requisite(s) – "SDI Concepts and Principles" and "SDI at work"

Level(s) and formats:

- Basic – Lectures (and demonstrations)
- Advanced – Lectures, exercises and group work

Required efforts: 1,5h – 24h

Value: 2 ECTS (when fully developed)

Reference material

LINKVIT: "INSPIRE and e-Government"; "INSPIRE maintenance approach" and "Geospatial Trends" (combined in the training package "INSPIRE Advanced").

6.2.8. SDI for thematic applications

Title: SDI for thematic applications (consists of different blocks, one for each thematic field)

Topics covered: Relevant European legislation for the thematic field; specific thematic SDI initiatives; thematic data models and standards; specific metadata implementations; particular data harmonization efforts; existing platforms and tools for the thematic community

Abstract:

While most of the building blocks focus on particular aspects of SDI implementation, this building block consists of several sub-building blocks for different fields of application. They are not described separately, but a canvas is given of what each of them can contain with some examples for particular areas. Thematic fields can be very diverse of which some are very important for the Western-Balkan region and the faculties active in the BESTSDI consortium: water and soils; geology and mining; nature and forestry; urban and spatial planning; agriculture; ... Each of the thematic fields are covered by dedicated European and national legislation in which reference is made to (administrative) work processes and (spatial) data collection: e.g. the Water Framework Directive (WFD) and the Soil Thematic Strategy. Moreover, in many application domains specific initiatives are taken to let the thematic community collaborate and to offer (technical) solutions regarding their specific data requirements and technical solutions: e.g. OneGeology and the Global Biodiversity Information Facility (GBIF). For some communities there exist very rich (geospatial) data models which go beyond what can usually be found in the basic SDI data models/specifications such as INSPIRE. The challenge is to link and integrate those data models. In some cases, metadata are treated in specific ways and more metadata elements are collected: e.g. in the air quality and meteo world specific metadata are collected on the sensors that measure different parameters. Some communities rely on specific standards for their geospatial and other data: e.g. NetCDF (meteo and aeronomy), Darwin Core/Ecological Metadata Language (biodiversity community) and Land Cover Classification System (LCCS) for the land/land-use community. They also often have their own platforms, systems and tools available: LPIS (agriculture), OneGeology (geology), ESDAC - European Soils Data Centre, etc.

Structure:

- Overview of relevant European Directives and national legislation in the thematic (and related) fields;
- Overview and analysis of specific spatial data models and comparison with the relevant INSPIRE specifications: examples of existing data sets;
- Analysis of differences and commonalities between different data sets and identification of specific challenges to link/integrate them;
- Approaches to make the linking and integration of disparate data resources from the same application field including some exercises;
- Identification of specific metadata initiatives and specifications, and different ways to handle and describe the metadata;
- Analysing metadata records and comparing them with basic discovery metadata collected in SDI catalogues;
- Visit to and exploration of specific platforms and tools: small assignments to access and use the available information/data.

Learning outcomes:

- Being able to identify the relevant European and national legislation for the particular thematic field;
- Being able to identify and explain the differences and commonalities of specific data sets and data models against international standards such as the INSPIRE specifications;
- Being able to understand and interpret specific metadata information collected and maintained by the thematic community and the differences with the basic SDI discovery metadata.

Pre- and post-requisites

Pre-requisite: “SDI Concepts and Principles”; “SDI at work”; “SDI data models and data harmonization”; “SDI Access Mechanisms”

Level(s) and formats:

- Basic – Lectures (and demonstrations)
- Advanced – Lectures and exercises
- Expert (LLL) – Lectures, exercises and group/home/project work

Required efforts: 3 – 24h

Value: 2 ECTS (when fully developed)

Reference material:

Currently no specific reference material available.

6.2.9. SDI application development

Title: SDI application development

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Topics covered: Requirements analysis in GI; methods for process description and GI; design of (web) applications and programming methods; user interfaces and usability; API's and geospatial API's.

Abstract:

SDI come to live when their components are used and a rich portfolio of (web) applications are built on top of them. Proper design of geospatial applications, models, and databases and the validation and verification of design activities are critical components of work in all areas related to GIS&T and SDI. Design failure can jeopardize well-intentioned efforts to apply concepts and technology to solve real-world problems. While sharing a number of concerns with general systems analysis, the specificity of geographic information provides significant additional challenges. The focus of this building block is on the design of applications and, to a lesser extent, databases (the latter is part of building block "SDI data models and data harmonization") for a particular need in the context of the exploitation of SDI. Application Design addresses the development of workflows, procedures, and customized software tools for using geospatial technologies and methods to accomplish both routine and unique tasks that are inherently geographic. The design of tools and software code should be based on a thorough analysis of (functional and non-functional) user requirements and on a good insight in how the business processes in which they will be used work. Specific attention must be paid to user interfaces and how users will interact with the system. Development of programming code and testing and validation can be done in different ways, e.g. by applying a highly interactive scrum method. Special attention should be paid to geospatial Application Programming Interfaces (API) which allow for rapid software development in particular in the context of distributed systems. Examples are: Google Maps, OpenLayers, MapQuest API for OpenStreetMap, Leaflet, Esri ArcGIS REST and Mapbox. Open geospatial API's will enhance the usability of SDI.

Structure:

- Different approaches and different steps in applications development: the need to start with a well thought and good design;
- Methods for requirements analysis in GI including the definition of work processes and data flows, functional and non-functional requirements;
- Some examples and exercises to identify use cases given a pre-defined work process for different actors;
- Methods for mapping and describing business/work processes to identify the activities, the actors and interactions that take place, and the role of data and geographic information in those processes in particular;
- The design of usable user interfaces to support the many interactions in the work process: using mock-ups to create a first visual outline of the intended interfaces;
- What are and how do Agile development methods work, such as Scrum: the interactive approach through the organisation of sprints;
- What are Application Programming Interfaces (API's) and what are geospatial API's: examples of how they are used in the context of SDI;
- Zooming in on different geospatial API's such as OpenLayers, OpenStreeMap, Leaflet, etc. Smaller exercises to use these environment to carry out simple GIS tasks.

Learning outcomes:

- Being able to identify and describe the importance of a good design for information systems (tools, web applications …) including the way a user requirement analysis is set-up;
- Being able to derive use cases based on de description of a work process (both narrative and in BPMN) by making use of UML diagrams;
- Being able to identify the role of (geospatial) API's and to use one of the common existing geospatial API's.

Pre- and post-requisites

Pre-requisite: "SDI Data Models and Data Harmonization" and "SDI Access Mechanisms"

Level(s) and formats

- Basic – Lectures (and demonstrations)
- Advanced – Lectures and exercises
- Expert (LLL) – Lectures, exercises and group/home/project work

Required efforts: 6 – 24h

Value: 2 ECTS (when fully developed)

Reference material:

LINKVIT Module (under development – ready 04/2018): "Scrum method for agile development of software code"

7. Project curriculum basis for adapted curricula

The project or baseline curriculum defined in section 6 does not contain all building blocks that were deemed necessary by the BESTSDI stakeholders (see section 5) such as: "Conceptual foundations" and "Analytical methods". They are considered important, but assumption is made that these are already covered in some of the existing courses at the different faculties (e.g. in Geographic Information Systems). So they are treated as 'pre-requisites' for the SDI curricula / building blocks. It was also found during the discussions in the Mostar Workshop (11/2017) that some of the partners' curricula lack basic teaching in Geodetic aspects. This will be further developed under Task 1.5 and later it might be added and integrated as part of the SDI project curriculum. However, these additional geodetic building blocks should also be considered as mandatory pre-requisites to teach correctly on SDI's.

Task 1.5 is developing localized curricula which aim to 'translate' the project curriculum into the local curricula. In Section 5 it was explained that many existing courses can 'host' SDI topics. How that will be done depends on the courses themselves, and also on the organisational and institutional settings. The way BESTSDI wants to approach this is to perform this integration in a flexible way (total new curricula/courses will be the exception). The BESTSDI project curriculum can be seen as an 'SDI Cookbook' (all the possible building blocks) from which faculties will derive 'SDI menu's' (see figure 5).

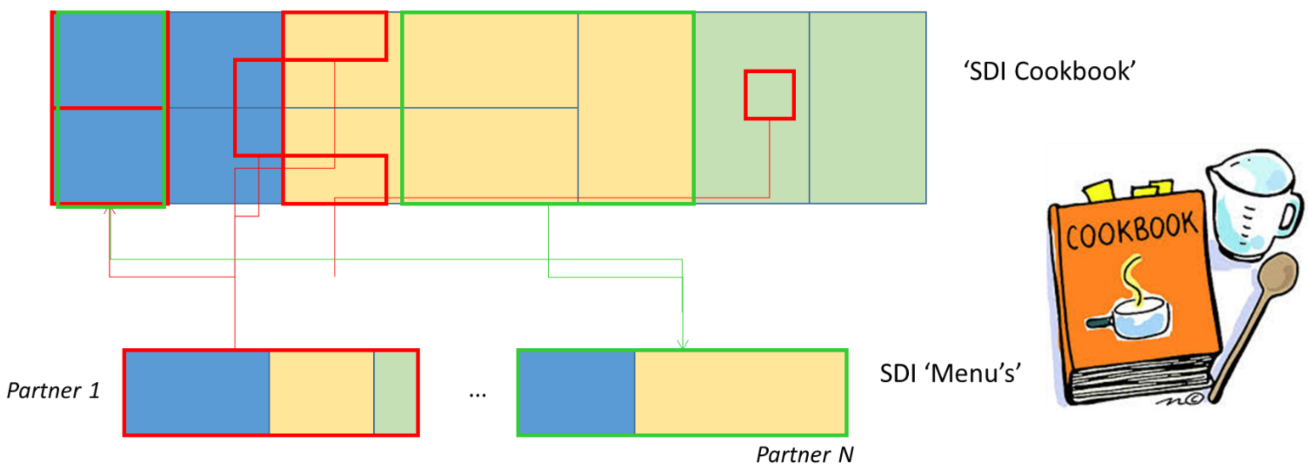

FIGURE 5: FROM PROJECT CURRICULUM TO LOCAL CURRICULA

Those menus can/will be different for each partner. Some partners will have a limited amount of hours available, others more. Some partners have a big interest in the technological aspects, while others are more focused on the thematic applications, or the data, etc. However, the project curriculum allows to select the most relevant parts that are then assembled into a consistent offer.

This can be clarified with an example: a partner might have room for 18h and foresee teaching on the concepts and usage of SDI's, exploring some of the spatial data (harmonisation) and SDI access mechanisms, while adding some elements on data & service quality and touching upon technological and non-technological trends as well. Another faculty might introduce SDI concepts and usage, while focusing on how SDI is/can be implemented in a particular field of application (data and services). Many scenario's exist.

The adaptation for localizing the curricula will be the topic of D1.5 - Curriculum adaptation specification.

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8. Conclusions

Task 1.4 is dealing with the design of the project curriculum, a sort of baseline curriculum or 'cookbook' from which partners will select the parts that fits best their interests/needs and that can be 'easily' integrated in existing courses.

In a first step, the results from task 1.1 (existing course descriptions), 1.2 (existing European SDI training materials) and 1.3 (user requirements) were analysed. The conclusion was that: 1) in every participating faculty at least one course exists that can 'host' SDI topics; 2) there is already a rich portfolio of English (and other) training material available that can be re-used and 3) there is a clear need for SDI/INSPIRE education and training while other needs are/should be covered in other courses as well (e.g. basics of Geodesy).

The curriculum design was done in a systematic way by defining major building blocks. For each building block the covered topics were listed, a brief abstract description given, the major learning outcomes and pre-requisites/post-requisites defined and required efforts estimated. Where known, reference materials were added and the 'value' of the building block in terms of ECTS estimated. In total 9 building blocks were designed (of which some consist of sub-building blocks): "SDI concepts and principles"; "SDI at work"; "SDI data models and data harmonisation"; "SDI access mechanisms"; "Assessing SDI"; "Non-technological developments"; "Technological trends"; "SDI thematic applications" and "SDI application development".

Finally, an approach for adapting the project curriculum to the local needs was proposed which will be further elaborated in D1.5 - Curriculum adaptation specification.

9. References

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