BARENTSWATCH - A NATIONAL SURVEILLANCE SYSTEM AND INFORMATION PORTAL FOR NORWEGIAN WATERS

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***ABSTRACT*:** There is a vast amount of information gathered on the oceans and coastal areas both in real time and in historical archives. This information is however scattered between several governmental and institutional bodies. The individual pieces of information are typically tailored for a large number of different, non-cooperating legacy systems.

This makes it hard to gather a complete multi-dimensional recognized picture over the area, whether the application domain is safety at sea, resource management, risk management or environmental monitoring.

Kongsberg Spacetec AS started a process preparing the ground for a harmonized, multi-discipline information portal for the area in 2003. In June 2011 we were awarded the contract for realizing BarentsWatch; a unified information and decision support system covering the Norwegian coast and the Norwegian waters. This contract only covers what is later referred to as BarentsWatch Open, while the closed part of BarentsWatch is pending a governmental decision.

This presentation will give an overview of the project goals and present the overall design of the distributed system. The benefits and limitations implied by our strict goal for using open OGC and ISO standards for both data and information exchange will be highlighted. It will be demonstrated how the system design itself can encourage collaboration and information sharing, and how new information can be provided by both the public and by agencies.

Furthermore we will demonstrate how the open system can be extended for secure, governmental use and at the same time function as a larger system of systems.

1. BACKGROUND

1.1 BarentsWatch – an initiative from the Norwegian Government

The BarentsWatch project was established by the Norwegian Government with the purpose of developing a harmonized data integration system for monitoring and warning in the Norwegian waters and coastal areas.

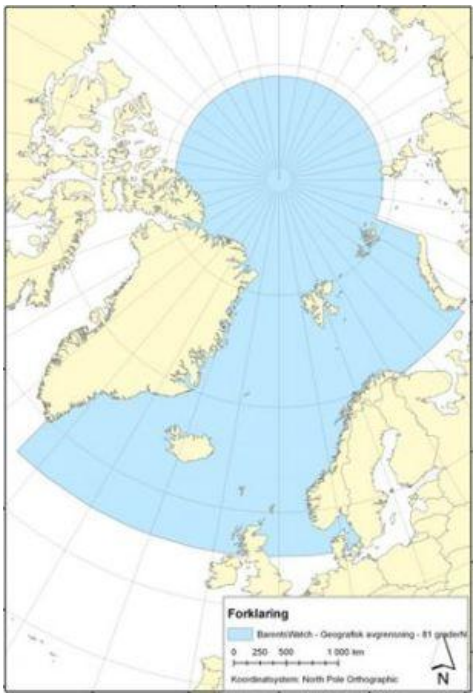

Figure 1: BarentsWatch coverage area

The system shall enable direct and easy access to high-quality information on climate and environment, marine traffic, marine resources and fishery, oil and gas exploitation and Norwegian sovereignty in the area.

The system shall be a tool giving the authorities a combined, recognized picture over activities in the northern oceans, and enable efficient information exchange and warnings in case of incidents or accidents.

Note, however, that BarentsWatch is the name of the *project*. The official name of the realized system is yet to be announced.

BarentsWatch consists of two different, logical parts; one open part and one closed.

1.2 BarentsWatch Open

BarentsWatch Open will act as a portal for the public, both in Norway and internationally. It will act as a free information channel for the general public, for industry, organizations and the media, as well as a source for information to be used in education at different levels. The portal will give access to data and services from a large number of BarentsWatch partners and service-providers. BarentsWatch Open will have interfaces to popular social media, and will encourage discussions and information sharing between the users.

The open part of BarentsWatch should be accessible and fully functional using nothing but a web-browser without specific plug-ins. This imposes strong restrictions on the map-client to use, and hence on data formats and protocols.

1.3 BarentsWatch Closed

The closed part of BarentsWatch will act as an information exchange hub between agencies having a management responsibility in the area. BarentsWatch will here provide unified, coherent and simultaneous information to all agencies, securing that every entity has the same, common evaluated picture. The system will be a decision support system, with means for collaboration and information exchange between its users. This is expected to lead to faster, more efficient and better targeted mitigating actions in case of emergencies, accidents or illegal activities. Relevant users of BarentsWatch Closed are, among others, the defense, customs control, police, rescue-service, coast guard and pollution control.

The closed version of BarentsWatch will most likely need interfaces, or stubs, to enable data and information exchange with various existing legacy systems.

2. SYSTEM DESIGN

BarentsWatch, or at least the open part of it, should be the natural first stop for information-seekers within the mentioned domains and coverage area. Still, it should not just be a portal collecting links to external service- and data providers. BarentsWatch must be a first source, hence all partners must commit themselves to keep the data-and information flow to the system updated, reliable and quality controlled.

The system must encourage collaboration. Once a visitor enters the system in search for information, she should be able to perform her analysis, annotations, data fusion, discussions and information sharing from the same place. She should even be allowed to complement the information flow with her own comments, uploaded documents or images. She must be able to share her findings and analysis easily through BarentsWatch, and invite new users to take part by posting references and summaries in social media.

BarentsWatch will in the beginning not provide much data by itself. The system is distributed by nature, and the main technical problem is harmonizing this data so that it becomes searchable and can be combined with other data sources. The architecture must not limit the BarentsWatch information and services to the partners already identified, but rather facilitate a continuously growing BarentsWatch, where new data, information and services are added along the line.

Consequently, BarentsWatch should encourage the use of certain standards for data, services and information exchange. These standards should be the ones most likely to be used by the majority of future service providers. Our best guess at present time is the open standards set forward by ISO and the OGC.

2.1 The Architectural Design

As the majority of data, information and services are provided by the BarentsWatch partners, i.e. external service providers, it is natural to select a service oriented architecture for the system. The externals to the system, although many different roles, responsibilities and privileges, can all be modeled as either *consumer* (user) or a *service provider*,

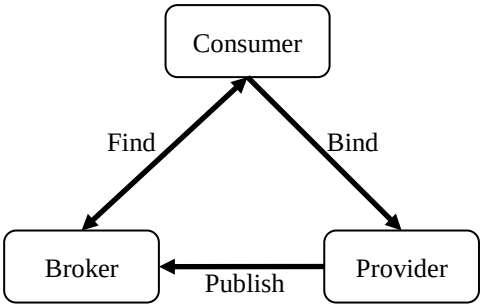

Figure 2: SOA Model

leaving the broker responsibility to the BarentsWatch core. In short, what this model describes is this: A provider of data or services publishes his availability to the broker. The broker keeps a registry of all published services. When a consumer wishes to use a given service, it asks the broker for availability, service type and location. Upon a successful lookup, the consumer uses the retrieved information to access the service directly from the provider in a standardized format.

Note that as this is a business-to-business model, the BarentsWatch system must also be the visual and highly interactive front-end for the geographical data and metadata. This is accomplished by adding a "portal" layer on top of the broker. This portal layer adds the possibility to include editor and collaboration content to be provided to the users; e.g. WEB 2.0 content provided by BarentsWatch through a content management system (CMS) integrated with a dynamic map client. In this model, the user and the portal will have a combined role as consumer.

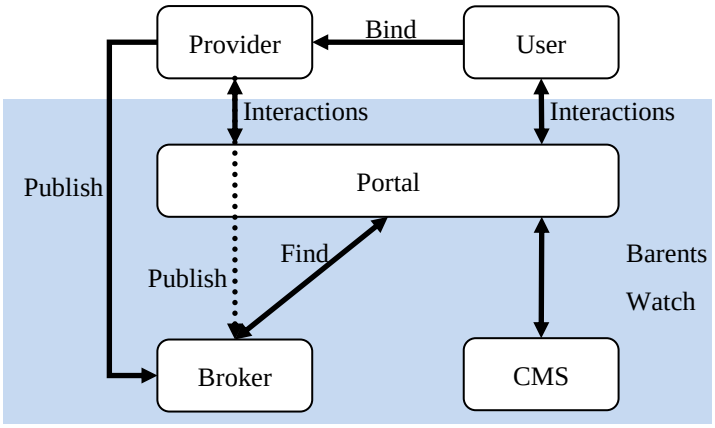

Figure 3: Adding CMS and portal to the SOA model

2.2 A Baseline Set of Standards

To ensure possible growth in data and information content, BarentsWatch will be developed with a limited, but carefully selected set of standards in mind.

For the broker we have selected a solution that is open-ended with respect to future updates, but the only one implemented in the first version will be Open Geospatial Consortium's Catalogue Service for the Web, version 2.0.2 (OGC CS-W 2.0.2). This standard for service-registry is widely used today, and is supported by a growing number of both COTS and open-source implementations. This enables new services to be added to BarentsWatch effortlessly, provided the format of the meta-data itself is supported. Referring to the above figures, the OGC CS-W implements "publish" and "find".

For registering geographic data we landed on the ISO-19115:2003 meta-data standard, and we use the ISO-19119 standard for registering geographic information services. More specifically, we support the ISO-19139 implementation schema of ISO-19115, including a specific Norwegian profile of this.

For retrieving data from the service providers we need a new set of standards. Also here we follow the recommendations by OGC, filtered by what is supported by major client applications supporting geographic data. Three different types of information must be supported: map layers (images), vector data (tracks and polygons), and scattered observations (points).

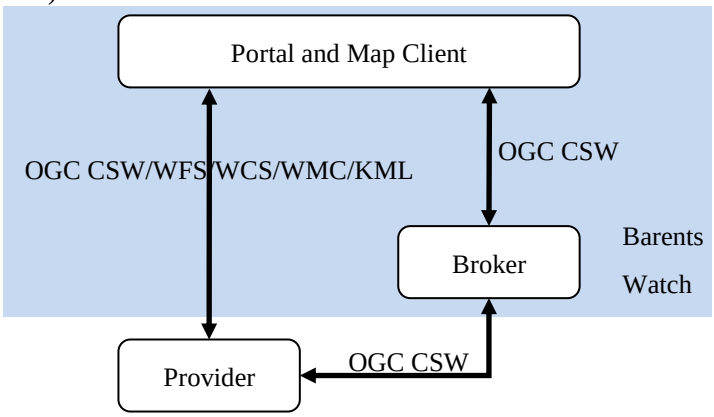

Figure 4: Interfaces between Portal/Map-client and Provider and Broker

For map or raster data, the most commonly used standard is WMS. This imposes little load on the client, as the data returned is an image *representation* of the data in a standard image format like png or jpeg. The data represented may be both raster data (images) or vector data, or a combination of the two.

For retrieving subsets of real raster-data, i.e. data that may be further processed on, the WCS (Web Coverage Service) standard should be used. It should be noted that WCS is not a format specific standard. The raster data received may be GeoTIFF, Shape, HDF or similar. For the purpose of BarentsWatch Open, where we need to use lightweight map clients, WCS will not be supported. In BarentsWatch Closed WCS may be supported through thick clients for a restricted set of data formats.
Points and polygons will be supported in BarentsWatch via KML and WFS standards, only.

In addition to these standards, BarentsWatch will have a need for storing and retrieving predefined map sections and layer combination. This is enabled by the WMC (Web Map Context) standard, which will be fully supported by the system.

2.3 User Contribution

There is a requirement for user contribution in BarentsWatch open. Users should be able to add information such as images, locations of interests or observations. This user contributed material will normally be georeferenced, but not necessarily. Storage, search and retrieval of this data must hence be supported by the system.

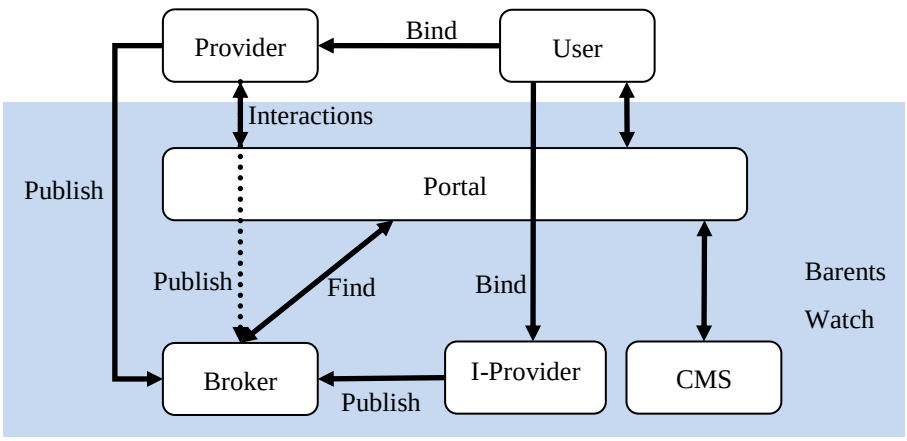

Figure 5: Adding the Internal Provider, I-Provider

We have selected to model this in the design by adding another component, the *internal service provider*, as illustrated in Figure 5.

When the user submits information, the data is split between georeferenced and geo-independent data (i.e. text). The georeferenced data is stored in the I-Provider, which publish the new information to the broker. The rest of the data is stored in the content management system of the portal. The pieces of information stored in the two locations are cross-referenced, so that the full content of the provided information can be retrieved. Data provided by users are hence readily searchable and accessible in the same way as data and service provided by the BarentsWatch partners.

The open architecture facilitates the development of dedicated mobile applications ("apps") for registering information in BarentWatch. Consider the popular application FixMyStreet, where users can report local problems like graffiti, fly tipping, broken paving slabs, or street lighting with their gps- and camera-enabled mobile device. Similar apps may be developed for BarentsWatch for reporting local pollution, ship wrecks, hazardous floating or dropped objects, ice condition and similar.

3. PREPARING FOR BARENTSWATCH CLOSED

A closed version of BarentsWatch can be realized within BarentsWatch Open. All service providers, and all contributed data will potentially be of importance in case of an emergency or accident to be handled by one or more agencies or governmental bodies. The extension to a closed version of BarentsWatch requires three additional main requirements:

1. A general hardening of the system with respect to access control, secure protocols and possible encryption of sensitive data,
2. secure and thorough logging of all changes to the systems, including added, altered or deleted data, with unique identification of the individuals in question, and
3. implementation of interface hubs between BarentsWatch and existing legacy systems

The first requirement is fulfilled through a Kerberos-based single-sign-on mechanism in combination with HTTPS and SSL. The portal, broker and service providers share (import/export) the same AD (Active Directory) directory service. If data encryption is required, this limits the selection of database providers the system can use, but it does not pose any significant new technological challenges.

Thorough logging of who-does-what is already secured, as all user traffic goes through the portal. All major web server and database implementations include this as a standard option.

The last requirement is however a challenging one. This will require separate mini-projects for each legacy system, and may in some cases require modifications to the legacy system itself.

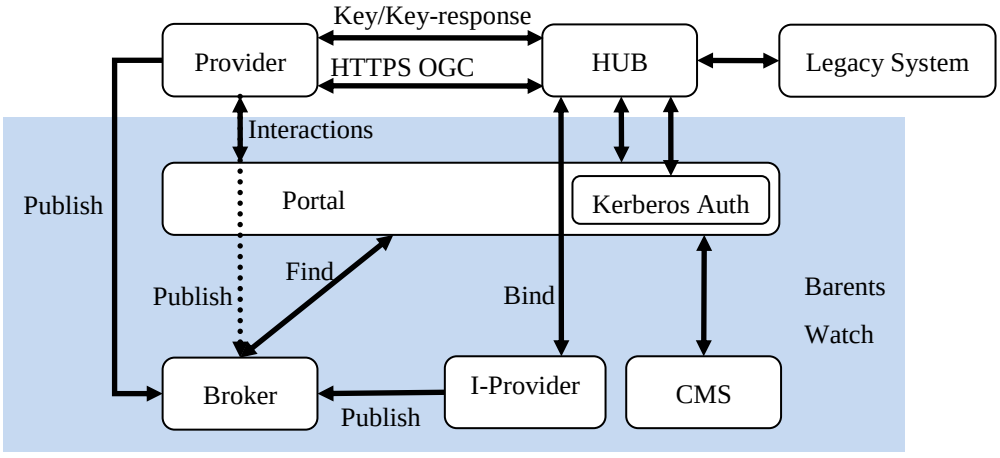

Figure 6: Extension with authentication and legacy-system interface

4. EXTENDING TO A SYSTEM OF SYSTEMS

The design selected for BarentsWatch can easily be extended to a system-of-systems, hence it can form buildings blocks in a system covering several geographical or thematic areas. The observant reader will already have identified that a *provider* in the described architecture may contain the very same architecture. The system design is hierarchical by nature, and the extension to a system-of-systems is hence trivial. There are, however, a few major

considerations that should be done that may have impact on the design. In a system made for multi-level risk management and decision support, it is crucial that every entity involved have the very same, correct picture of the situation. There are several ways in which such a system may be attempted to be kept in sync at all nodes. For BarentsWatch we found the three most relevant to be

1. redirected search,
2. multi-node sync + local find, local publish
3. harvest + global find, local publish

4.1 Redirected Search

In a redirected search approach the "find" call is forwarded by the receiving node to all other known nodes, and the combined result is returned. Each node must have awareness of the other nodes in the network, but does not need to have knowledge of the contents in each node. This approach creates a true hierarchical system, where each node may be a collection of sub-nodes. The downside of this approach is search latency, availability, and non-determinism. As the result of a search and the time of the reply will depend on the up-time of individual nodes, this is not considered as a solution for BarentsWatch.

4.2 Multi-node Sync

In a multi node sync approach each provider will "publish" his services to the local node. A user will perform its "find" at the local node. As a background process the different nodes synchronize their meta-data catalogues (brokers) so that every broker has knowledge of all data and services. This method ensures a fixed latency-order in the search call, but keeps the latency problem – and hence a non-determinism problem – in the result set. The local node will return its answer in a predictable time, but its answer may differ from the answer given at a different node due to time-skew in the meta-data synchronization. This is not considered as a solution for BarentsWatch

4.3 Harvest + global find

In the Harvest approach, each service and data provider "publish" to their local node. Every user "find" on a dedicated global node. The global node performs a uni-directional "harvest" of meta-data from all sub-nodes. All users therefore see the exact same information at the same time. The downside of this is that local users will not see their local data until the global node becomes aware of it.

The BarentsWatch design supports this method of system expansion. Note that in systems where it is *not* of crucial importance that every user has the exact same picture, a multi-node sync or redirected search implementation may be a better choice.

5. CURRENT STATUS AND PLANS

BarentsWatch Open is an ongoing project set out to Kongsberg Spacetec, with sub-contractor Know IT, by the Norwegian Coastal Administration. A first version of the system will be made operational in May 2012.

The decision on if, and how, BarentsWatch Closed should be realized is still pending.