# THE COMPONENTS OF AN OPEN SOURCE-BASED GEOPORTAL

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**Abstract:** A thorough analysis of the basic Open Source software components, consistent with the Open Geospatial Consortium (OGC) [1] is carried out in this document, making up a Geospatial Portal such as the U.S. Government has proposed for the Geospatial One-Stop (GOS) Portal Version 2 [6]. Since the aim is to meet those requirements, different components are analysed belonging to different Open Source projects offering Web Map Servers (WMS), such as MapServer [15] of the University of Minnesota, Web Feature Servers (WFS) such as GeoServer [5], Web Feature Search by name or Gazetteer (WFS-G), such as Deegree [2] and dataset or service search in metadata repositories (Web Catalogue Search, WCAS), such as GeoNetwork [4].

## 1. Introduction

In recent years a change has been observed among programme advanced users and developers which has been called Open Source. It is a kind of approach whereby the users themselves propose operations; they report errors and put forward solutions in the shape of a source code, so that the user community takes advantage of the common work. In Open Source projects, experienced programmers sponsored by companies participate, contributing their knowledge. Other inexperienced programmers use their available time trying to find their place in the market. A third group of programmers contribute their experience and developments through projects supported by governmental agencies [10] friendly towards the Open Source movement. This movement has also reached the software tools related to Geographic Information and Geospatial solutions through the implementations of the OGC Web Service specifications. This is no surprise to the user community, since for a few decades there have been projects such as Grass Proj [20] and more recently Gdal [9], MapServer, Geotools, GeoServer, PostGis [19], Deegree and GeoNetwork, all of which have used a similar approach.

Finally the future users of the applications distributed as Open Source should be aware of the copyright, which is protected through legal licensing defining the kind of utilization, permits and responsabilities deriving from the modification of the source code, and the permits and obligations incurred when giving out executable applications based on Open Source with regard to the used source code. The most relevant characteristics of a representative set of this type of licences is briefly described as follows:

- BSD (Berkeley Software Distribution): This licence allows making binary distributions (executable code) and source code distributions. It allows use of the source code to incorporate it into other developments, with the obligation of mentioning the authors.
- GPL (GNU Public Licence): It realizes an intelligent use of copyright laws, allowing binary distributions and imposing the obligations of distributing the source code as well. This way the users utilizing and modifying the software are compelled to publish changes and developments, thus allowing the whole community to take advantage of changes, improvements and advances. It contains an important restriction derived from its definition: only a GPL source code may be incorporated with other software developments that share the same type of licence.
- MIT (Massachusetts Institute of Technology): This licence cancels any restriction protecting the copyright, allowing any type of changes, redistributions, incorporation, etc… It is warranted that every product based on another one with this type of licence will comply with the copyright, allowing third persons to increase and take advantage of the development wealth.


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The main objective of this document is to analyse the degree of development of Open Source type software projects related to the OGC specification implementation. This allows searching of and accessing to Geospatial information (Geo-Portal). Thereby the functional requirements proposed by the U.S. Geospatial One-Stop initiative will be adopted as a reference model.

The remainder of the document is structured as follows: in the first place the Web services as defined by OGC are enumerated and briefly described. In the second place the functional design requirements defined by GOS are enumerated, described and analysed, with the purpose of identifying the components standardized by OGC that shall be used in the design of the Geo-Portal.

In the third place the different widely known Open Source projects implementing specifications agreed on by OGC for the previously identified components are analysed and described. This will be done by outlining the different implemented Service Versions, the types of data stores that can be managed, the tools available for management as well as the accompanying utilities for Geographic Information handling. Documentation availability and existence of prototypes proving and/or certifying their correct functioning will be borne in mind.

Finally several tables are shown defining the degree of compliance of the functional requirements proposed by GOS for the different service implementations concerning Open Source projects. As a result of this analysis, several conclusions related to compliance identifiers are drawn. A set of guidelines will be proposed that may be of use as a feedback element for the projects. Finally, the acknowledgements and the references are shown.

## 2. Overview of OGC Defined Web Services

In this chapter, main four Web Services and main four encoding specifications defined by the Open Geospatial Consortium are described as key components for GOS Portal implementation. In its reference model [1] OGC defines a taxonomy for services, classifying them as human interaction services, model and information management services, task control and work flow services, processing services, communication services and system management services. Next the operations described in the service abstract specifications by OGC are mentioned.

WMS: Web Map Service. This is a human interaction and processing service allowing access to dynamically generated images through a simple interface (GetMap). These images are defined by their size (lines * columns) and by their image format. Images are generated from a set of grid or vector layers of geographic information framed in a given temporal, vertical and geographic enclosure (BBox), whereon a priority order has been established and whereto a set of styles is applied, defined to be used by default or, quite the opposite, it is the user the one who establishes it. That information manifests itself in an image whose CRS may be chosen by the user. This service may also provide description of the structure and types of data associated to the features (DescribeFeature). Another capability of this service consists of the delivery of information associated to a feature coming from a layer that has been drawn on an image (GetFeatureInfo).

WFS: Web Feature Service. This is a model management and information service allowing access to vector data stores through request encoded in *Extended Mark-up Language* (XML). This service uses the OGC *Filter Encoding* specification to state spatial restrictions, comparisons, aggregations, etc. It also allows to get information from the stores (GetFeature), to get information from the data model used in the store (DescribeFeatureType), to lock features (LockFeature) and finally, to optionally carry out transactional operations with features: insertions, updates and deletions (Transaction: Insert, Update, Delete).

WFS-G: Web Feature Search-Gazetteer. This is a model management and information service allowing access to feature geometry, properties, synonyms (*alternative geographic identifiers*) defined as related terms ( *Related Term:RT*), i.e. spatial relationships where the *parent* is searched for (*Contain*) (*Broader Term: BT*) and relationships where terms depend on the *child* (*Inside*) (*Narrower Term: NT*). The final aim of this service is to allow to navigate in a dictionary of related terms (thesaurus) through the geometric component.

WCS: Web Coverage Service. This is an information management service allowing access to coverages through a simple interface (*GetCoverage*). It is has similar interface to WMS *GetMap*, whereon the layers are the coverages. The Service output graphic formats shall allow carrying out different types of analysis. The Service uses parameters directly related to the spatial and/or temporal dimensions of every coverage. The realization of a sampling on the coverage with a resolution different than the original one may be required to get the result when a request is made. Furthermore this service shall implement the operation *DescribeCoverge*, in order to allow to get the descriptive information of the coverage that does not turn up in the service metadata (*GetCapabilities*).

Filter: Filter Encoding (also Common Query Language). This is an XML encoding schema whose aim it is to allow consultations on layers, coverages and features. With these consultations, geometric restrictions may be defined, the maximum number of results for a consultation may be restricted, Boolean and comparison relationships between several conditions may be established and function-based calculations may be carried out.

SLD: Styled Layer Description. This is a specification defining an XML encoding schema whose aim it is to allow setting visualization rules and characteristics of geometric elements (points, lines and surfaces) and their attributes. It enables to individually or collectively define colours, widths, filling styles and family, sizes and styles of font to be applied on the texts.

Context. This is an XML encoding schema whose aim it is to allow storage of the necessary information to reconstruct somewhere and sometime a setting whereon the sources of the present layers, their order and style, the spatial dimension, the coordinate system, etc. shall be registered. In short, it allows to reconstruct a snapshot taken by another person somewhere, sometime.

GML: Geographic Mark-up Language. This is an XML encoding system defined by OGC to store and exchange all kinds of tabular information associated to any geometry (points, lines, surfaces, complex data). It is an encoding language of the responses provided by WMS, WFS and WFS-G. Certain parts of the schema are also used to set filters (Filter) in the requests on the above-mentioned services.

## 3. Functional Requirements for a Geospatial One-Stop (GOS) Portal

In the SDI context, the chief, pioneering world power is the U.S.A. The GOS initiative is one of the 24 measures of the Presidential Agenda to promote the eGov [6]. Recently (25-August-2004) the actors involved in the GOS initiative presented a draft putting forward a package of functional requirements for Version 2 of a Web Portal of access to Geospatial Information. Taking into account the experience gathered in Version 1 and considering that this document is openly presented to the whole OGC community for comments, we believe it would be of much interest to adopt the functional requirements defined in this document as a reference framework. Its reading has been of use to identify services, encoding and other OGC and ISO specifications that shall be part of the Web Portal.

First the general ideas described in the document are presented. Next the Web Services and the encoding specifications, to be used to reach the maximum degree of conformance with the requirements, are identified.

The general targets for a Geospatial Portal are as follows: to have a user interface designed for maximum utilization capability, to have search tools and access to resources, to have tools for system management and hosting and finally to have special tools for portal management and maintenance. In view of the fact that these are common requirements, a series of more precise descriptors is enumerated next.

The most important functions a portal should provide are as follows: 1.- To be useful for localization and access by the Internet to service collections providing reference geospatial data, maps, applications with geospatial functions and web sites. 2.- To allow search of information relying on metadata of datasets and its geographic location. 3.- To have tools in order to gather copies of metadata from its sources, i.e. SDI's, by using interconnection protocols of metadata catalogues, XML files stored in accessible directories from the Web and providers of data or services implementing discovery protocols. 4.- To access and show the metadata available for the data. 5.- Locate and display maps of areas or subjects of interest with geospatial data. 6.- To locate and access the data associated to features and spatial coverages for the area and subject of interest. 7.- To have tools allowing to publish metadata on the existing data or planned acquisitions to the owners. 8.- To allow governmental agencies to locate possible members who will share the acquisition expense of geospatial data. 9.- To ensure that services will be accessible through web page browsers 24 hours a day 7 days a week.

In order to meet all these requirements through a friendy web interface, the following services shall be available: WMS, (WFS, WCS) for local data, WFS-G, metadata catalogue and different kinds of clients: WMS, WFS-G and metadata editor. In order to navigate through the geospatial information, a WMS client is required who may add or remove layers, change their order and styles and store or reestablish the instantaneous context of the visualized map. In order to carry out data serches using site names, a gazetteer client is required, so that all the results found and the existing spatial relationships are shown. In order to interactively select the geographic extension of the searches, a simple WMS client is required who shows information with little detail. Classification of described contents by means of metadata is necessary, so that access is possible by just two mouse clicks. In short, the Web Portal of access to geoinformation requires several clients to be integrated in one or several interfaces interacting among themselves and with the services.

In order to carry out these interactions, the Filter, SLD, Context and GML encoding, as standardized by OGC, shall be used.

Other important capabilities mentioned in the document, though with a different priority, are as follows: 1.- Classification of search results. 2.- Suggesting other products also searched by similar users. 3.- Allowing the user to edit geoinformation presentation styles. 4.- Carrying out searches using pre-established patterns in natural language. 5.- Having tools enabling to print combined quality maps. 6.- Publish service interfaces. 7.- Having interfaces designed to be used by individuals with disabilities. 8.- Including help information. 9.- Having category or channel managers. 10.- Having authentication management. 11.- Filtering access to IP addresses. 12.- Restricting searches of and access to certain metadata. 13.- Ensuring a minimum in request concurrence. 14.- Ensuring a maximum time lapse in requests. 15.- Using open standards. 16.- Ensuring management of catalogue loading.

## 4. Open Source Projects Implementing OGC Services.

In this chapter the state of the art of several *Open Source* software projects implementing OGC-defined Services is described. Reference is made to other projects directly related to the previously mentioned projects. Next the life cycle of the different project versions is presented. Finally a summary of the services and OGC specifications implemented by each one of them is shown as a table.

As a starting point for this study, the OGC product registry [17] has been used. By reviewing it, the following Open Source projects have been identified: MapServer, Geoserver, Geotools, Deegree and GeoNetwork.

MapServer, University of Minnesota: This is the oldest and best known Open Source project in this field. It was started in 1996, it is developed in its entirety in C++ and has got the recopilation files for the operative systems Windows, Linux and Unix. The project uses the following libraries: gd [8], regex [21], libtiff [14], freetype [3], proj4, libcurl [12], pdflib [18] and gdal that allow access to a great variety of file formats, raster, vectorial formats or databases. At the present time it implements the following OGC specifications: WMS, WFS and WCS servers; WMS and WFS clients; it accepts SLD, Filter, GML and WMContext.

Geotools. This is a project developed in Java with the aim of getting a collection of tools for GIS. The literal descripción [7] of the project in SourceForge is: "*GeoTools is *the* Open Source Java GIS toolkit. Used for OGC-based projects via GeoAPI interfaces. Includes two great SLD- based renderers, raster access and reprojection. Plug-ins for Shapefile, ArcGrid, ArcSDE, Postgis, OracleSpatial, MySQL and many more*". This project and its code is being integrated in multiple projects such as Jump [11], Udig [22] and GeoServer. Geotools only implements WMS in conformance with OGC.

Geoserver. This is a good example of an Open Source project whose development have been/ is being supported by different private and governmental initiatives with the aim of reaching a series of objectives of interest for the organizations [10]. Geoserver implements the transactional WFS and WMS specifications of the OGC. It may use different sources of information, among them Oracle, ArcSDE, PostGis and Shapefile. The quality distinguishing the project of the rest is that the Service management is integrated in a Web interface.

Deegree. This project has its roots in the JaGo project of the Geography Department of the University of Bonn. It is a project developed in Java whose task is as follows: "*The free software project Deegree offers the substantial building blocks for the building of a Spatial Data Infrastructure by implementing the standards of the Open GIS Consortium (OGC) and ISO/TC 211* ". It implements the following Web Services conformant to OGC specifications: WMS, WFS-T, SLD, Context, WFS-G, WCS, WCAT y WCTS. It has got a WMS client called iGeoPortal, allowing access to WMS and WFS to show information. The main drawback for the utilization of this project is the ongoing development and the lack of documentation and tools that facilitate the installation and configuration of the services. WMS, WFS and WCS tutorials may be found in the demos.

GeoNetwork: this is also a project developed in Java that implements a catalogue and geo-information search service, access and visualization of geo-data and metadata edition and management. The official definition of the project is: "*GeoNetwork is a Web-based Geographic Metadata Catalog System developed by FAO-UN and WFP-UN. The system implements the ISO 19115 Geographic Metadata and ISO 23950 (Z39.50) standards.*" [4].

The main characteristics of the project are:

1.- Availability of a Web tool for metadata edition with direct links to “Help”, that may include examples.
2.- Availability of administrative tools to define the policy of access to metadata and data by arranging privileges for users and groups of users.
3.- Possibility of defining metadata templates or profiles.
4.- Capability of catalogue federation in order to distribute consultations and standardize results.
5.- Ordering of search results on the basis of different criteria.
6.- Access to complete visualization of metadata.
7.- Access to visualization of available data in WMS or ArcIMS Servers in a WMS client.
8.- Installer with assistant.
9.- Possibility of SGBD choice between McKoi, Oracle, Postgres or MySql.
10.- Designed for internationalization.

The following table show the temporal development of the previously described projects.

| **Date** | **MapServer** | **Deegree** | **Geotools** | **GeoServer** | **Gdal** | **PostGis** |
|---|---|---|---|---|---|---|
| 1997 $1^{1/4}$ | 1.0 | | | | | |
| 1998 $1^{1/4}$ | 2.0 | | | | | |
| 1999 $1^{1/4}$ | 3.0 | | | | | |
| 2000 $2^{1/4}$ | 3.3 | | | | 1.1.0 | |
| 2000 $3^{1/4}$ | | | | | 1.1.1 | |
| 2000 $4^{1/4}$ | 3.4 | | | | 1.1.2 | |
| 2001 $1^{1/4}$ | | | | | 1.1.4 | |
| 2001 $2^{1/4}$ | | | | | | 0.2 |
| 2001 $3^{1/4}$ | 3.5 | | GT-little | | 1.1.5 | 0.6.0 |
| 2001 $4^{1/4}$ | | | | | | 0.6.2 |
| 2002 $1^{1/4}$ | | | | 0.90 | 1.1.6 | |
| 2002 $2^{1/4}$ | 3.6.b1 | | | | 1.1.7 | 0.7.1 |
| 2002 $3^{1/4}$ | | 0.7.5 | | 0.91 | | 0.7.3 |
| 2002 $4^{1/4}$ | | 0.7.6 | GT2 | | 1.1.8 | |
| 2003 $1^{1/4}$ | | 1.0.0 | | 0.93 | | 0.7.4 |
| 2003 $2^{1/4}$ | 4.0.b1 | 1.0.11 | | 0.95 | 1.1.9 | 0.7.5 |
| 2003 $3^{1/4}$ | 4.0 | 1.1.0 | GT2.0.b1 | 0.98 | | |
| 2003 $4^{1/4}$ | | | | 1.1.beta | | 0.8.0 |
| 2004 $1^{1/4}$ | | | GT2.0.b2 | 1.2.beta | 1.2.0 | 0.8.1 |
| 2004 $2^{1/4}$ | 4.2.b1 | 1.2.2 | GT2.0.b5 | 1.2.0.rc2 | 1.2.1 | 0.8.2 |
| 2004 $3^{1/4}$ | 4,4,b1 | | GT2.0.RC1 | 1.2.1 | 1.2.3 | 0.9.0 |
| 2004 $4^{1/4}$ | 4.4.0 | | GT2.0.M1 | 1.2.4 | 1.2.5 | 0.9.1 |
| 2005 $1^{1/4}$ | 4.4.1 | | GT2.1.M3 | 1.3.0-beta | 1.2.6 | 1.0.0-rc6 |
| 2005 $2^{1/4}$ | 4.4.2 | | | 1.3.0-beta2 | | |

Table 1: Software release history.

The following table summarizes the OGC specification versions implementing each one of the 4 projects.

| | WMS | WFS | WFS-G | WCS | CAT | Context | Filter | SLD | GML |
|---|---|---|---|---|---|---|---|---|---|
| Mapserver | 1.1.1 | 1.0.0 | | 1.0.0 | | 1.0.0 | | 1.0.0 | 2.0 |
| Deegree | 1.1.1 | 1.0.0 | 0.8 | 1.0.0 | SCat 0.06 | 1.0.0 | 1.0.0 | 1.0.0 | 2.1.1 |
| Geotools | 1.1.1 | | | | | | | | |
| GeoServer | 1.1.1 | 1.0.0 | | | | | | | |
| GeoNetwork | | | | | | | | | |

Table 2: Projects OGC Service implementation

**5. Conformance Analysis of the Geoportal Functional Requirements for Open Source Projects**

In this chapter the results of the conformance analysis of all functional requirements defined in the document GOS Portal are shown. This analysis has been reflected in a table whose columns are: requirement, priority, identified services, projects involved, conformance percentage value and actions to take to be able to reach conformance. The table is shown in the document annex.

After having analysed every element, the results have been processed to show in an aggregate form the results classified by general objectives and degree of priority. The results about the degree of conformance reached in aggregate form by degrees of priority are presented in the following table.

| **Requirement** | **Priority** | **Conformance (Mean)** |
|---|---|---|
| 1. Search (Role:User) | 1 | 39.68% |
| 1. Search (Role:User) | 2 | 43.75% |
| 1. Search (Role:User) | 3 | 2.5% |
| 2. Map Display (Role: User) | 1 | 65% |
| 2. Map Display (Role: User) | 2 | 50% |
| 2. Map Display (Role: User) | 3 | 0% |
| 3. Data and Metadata Access (Role: User) | 1 | 50% |
| 3. Data and Metadata Access (Role: User) | 2 | 66% |
| 3. Data and Metadata Access (Role: User) | 3 | 0% |
| 4. Transformation and Processing (Role: User) | 1 | 100 |
| 4. Transformation and Processing (Role: User) | 2 | 100 |
| 5. User Interface (Role: User) | 1 | 68.75% |
| 6. Publication (Role: Provider, Maintainer) | 1 | 60% |
| 6. Publication (Role: Provider, Maintainer) | 2 | 0% |
| 7. Authentication (Role: Maintainer, Provider) | 1 | 100% |
| 7. Authentication (Role: Maintainer, Provider) | 3 | 100% |
| 8. Scalability (Role: Provider) | 1 | 100% |

Table 3: Functional requirement conformance.

| **Final report** | Priority | Conformance |
|---|---|---|
| Requirement Priority | 1 | 72.92% |
| Requirement Priority | 2 | 51.92% |
| Requirement Priority | 3 | 25.62% |

Table 4: Aggregate functional requirement conformance.

## 6. Conclusions.

This piece of work is an overview of the Open Source movement with a reference to the main type of licences. The main specifications of services involved in the SDI's (some of them ISO standards) have been described. A number of Open Source software projects are described. They are related to SDI's in different ways: descriptive, historical and in regards to implemented OGC specifications. A conformance analysis of the different functional requirements of a Web Portal allowing access to Geo-information, as defined by GOS, has been carried out, and the single results have been presented, in table form.

After having described the achievements attained, it may be stated that a Web GeoPortal may be created having a high degree of conformance (~73%) with GOS-Portal defined functional requirements.

This way it may be proven that Open Source software projects are well attuned, they implement and comply in a high percentage with the web service specifications as defined by OGC.

In the table shown in the annex, suggestions have been contributed which are intended to encourage the managers of the referenced projects, and a good part of the community of users concerned with Geographic Information and SDI's, to merge with GOS recommendations.

## 7. Acknowledgements.

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12. Libcurl. Curl is a tool and libcurl is a library for transfering data with URL syntax
http://sourceforge.net/projects/curl/
13. LibJPEG. From the International JPEG Group. http://www.ijg.org/
14. LibTIFF. TIFF/GeoTIFF support. http://www.libtiff.org/
15. Mapserver. MapServer project. http://mapserver.gis.umn.edu
16. MySQL. http://dev.mysql.com/
17. OGC: Open Geospatial Consortium registered products. http://www.opengeospatial.org/resources/?page=products
18. Pdflib. Library for processing PDF on the fly. http://www.pdflib.com/
19. PostGis. Geographic Objects for PostgreSQL. http://postgis.refractions.net
20. Proj.4. Cartographic projection library from the USGS. http://proj.maptools.org/
21. Regex. Regular expression library. http://regexlib.com/
22. Udig. User-friendly Desktop Internet GIS. http://udig.refractions.net:8080/confluence/display/UDIG/UDIG+Project

## Annex:

| Requirement | Priority | Service | Projects | Conformance | Actions |
|---|---|---|---|---|---|
| **1. Search (Role: User)** | | | | | |
| Search for …based on type of data. | 1 | WCAS + WCAS-Client | GeoNetwork | Data 100%, service 0% | Implement service metadata catalogue. |
| Search for … based on named locations | 1 | WCAS-Client | GeoNetwork | 25% (country + topological relations) | Add gazetteer capabilities |
| Search for …based on user-specified polygons | 2 | WCAS-Client | GeoNetwork | 0% | Add tools to define polygons & other geometries |
| Search for … based on other selected dataset or service metadata parameters. | 1 | WCAS-Client | GeoNetwork | 5%, Only 8 metadata fields are indexed | Add new field criteria to custom-made search |
| Search for … using full text search. | 2 | WCAS-Client | GeoNetwork | 100% | |
| Search without needing to view or select. | 1 | WCAS-Client | GeoNetwork | 100% | |
| Discover, display and access on "Channel" | 1 | WCAS-Client | | 0% | Add capabilities to classify metadata on topics categories |
| Allow users to limit search to Web Mapping Services and downloadable information resources. | 1 | WCAS-Client | GeoNetwork | 100% | |
| Allow users to limit search metadata describing "planned" geospatial data acquisitions. | 1 | WCAS-Client | GeoNetwork | 0% | Add new fields and search capabilities |
| Broaden search to include other information sources. | 1 | WCAS | GeoNetwork | 100% (federated catalogues) | |
| Specify or navigate to locations by gazetteer. | 1 | WCAS-Client + Gazetteer | Degree WFS-G | 50% | Build a gazetteer client |
| Specify or navigate to locations by coordinates. | 1 | WCAS-Client + Geocoder | GeoNetwork | 0% | Add field entry to get coordinates & show in WMS Client |
| Specify or navigate to locations by clicking on map. | 1 | WCAS-Client + WMS-Client | GeoNetwork | 25% | Add WMS client as Bounding Box source |
| Enhance access to the source scale-related in same theme as user navigates. | 1 | WCAS-Client | GeoNetwork | 0% | Add button to link with other data type with same scale |
| Enable user to select multiple sources based on available metadata | 1 | WCAS-Client | GeoNetwork | 100% | |
| Order sources based on appropriate criteria and policies. | 2 | WCAS-Client | GeoNetwork | 50% | Include other order criterias |
| "Channels" as "two clicks to content" access method. | 1 | WCAS-Client | GeoNetwork | 0% | Make and include interface to navigate on channel content |
| Offer alternative search interfaces | 2 | WCAS-Client | GeoNetwork | 25% | Add new alternative interfaces. |
| Prompt users to ask for queries similar to the one he just used | 3 | WCAS-Client | GeoNetwork | 0% | Add client user criteria to be able to suggest other |
| Offer a natural language interface allowing English sentences | 3 | WCAS-Client | GeoNetwork | 5% | Create usual patterns sentences in with user can complete with his worlds. |
| **2. Map Display (Role: User)** | | | | | |
| Display a map produced by a map service. | 1 | WMS-Client | Intermap. iGeoPortal | 100% | |
| Specify the geographic extent of the map. | 1 | WMS-Client | Intermap. iGeoPortal | 100% | |
| Specify the size of the map image. | 1 | WMS-Client | Intermap. iGeoPortal | 100% | |
| Overlay several maps from different sources. | 1 | WMS-Client | Intermap. iGeoPortal | 100% | |
| Turn off and reorder maps in an overlay. | 1 | WMS-Client | Intermap. iGeoPortal | 100% | |
| Automatically use available scale | 1 | WMS-Client | Intermap. iGeoPortal | 0% - 100% | |

| | | | | | |
|---|---|---|---|---|---|
| Display scale-appropriate annotation for each map layer. | 1 | WMS-Client | Intermap. iGeoPortal | 0% - 100% | |
| Display legend for each map layer. | 1 | WMS-Client | Intermap. iGeoPortal | 0% - 100% | |
| Create and display a map using predefined styling. | 2 | WMS-Client | Intermap. iGeoPortal | 100% | |
| Create and display a map using user-defined styling. | 2 | WMS-Client | Intermap. iGeoPortal | 0% | Add Style Layer Descriptor Editor. |
| Display a map with user-selected false-color. | 2 | WMS-Client + SLD | Intermap. iGeoPortal | 0% | Add image band combination. |
| Save and restore a multi-source map view. | 2 | WMS-Client + Context | Intermap. iGeoPortal | 0% - 100% | |
| Show printable map with only all displayed layers. | 1 | WMS-Client | Intermap iGeoPortal | 100% | |
| Find a third-party service that can access it, and bind the two together. | 3 | WCAS-Client | InterMap | 100 | |
| Dynamically populated mapping services | 2 | WCAS-Client + WMS-Client | InterMap | 100% | |
| Display "footprint" of planned geospatial data acquisitions. | 1 | WCAS-Client | InterMap | 0% | Add display button for planned data acquisition |
| **3. Data and Metadata Access (Role: User)** | | | | | |
| View detailed metadata for the map or data. | 1 | WCAS-Client | GeoNetwork | 100% | |
| Always display specific metadata fields for each map layer. | 1 | WCAS-Client | GeoNetwork | 0% | Include all time related fields on preview search result |
| Download and save the data upon which a map is based for future use | 1 | WCAS-Client | GeoNetwork | 100% | |
| Download and save entire map dataset | 2 | WCAS-Client | GeoNetwork | 100% | |
| View information about a feature shown on a map | 1 | WMS-Client | InterMap iGeoPortal | 100% | |
| Enable access to other applications. | 1 | WCAS | | | |
| Provide direct access to metadata about planned data acquisitions. | 1 | WCAS-Client | | | |
| Search for available vector data based on feature property values. | 2 | WFS Client | GeoServer, MapServer, Deegree | 0% | Add WFS Client on Search Catalog interface |
| Provide a visual indicator about "cost" and/or "open access" | 1 | WCAS-Client | GeoNetwork | 0% | Add icon visualization of cost |
| Provide an indicator identifying the resource as being downloadable or requiring authorization. | 2 | WCAS-Client | GeoNetwork | 100% | |
| Metadata results ordered and ranked based on "completeness" | 3 | WCAS-Client | GeoNetwork | 0% | Add result order based on completeness |
| **4. Transformation and Processing (Role: User)** | | | | | |
| Transform maps to other image formats. | 1 | WMS | Mapserver | 100% | |
| Transform maps to other coordinate reference systems. | 1 | WMS | Mapserver | 100% | |
| Transform data to other coordinate reference systems. | 2 | WMS | Mapserver | 100% | |
| **5. User Interface (Role: User)** | | | | | |
| Operate using a basic web browser | 1 | WCAS, WMS Clients | GeoNetwork, InterMap, iGeoPortal | 100% | |
| Operate user interface without requiring use of a particular vendor's web browser. | 1 | WCAS, WMS Clients | GeoNetwork, InterMap, iGeoPortal | 100% | |
| Be able to operate user interface even if user's security settings prohibit the downloading of executable code. | 1 | WCAS, WMS Clients | | | |
| Be able to operate all functions in accordance with federal rules for access by individuals with disabilities | 1 | WCAS, WMS Clients | GeoNetwork | 0% | Enhance user interface to enable access for individuals with disabilities |
| Be able to access user documentation and Help access to user documentation | 1 | WCAS, WMS Clients | GeoNetwork | 100% | |
| All navigation tools have informative and easy-to- understand labels that appear on or near the tool. | 1 | WCAS, WMS Clients | GeoNetwork, | 100% | |
| Links to a content disclaimer and privacy statement. | 1 | WCAS, WMS Clients | GeoNetwork, | 100% | |

| | | | | | |
|---|---|---|---|---|---|
| Terms used to label fill-in forms or search results shall be defined and easily and noticeably accessible by the user. | 1 | WCAS, WMS Clients | GeoNetwork | 50% | Enhance user interfaces to easily communicate to users |
| **6. Publication (Role: Provider, Maintainer)** | | | | | |
| Enable review new metadata before being shown. | 1 | WCAS | GeoNetwork | 100% | |
| Maintain a local repository of service metadata harvested from data providers' information resources. | 1 | WCAS | GeoNetwork | 100% | |
| Enable data providers to register the Internet location where they store their metadata sources for scheduled harvesting . | 1 | WCAS | GeoNetwork | 100% | |
| Enable provider to publish metadata for planned geospatial data resources. | 1 | WCAS | GeoNetwork | 0% | Include new type of metadata insertion for planned data resources. |
| Publish custom-made symbolization rules for use by others if authorized. | 2 | WCAS | GeoNetwork | 0% | Add style capabilities to show data based on authorized access |
| Enable to maintainer the manage ability of "two clicks to content" areas. | 1 | WCAS | GeoNetwork | 0% | Add Metadata Categories administration tool |
| **7. Authentication (Role: Maintainer, Provider)** | | | | | |
| Independently restrict access to each of the Portal user interfaces | 1 | WCAS | GeoNetwork | 100% | |
| Enable to restrict access to their offerings | 1 | WCAS | GeoNetwork | 100% | |
| Enable Providers to restrict discovery | 3 | WCAS | GeoNetwork | 100% | |
| Enable Providers to restrict access | 1 | WCAS | GeoNetwork | 100% | |
| **8. Scalability (Role: Provider)** | | | | | |
| Support at least 100 simultaneous users. | 1 | WCAS | GeoNetwork | 100% | |
| Each user shall be able to display maps representing content from up to 20 remote service providers. | 1 | WCAS | InterMap iGeoPortal | 100% (Z39.50 & lucene) | |
| The Local Registry shall be able to catalog at least 300,000 information sources. | 1 | WCAS | GeoNetwork | 100% (Oracle, etc SGDB) | |
| The Portal design shall be modular, scalable and extensible. | 1 | WCAS | GeoNetwork | 100% (Java) | |
| The metadata contents shall be accessible using open standards | 1 | WCAS | GeoNetwork | 100% ISO & others | |
| Search results must be shown within 5 seconds. | 1 | WCAS | GeoNetwork | 100% | |