Baltic LINes

Coherent Linear Infrastructures in Baltic Maritime Spatial Plans

Data Exchange and Dissemination

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Preface

The aim of Work Package 3 is to provide data and build a prototype Baltic Marine Spatial Data Infrastructure (MSDI), which will make it easy to access open standard datasets.

Based on the analysis of data needs and availability (Report 3.1) the next step towards designing this prototype MSDI is to establish guidelines on data exchange and dissemination.

This report summarizes the results of the analysis of the prerequisites for a Systems Architecture for a Transnational Data Infrastructure for MSP. The first part includes the findings of a desktop study of available systems providing interoperable data and existing technology standards. The second part is presenting the analysis of user demands based on experience from former projects as well as interviews with planners carried out during this project. Finally, the specification of the design requirements and a conceptual model for the system is presented.

This report is produced by Henning Sten Hansen and Lise Schrøder, AAU, in collaboration with Manuel Frias and Florent Nicolas, Helcom. Thanks to Ida Reiter, AAU, for valuable input. The analysis is also published as a scientific paper (Hansen et al, 2017).

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1. Introduction

The Baltic LINes INTERREG project seeks to increase transnational coherence of shipping routes and energy corridors in Maritime Spatial Plans in the BSR. This will prevent cross-border mismatches and secure transnational connectivity as well as efficient use of Baltic Sea space. Thereby Baltic LINes contributes to the development of appropriate framework conditions for Blue Growth activities (e.g. maritime transportation, offshore energy exploitation, coastal tourism etc.) for the coming 10-15 years increasing investors' security. A precondition for this is to create the informational as well as institutional capacities of Maritime Spatial Planning (MSP) bodies. Based on past experiences and a sector involvement strategy, a structured and coordinated involvement process with relevant national/transnational stakeholder fora will be carried out in close cooperation with stakeholders from the shipping and the energy industry. The Baltic LINes project partners will analyse requirements for MSP of the shipping and energy sector (based on forecasted economic, environmental, technological and land-sea related developments) and their spatial implications. The information gathered will be visualised in scenarios with the help of the MSP Challenge, a computer-supported simulation game based on accurate data and feedback, that gives maritime spatial planners insight in the diverse challenges of sustainable planning of human activities in the marine and coastal ecosystem.

The Baltic LINes project will improve access to relevant transnational MSP data needed for making spatial allocations for shipping and energy uses in MSP by piloting the first ever BSR MSP data infrastructure. This infrastructure will allow access to decentralised MSP data beyond the project lifetime and may be expanded to other sectors.

In order to come up with planning solutions, Maritime Spatial Planners will identify transnational cross-sectoral planning issues. These single or cross-sectoral mismatches/foregone synergies may currently prevail or may be forecasted based on future scenarios.

Planners will jointly agree on planning criteria, taking into account sector requirements for MSP and the ecosystem approach. They will determine options for planning solutions for shipping routes and energy infrastructure, which will be consulted with sectors via the MSP Challenge. The finally suggested planning solutions will be presented to the national MSP processes and, hence, are expected to be considered in the national Maritime Spatial Plans in their development or revision stage. Consequently, increased transnational coherence of linear infrastructures in MSP is achieved. To set conditions for a continuous MSP coordination on linear infrastructures, Baltic LINes will develop recommendations for a BSR agreement on transboundary consultations on linear infrastructures within the MSP process. They will be presented to the HELCOM-VASAB MSP Working Group to decide on and follow up their implementation.

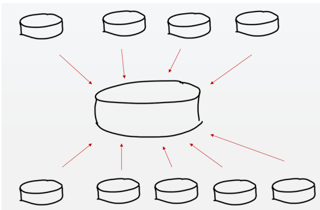
A work plan divided into 5 Work Packages

Baltic LINes will achieve its aims thanks to a consortium of 15 partners led by the Federal Maritime and Hydrographic Agency of Germany. The project is divided in 5 Work Packages (WP) including WP 1 for the project management and administration.

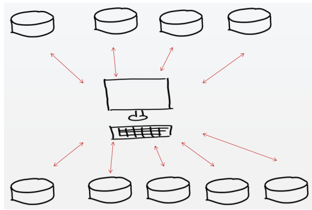
WP1 Management	The WP 1 is led by a project steering committee which monitors the implementation of the project in relation to the work plan and the obligations towards the Baltic Sea Region Programme Secretariat.
WP2 Requirements for MSP	The WP 2 “Requirements for MSP in relation to the shipping and energy sector in BSR” aims to increase the understanding of maritime spatial planners on the future sectoral developments and to anticipate spatial uses for the Baltic Sea. The results will be used to develop future scenarios to highlight cross-border mismatches and discuss potential gates for shipping corridors and power cables within other WPs.
WP3 Data Infrastructure	The WP 3 “Baltic Sea Region MSP data infrastructure for shipping routes and energy corridors”, led by the HELCOM Secretariat, is concerned with the development of a pan-Baltic data infrastructure for Maritime Spatial Planners. This report will explain the results of one of the Group of Activities to analyse the data exchange and dissemination alternatives.
WP4 Transnational planning	Work package 4 named “Transnationally coherent planning of infrastructure” aims to develop and propose transnationally coherent planning solutions for linear energy infrastructures and shipping corridors which are in line with the ecosystem approach.
WP5 Governance	Work package 5 “Governance for the coordination of linear infrastructures” ensures that the project activities and results are shared among project partners and relevant stakeholders. It is important to safeguard the main outputs for implementation after the finalization of the project.

Towards a decentralized system with the Work Package 3

WP 3 aims at developing a prototype Marine Spatial Data Infrastructure (MSDI) to provide data to the planners who carry out the planning proposals. This infrastructure will allow MSP practitioners to access MSP data in a decentralized system.



In a centralized system data is sent to a database from the original source.



In a decentralized system data is not sent anywhere. A system access it from the original source.

This decentralized system allows the users to have access to the most update datasets hosted by the countries.

WP3 includes four groups of activities:

3.1 Data needs and availability

3.2 Harmonised data layers

3.3 Guidelines on data exchange and dissemination

3.4 Regional MSP data access and visualisation tool

Data exchange and dissemination

This document is reporting on task 3.3 on data exchange and dissemination. In order to specify the requirements for the new system, available systems providing interoperable data and existing technology standards have been studied and user demands have been analysed. Based on experience from other projects and interviews carried out among planners in the partner countries and an analysis of user demands in order to design the requirement specification. Furthermore, the report is referring to the results of the previous work documented in report 3.1 on data needs and availability.

2. Data portals for Marine Spatial Planning

Within marine spatial planning, marine geoportals are important tools and various geoportals containing marine data already exist around the world. Besides allowing portal users to find existing marine data, these web-based access points containing networks of geographic data facilitates collaboration projects between different shareholders owning marine data, and improve interoperability between technical platforms of different data users and data owners by using internationally recognised standards (Strain et al, 2006).

Many portals have been evaluated in scientific papers within recent years. Referring to the concept of spatial data infrastructures by Rajabifard et al (2003), which will be introduced in the Chapter 2, Seip and Bill (2016) deduce the following indicators to evaluate marine geoportals:

- the extent of marine data covered
- the availability and structure of metadata,
- the availability of options for discovering, viewing, and downloading data,
- the use of standards ensuring interoperability between technical platforms
- degree to which the portal is related to a government policy for marine planning.

This approach will be used as a framework for describing the basic qualities of a maritime geoportal (see table 1).

2.1 Marine geoportal designs

Seip and Bill (2016) refers to Canada and Australia, as they have geoportals developed early as they are dating back to at least 2004. Canada and Australia have portals, that were initiated as part of national governmental marine strategies (Canada: the GeoGratis portal and the DFO GeoPortal; Australia: AMSIS and IMOS), Ireland has a marine portal called MIDA that originally was based on a project of a 3-year duration (Seip & Bill, 2016). Seip and Bill (2016) point out that all three countries are successful in using international standards and open source to improve interoperability, gathering data from many different shareholders, and presenting many core datasets. However, they also mention that the portals from Canada and Australia lack a single entry, while all three countries have separate metadata portals.

Kocur-Bera and Dudzińska (2014) examine geoportals of interest for the Baltic Sea region, and they similarly conclude that current environmental data unfortunately are not available from one single entry and that the resolution of the data is sometimes inadequate for marine planning. Kocur-Bera and Dudzińska (2014) refer to the INSPIRE geoportal, which links the user to terrestrial and marine environmental data at various European institutions' homepages, and HELCOM Data & Map Service, hosting many marine datasets from the Baltic Sea region, which can be viewed through ArcGIS rest service or WMS.

When examining these geoportals, it becomes apparent that the setup, interfaces, and abilities of the platforms vary as listed in table 1. Some of the geoportals have only a small map viewer (e.g. the INSPIRE geoportal and Canada's Geogratis), while other portals have a big map viewer (e.g. HELCOM Data & Map Service, Canada's DFO GeoPortal, Australia's AMSIS, IMOS and the INSPIRE portal). Some portals have few or no data search options (e.g. DFO Geoportal and AMSIS), while others have more advanced data search options (e.g. HELCOM Data & Map Service, Geogratis, IMOS, and MIDA). In general, it is difficult to gain an overview over the data download options. MIDA appears to be the only portal for which it is possible to search for only 'downloadable data'. However, the IMOS portal seems to be more consistent in regards to its download options by providing data in netCDF and URLs. Furthermore, the IMOS portal has a very nice stepwise and intuitive interface with big buttons providing a fine overview over the structure of the portal. All portals include metadata to some extent, for the European portals the metadata is in the INSPIRE standard, but it is difficult to gain an overview over all the data provided and the date of origin of the data. The Geogratis portal and the IMOS portal are the only portals enabling a time-based search function based on creation time and publishing date respectively. None of the portals provide a clear overview of the quality and resolution of the data. Furthermore, not all data is downloadable, and the degree to which the portals include data from private companies appear to be limited. Strain et al (2006) mention that many organisations are reluctant to share their geographic data.

To sum up, the development of marine geoportals based on open source technology are introduced all over the world. However, they appear to lack

- a single entry,
- an overview over the origin, the quality, and the resolution of the data,
- an overview of download and access options,
- proper marine data overview catalogues,
- collaboration with private data owners,
- specific procedures for updating the data that are obvious to the users of the portal

As Hartmann (2014) states, it is difficult for all potential users of geoportals to have the proper technical skills for using the portals, for which reason better guides, interfaces, and more clear procedures are needed.

Table. 1. Marine geoportals basic qualities referring to the indicators by Seip and Bill (2016)

Dataportal	Extent of marine data covered	Metadata	Functionality (discovering, viewing, download)	Standards	Relation to government policies
GeoGratis Canadian national repository	Marine-themed data for (almost) everybody	Separate portal: GeoConnections Discovery Portal (GDP)	No single entry Small map viewer Time-based search function	International standards and open source	Initiated as part of national governmental marine strategies including MGDI*
DFO GeoPortal Canadian Department of Fisheries and Oceans	Enable DFO employees to index and publish their data and find, view and download other spatial data	Separate portal: GeoConnections Discovery Portal (GDP)	No single entry Big map viewer	International standards and open source	Initiated as part of national governmental marine strategies including MGDI*
AMSIS Australian Marine Spatial Information System	80 layers of information in the Australian marine jurisdiction (boundaries, infrastructure, cadaster, etc.)	Separate portal: Australian Spatial Data Directory (ASDD)	No single entry Big map viewer	International standards and open source	Initiated as part of national governmental marine strategies – including ASDI**
IMOS Integrated Marine Observing System Ocean Portal	Variety of data mostly from scientific research in Australia	Separate portal: AODN - GeoNetwork metadata catalogue	No single entry Big map viewer Stepwise and Intuitive interface Time-based search function	International standards and open source	Australian Government's National Collaborative Research Infrastructure Strategy (NCRIS)
MIDA (Ireland)	140 data layers (+ metadata) from more than 35 data sources	Separate portal: Marine Data Online (MDO)	Big map viewer Search facility: "downloadable data"	INSPIRE compliant***	A project of a 3-year on marine and coastal geospatial information in Ireland
INSPIRE Geoportal	EU	Integrated portal	Small map viewer	INSPIRE compliant***	EU directive
HELCOM Data & Map Service	Baltic Sea Region	Integrated portal	Big map viewer	INSPIRE compliant***	1992 Helsinki Convention on the protection of the Baltic Sea area

* Canadian Geospatial Data Infrastructure (CGDI), also known as "GeoConnections", which includes the Marine Geospatial Data Infrastructure (MGDI)

** Australian Spatial Data Infrastructure (ASDI)

*** See paragraph 3.1

2.2 Demands for marine geoportals

To conclude, based on the review of geoportal designs and the theory of marine SDI, it is important for geoportals to be founded in national marine SDIs to ensure long-term strategies for data sharing and less redundant data displays.

These recommendations include:

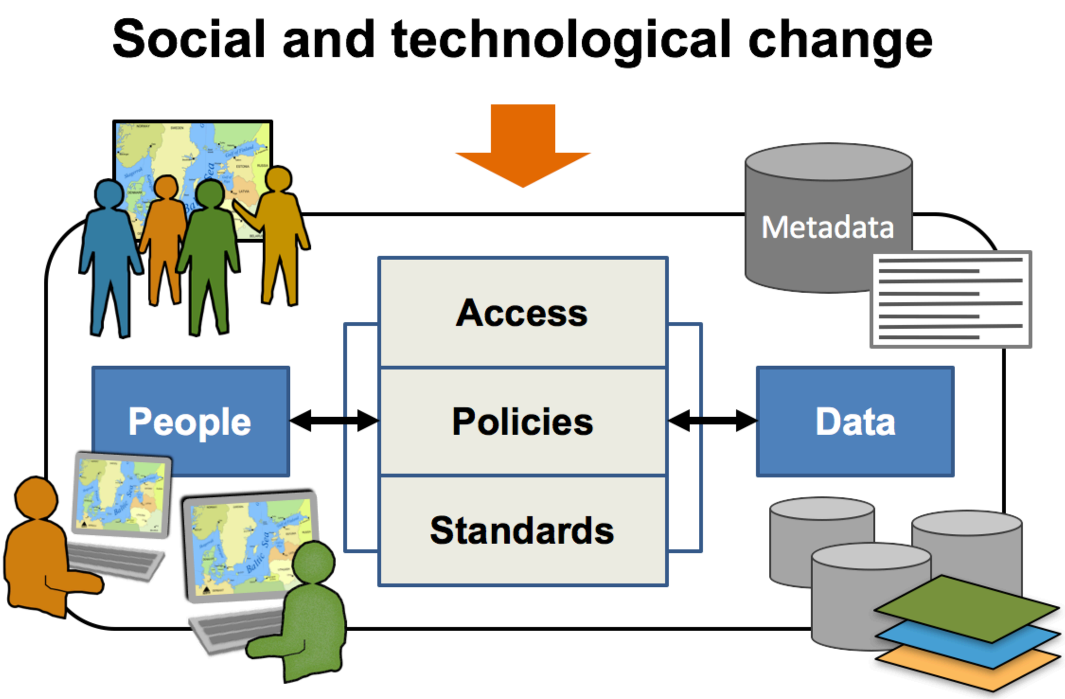
- There should be only one single overall national geoportal entry providing a clear overview of all data and download options available and the data should be regularly updated in order to improve the usability of the data.
- A better overview should be provided over the quality and resolution of the data.
- A clear strategy should be developed for how the data is published and updated, and it should be possible to search for data based on resolution and time of origin.
- geoportals should include web services to allow viewing the data in the users' own applications, improving interoperability.
- International, open technical standards should be used, ensuring interoperability between platforms of different countries.
- If any overlap between data in different portals exist, it needs to be clearly communicated to the users of the portals.
- Easy-to-read guides should be provided for how to use the portals.

Furthermore, strategies should be implemented to improve the data sharing of private data shareholders to expand the sources of open marine data.

3. Spatial Data Infrastructure

A Spatial Data Infrastructure (SDI) is about facilitation and coordination of the exchange and sharing of spatial data. It is described as the underlying infrastructure, often in the form of policies, standards and access networks that allows data to be shared between people within organisations, states or countries. The fundamental interaction between people and data is governed by the technological components of the SDI represented by the access network, policies and standards (Rajabifard et al., 2003). In accordance with this understanding, the diagram in figure 1 illustrates the dynamic inter-relationships between the people and spatial data within an SDI. The dynamic nature of the spatial data infrastructure is attributed to the rate of technological advancement and changing user needs. People and data are the key elements in SDI, and a spatial data infrastructure at any level whether local, regional, national or even global involves an array of stakeholders both within and across organisations including different levels of government, the private sector and a multitude of users. In order to design and implement a spatial data infrastructure, the stakeholders need to be identified together with the business processes and functions of the organisations involved. The data required and the flow of data between various functions must be known by the user or provided by the functions. In this respect data sharing, exchange, security, accuracy and access as well as rights, restrictions and responsibilities must be managed.

Figure. 1. Components of a Spatial Data Infrastructure referring to the illustration of the SDI concept by Rajabifard et al (2003).



3.1 INSPIRE

in order to ensure SDIs as a backbone in enabling a digital society within Europe, the legal framework including data-related EU directives is important. Among the very important EU initiatives relating to SDIs, are Directive 2003/98/EC on the re-use of public sector information (known as the 'PSI Directive') was entered into force on 31 December 2003, which has gained a very high impact for example on the creation of European geoportals. Also Regulation 1367/2006 (COM 2006) on public access to environmental information has contributed significantly to the notion of easier access and sharing of public sector information (It was revised by Directive 2013/37/EU which entered into force on 17 July 2013). A third major step towards a pan-European spatial data infrastructure was Directive 2007/2/EC on establishing an Infrastructure for Spatial Information in the European Community (INSPIRE), which was entered into force in 2007.

Figure 2. A key objective of INSPIRE is to make more and better spatial information available for EU policy-making and implementation in a wide range of sectors as specified in the three annexes (COM 2007).

- **Annex I: addresses, administrative units, cadastral parcels, coordinate reference systems, geographical grid systems, geographical names, hydrography, protected sites, transport networks**
- **Annex II: elevation, geology, land cover, orthoimagery**
- **Annex III: agricultural and aquaculture facilities, area management / restriction / regulation zones & reporting units, atmospheric conditions, bio-geographical regions, buildings, energy resources, environmental monitoring facilities, habitats and biotopes, human health and safety, land use, meteorological geographical features, mineral resources, natural risk zones, oceanographic geographical features, population distribution and demography, production and industrial facilities, sea regions, soil, species distribution, statistical units, utility and governmental services**

3.2 Standards for data exchange

Recently the EU e-Government Action Plan 2016-2020 was introduced, which underlines the importance of reusability of data and technologies and refers to the European Interoperability Framework (EIF) (COM 2016), and it is the core document defining interoperability seen from a common European perspective (Bovalis et al, 2014). Ensuring interoperability means ensuring reusability of data and technologies, which is cost-saving in regards to time and economy (Bovalis et al, 2014). Interoperability within EU has been closely linked to a public-sector agenda since 1995 through various programs: IDA (1995-1999), IDA II (1999-2003), IDABC (2004-2009), ISA (2010-2015), and now ISA2 (2016-2020) (Bovalis et al, 2014). During the IDA

(Telematic Interchange of Data between Administrations) program, the primary focus was to develop trans-European telematics network. Later with the ISA (Interoperability Solutions for Public Administrations) program, the EU leaders agreed to align their national interoperability frameworks with the European interoperability framework (EIF). Thus, since IDA's introduction in 1995, the focus has moved away from being on technical interoperability within single sectors to include semantic, legal, and organizational interoperability aspects working not only within sectors, but also across sectors (Bovalis et al, 2014).

Criado (2011) refers to the European interoperability framework (EIF), including four types of interoperability:

- *Technical interoperability* linking data and technologies through formats and standards
- *Semantic interoperability* preserving the meaning of semantic concepts when sharing data and information
- *Legal interoperability* introducing legislation for data and technology reuse
- *Organisational interoperability* coordinating information-based processes between different organizations with mutually beneficial goals

As pointed out by Bovalis et al (2014) other key components of the ISA programs are:

- *the European Interoperability Strategy (EIS)* stating objectives for interoperability within EU and builds the objectives on the conditions contained in the EIF.
- *the European Interoperability Reference Architecture (EIRA)* providing a service-oriented architecture-based and platform-independent model for creating from-scratch interoperable architectures or improving interoperability for existing ones.
- *the European Interoperability Cartography (EIC)* presenting an overview over interoperability solutions for European public administrations
- *the Common Assessment Method for Standards and Specifications (CAMSS)* is a standard process enabling EU member states in specific projects to systematically evaluate and compare candidate standards and specifications

Regarding technologies enabling technical interoperability and expanding options for data sharing, web services are applications that use the Internet to make themselves accessible for other applications. As described by Treiblmayr et al (2012), web services are characterised by:

- being a service-oriented architecture (SOA), which means an architecture involved when providing, searching for, and using services over a network
- being based on the hypertext transfer protocol (HTTP) and sometimes the simple object access protocol (SOAP) in order to communicate with servers over the internet.
- the use of the web service description language (WSDL), based on the extensible markup language (XML), is used to describe the specific abilities of web services

The Open Geospatial Consortium (OGC), which is an international, non-profit organization including members from government, companies, and NGOs, have defined some of the most used network services:

- The web map service (WMS) enables sharing of images,
- the web feature service (WFS) enables sharing of feature data with attributes,
- the web coverage service (WCS) enables sharing of raster data
- the web processing service (WPS) enables sharing of algorithms to perform on data (for example coded in Python) (Cannata et al, 2014).

All these OGC web services are ISO-approved standards, which means that they are standards acknowledged by the International Organization for Standardization (ISO).

Besides web services, other open technology options are developed and gaining popularity around the globe at a fast pace. Within the geographic data sector, important examples are GeoServer and MapServer, which are servers for distributing web service, OpenLayers, which enables dynamic maps on web pages, the open source database postgreSQL with its spatial postGIS extension, and the NetCDF software libraries that enable three-dimensional datasets, which is very important for marine ecosystem modelling.

The important technical standard for the marine sector, the S-100 data model, is created by the International Hydrographic Organization (IHO) and adopted by the United Nations' International Maritime Organization (IMO) to be the basis of IMO's Common Maritime Data Structure (CMDS) of e-navigation. E-navigation covers strategies aimed at improving the sharing of marine information through the use of modern technology and includes marine data such as Electronic Navigation Chart (ENC) data, bathymetric data, tidal data, meteorology data, radar-image data, and the radio-based Automatic Identification System (AIS) data (Park & Park, 2015). The S-100 standard is based on the ISO 19100 series of geographic information and is thus, similarly to the OGC web services, ISO-approved (Park & Park, 2015).

The importance of interoperability within EU, both from a strategically and technically point of view, also relates to INSPIRE urging member states to share environmental data and now as part of the EU eGovernment Action Plan 2016-2020 implementing a metadata standardization for the whole of EU (COM 2016).

4. Systems Design

Based on the experiences gained from earlier projects and the requirements from a rather diverse and transnational user community a systems architecture has been defined in order to develop the systems architecture and a prototype to be tested during the project.

4.1 User demands – specifications

Based on the results of surveys among planners conducted in the Baltic Scope INTERREG project (www.balticscope.eu) as well as supplementary interviews carried out in Baltic LINes, the needs planners dealing with cross-border issues of MSP are facing, has been specified. In both projects, there are focus on awareness creation concerning processes and challenges referring to the Blue growth strategies, sustainability and the ecosystem-based approach as well as collaborative issues focussing on learning from each other and collaboration across borders. Concerning the MSDI, the challenge is how to support usability and address the actual needs concerning data and functionality and how to actually get access to data, that fits the purpose.

In the Baltic LINes project the focus is on cross-border issues on shipping and energy lines, leading to a specific need for information on respectively connections on borders and connections of structures. The importance of paying attention to other important cross-border issues, is pointed out by the planners:

- the MSP process timeframes between countries varies;
- military areas are difficult to include in planning, because data is restricted;
- some national borders at sea are not defined;
- Natura 2000 network and blue corridors are not coherent;
- monitoring fisheries is a challenge.

Overarching needs as decision support due to the ecosystem approach and the provision of strategic environmental assessments (SEA) are also emphasized.

According to the answers from the planners, most users of the data and the system as such are planners (GIS users and others) and researchers. Furthermore, institutions giving licenses (i.e. fishing), academics (research institutions) as well as everyone involved in MSP are using the services. In table 2 the responses regarding requirements for a decision support tool providing access to data and information as well as functioning as a platform for collaboration is listed.

Table. 2. Requirements for decision support and collaboration.

	Data and information	Platform for collaboration
Decision support	Access to data for statistics and models	Cooperation with national institutes
	Access to all available data (updated)	Collaboration with stakeholders
	Access to GIS tools from other projects	
	Access to Policy documents	

The countries are mostly collaborating directly or via projects (e.g. TOPCONS in the Gulf of Finland between Finland and Russia), as regards energy for instance, there is a common grid between Lithuania and Sweden, but it is emphasized, that the service should also include access to future plans. Specific requirements for shipping and energy planning purposes are listed in table 3.

Table. 3. Requirements for shipping and energy planning purposes.

	Most of the planners answered	Other answers
Important element for shipping	up-to-date data	upload your own layer to the system
	metadata viewer	include AIS data
	open/remove layer	select/filter the type of ports
	download data	
Important elements for energy	Metadata search (source of data, relevance, etc.) and views	link inshore/offshore grid
	Download data	Meteorological stations / data
	Present and future plans in bordering countries	Safety zone of structures
		Gateways

Background data is important concerning other aspects: MPAs, fisheries, hotspots of ecological features (nursery areas, etc.) and also concerning aquaculture especially the possibilities for co-location. And background data should also include also all the marine areas – not only coastal area but also offshore.

The interviews illustrate big differences among the countries concerning the planning process as well as concerning data availability. A specific challenge is how to deal with the issues of harmonisation. In general, the approach will be pragmatic and aiming at solutions fit for the purpose. Detailed datasets are needed, when doing complex analysis, though a lot of cross-border planning matters can be handled based on simple harmonised images. Likewise, the planners have pointed out the importance of focussing on semantics and the attributes needed. Some planners also emphasized how shared GIS expertise in order to perform more complex analysis would support the planning procedures.

4.2 Conceptual model

Many countries are now developing national Spatial Data Infrastructures for marine and maritime information – so-called MSDIs. These national nodes will serve as base components in a transnational data infrastructure in accordance with the INSPIRE principles (COM 2007), that 'data should be collected once and maintained at the level where this can be done most effectively', and that 'it should be possible to combine seamlessly spatial information from different sources across Europe and share it be-tween different users'.

Data are most often stored in spatial relational databases like Oracle, SQL Server, and PostGIS. The ISO 19125 standard defines a data model for simple features (2D features) with a hierarchy of geometry classes from points over lines to polygons. Besides, the distributed national data servers, it is most often necessary to have a dedicated central data server containing data, which are not general available from the official data servers. These data comprise research data, voluntary geographic information, and other non-operational data sets.

The central node should in principle only be an access point (a data portal), where the different users can

1. search for data through a Catalogue and Discovery service
2. visualise the data through a Portrayal service,
3. transform the data through a Processing service
4. get access to the data through download or via web services.

4.2.1 Data Discovery

A catalogue service enables you to search for geographical data sets and geoservices based on the corresponding metadata. In Europe, INSPIRE Directive sets the rules for metadata used to describe the spatial data sets and services as listed in the directive. The Member States within the EU are obliged to describe their data by metadata and setting up local catalogue services. The metadata elements follow the ISO 19115 for data and services. The Metadata XML schema implementation is defined by ISO 19139.

4.2.2 Data Visualisation

The Portrayal service allows data to be presented interactively through services such as WMS (Web Map Service) and using a standard interface over the internet. The ISO 19117 standard defines a schema to create graphic output for data provided through the ISO 19110 group of standards (REF). The ISO 19117 standard does not contain standardisation of cartographic symbols, which are kept separate from the data. Thus, the cartographic representation of an object is stored in a portrayal catalogue.

4.2.3 Data Processing

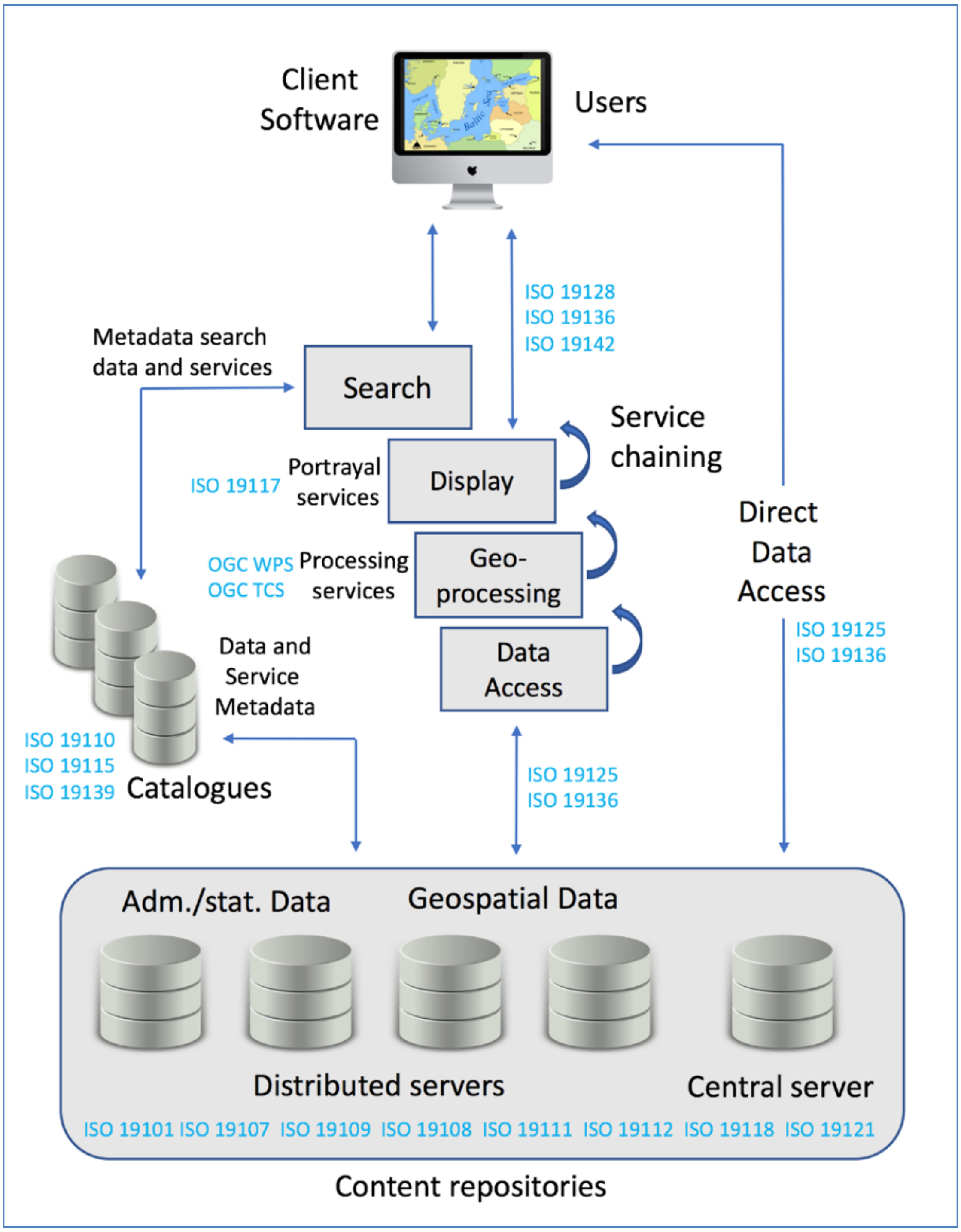
The processing services allows spatial data to be processed by using Web Processing Service (WPS), which is an OGC implementation (OGC, 2007). Web Coordinate Transformation Service (WCTS), Routing Service or Analysis and Topologic Overlay Service are other examples on web-based processing. The WPS standard defines how a request send by the client can initiated the execution of a process, and how the output from the process is afterwards handled. The data required by the Web Processing Service can be delivered across a network or they can be available at the server. A WPS process is normally a singular function that performs a specific geospatial operation, but a WPS process can be designed to call a sequence of web services including other WPS processes, thus acting as the service chaining engine (REF).

4.2.4 Data Access

These services are needed to access raw geo-spatial data (not maps in case of Web services) by downloading static data files through FTP or via Web Services using common file formats such as XML, GML, NetCDF, GeoTIFF, and ASCII. Access though FTP most often uses proprietary file formats like ESRI's Shape file, or MapInfo's MIF file. Recently, SQLite (REF) and its spatial extension SpatiaLite have gained increasing popularity in file based access (downloading).

Figure 2 illustrates the described architecture, which will provide a robust platform for developing the new data infrastructures supporting marine e-governance in the Baltic Sea Region. Most data are still collected, stored and maintained by the national agencies, authorities, and other data providers, but will be distributed by web services based on international standards.

Figure. 3. Components of a Systems Architecture for a Transnational Data Infrastructure for MSP (Hansen et al 2017)



The standards referred to in the text and figure 2 are listed in table 4.

Table. 4. Standards for metadata search data and services

Standard	Name
ISO 19101	Geographic information – Reference model
ISO 19107	Geographic information – Spatial schema
ISO 19108	Geographic information – Temporal schema
ISO 19109	Geographic information – Rules for application schema
ISO 19110	Geographic information – Methodology for feature cataloguing
ISO 19111	Geographic information – Spatial referencing by coordinates
ISO 19112	Geographic information – Spatial referencing by geographic identifiers
ISO 19115	Geographic information – Metadata
ISO 19117	Geographic information - Portrayal
ISO 19118	Geographic information – Encoding
ISO/TR 19121	Geographic information – Imagery and gridded data
ISO 19125	Geographic information – Simple feature access
ISO 19128	Geographic information – Web map server interface
ISO 19136	Geographic information – Geography Markup Language (GML)
ISO/TS 19139	Geographic information – Metadata – XML schema implementation
ISO 19142	Geographic information – Web Feature Service
OGC TCS	Thematic Core Services
OGC WPS	Web Processing Service

* ISO standards (www.iso.org)

** OGC standards (www.opengeospatial.org)

5. Implementation

Based on the architecture described above, the prototype for the new **Ba**ltic **Se**a **Map S**ervice, BASEMAPS, will be developed. Access to data varies, but based on the available data BASEMAPS will provide a testbed for a new data infrastructure supporting governance of the Baltic Sea in a transnational context.

Concerning the server technology, HELCOM's existing solution is based on ArcGIS Server, while the prototype will be based on the open source GeoServer platform. This provide a good basis for testing the architecture as well as comparing the underlying software technology for the system. Both software platforms have its advantages as well as disadvantages.

The overall architecture of the prototype is compliant with the model described in figure 3, but several obstacles need to be overcome as described in the following paragraphs.

5.1 Challenge 1 – data availability

The first challenge relates to lack of availability. The data required by the maritime authorities are not available under similar conditions among the countries surrounding the Baltic Sea. Some countries like Denmark and Finland has implemented the principle of Open Government Data, while other countries have various degrees of restrictions. Data may in principle be open, but you must pay for the data, or the data may be available free of charge but confidential due to military or other security reasons.

Luckily, several data are imposed by regulations according to the INSPIRE Directive, and at least available in some degree. Although some data still have limited accessibility, this may change in a rather short term. Likewise, it can be expected, that even data which are not general available will be accessible during the project period.

5.2 Challenge 2 – data interoperability

Secondly a big challenge relates to lack of interoperability. The data are only available in formats, which are not interoperable and compliant with the architecture of fig. 2. If the data is open and freely available, they can in most cases be downloaded in shape-files or GML-formats, while the accessibility to the data via web services are less frequent. This is particularly the case for the highly valuable data in GML-format provided through WFS (Web Feature Service). For instance, trying to get access to free Danish data through web feature services, will require a special permission by the mapping authority, and in that case, only for a limited amount of data. This is due to the heavy processing power and network bandwidth needed to process and transfer the data.

The INSPIRE Directive defines the data specifications for several data sets included in the data requirements list (See report 3.1), which is the guideline behind the implementation of the

BASMAPS prototype. Data available through web services are used directly in BASEMAPS data infrastructure and hereby follow the main road in the distributed systems architecture of fig. 2. Data that are not available through web services are stored in a central database, until they eventually become available by web services. Thus, the systems architecture in the prototype is a mixture between a pure centralised solution and a decentralised solution. We use the term hybrid systems architecture for our prototype. This approach gives the advantage that data sets, which do not support a pure decentralised solution through web services, gradually can be adapted in the system over time, when more data becomes available through web services.

5.3 Challenge 3 – shipping data

Most of the data referred to above is available through the public authorities and are required to follow the INSPIRE Directive. But information on shipping traffic is provided through the so-called AIS-system standardised by the S-57 and S-100. Through the national AIS centres you can be granted access to data by a (low cost) annual subscription.

This challenge is not a real issue, because HELCOM already have access to shipping traffic and have the permission to deliver generalised historical data for shipping traffic to the members of HELCOM.

5.4 Challenge 4 – language issues

The last challenge is related to the fact, that each of the nine countries around the Baltic Sea have their own language, and this creates difficulties combining data sets from different countries.

The language issue is solved through a translation table for the layer names in the map services from the different countries around the Baltic Sea. The layer names in our system are in English, but before sending a request for a data layer, the name of the data set is converted to the local name for that data layer. This, principle can later be extended so the users in the individual countries can use their native languages when requesting data from the neighbouring countries.

6. Conclusion

This report documents the first step towards developing the systems architecture for the new Baltic Sea Map Service, BASEMAPS, providing a transnational data infrastructure for MSP in the BSR.

The main challenges relate to data not being available and if available not available in formats, that are interoperable and compliant with the suggested architecture. Most of the information to be included in BASEMAPS should in principle be available through the public authorities and required to follow the INSPIRE Directive. Though, information on shipping traffic is provided through the AIS-system standardised by the S-57 and S-100. Besides that, each of the nine countries around the Baltic Sea have their own language, which creates difficulties combining data sets from different countries. But several data are imposed by regulations according to the INSPIRE Directive, and at least available in some degree.

In order to deal with the challenges concerning access to decentralised data, the systems architecture in the BASEMAPS prototype is a hybrid systems architecture based on a mixture between a pure centralised solution and a decentralised solution, which will be updated gradually over time, when more data will be available through web services. The language issue will be solved through a translation table for the layer names in the map services from the different countries around the Baltic Sea. This principle can later be extended so that the users in the individual countries can use their native languages when requesting data from the neighbouring countries.

The prototype will be further tested and adjusted during the project, and the next steps will be to further develop the prototype with data harmonisations tools.

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