ACTUAL STATE IN DEVELOPING GEONETWORK OPENSOURCE AND METADATA NETWORK STANDARDIZATION

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Abstrakt. Článek se věnuje popisu schopností aktuální verze GeoNetwork opensource, představuje novinky ve funkcionalitě systému a přináší srovnání s předchozími verzemi GeoNetwork opensource. Dále rozebírá možnosti GeoNetwork opensource jako nástroje pro tvorbu metainformací infrastruktury postavené na katalogových službách pro web (CSW).

Klíčová slova: GeoNetwork, CSW, Catalogue, Catalog Services, Web Services, ISO 19115, ISO 19139, FAO, JAVA, Jeeves, Open Source.

Abstract. This paper describes the abilities of the actual version of the GeoNetwork opensource, it presents news in the functionality of the system and it brings the comparison with the previous versions. The paper analyzes the possibilities of the GeoNetwork opensource as a tool for creating metadata network, which are build on Catalogue services for web (CSW).

Keywords: GeoNetwork, CSW, Catalogue, Catalog Services, Web Services, ISO 19115, ISO 19139, FAO, JAVA, Jeeves, Open Source.

1   Introduction

The INSPIRE Directive entered into force on the 15th May 2007. Directive means an obligation of the member states EU to create and ensure legal enactment, which will enable an achievement of directive requirements. One of the main areas required by the directive is metadata collecting and administration of the geoinformation resources. The metadata should be created in compliance with INSPIRE implementation rules. Number of organizations should interrogate how to achieve these requirements.

Several projects were implemented in the Czech Republic for the last ten years. These projects solved the problems of metadata. The activity of Institute of Geoinformatics in VSB-TU Ostrava is the continuing of these projects. The purpose of this activity is to support organizations in finding the ways how to provide the technical administration, evidence and sharing of metadata. One of the possible steps is the usage of open source technical solutions. The purpose of this paper is not to consider the applicability of the open source for individual purposes of the usage, but to inform about the possibilities and functionality of the system GeoNetwork opensource, which is developed and supported by Uniter Nations (UN) organizations. The development of GeoNetwork opensource is in compliance with the INSPIRE requirements.

2   GeoNetwork opensource characterization

2.1   Common specification

GeoNetwork opensource is a catalog application, which is useful for managing the spatially referenced resources. It has been developed for the purpose of the connection between the spatial information communities and their data. GeoNetwork opensource allows building of a modern architecture, which is at once powerful and low cost, based on principles of Free and Open Source Software (FOSS) and International and Open Standards for services and protocols (ISO/TC211, OGC)[3]. GeoNetwork is a *web based Geographic Metadata Catalog System* developed by FAO-UN (Food and Agriculture Organization of The United Nations) [1], WFP-UN (World Food Programme) and UNEP (United Nations Environment Programme). [11]

The three agencies cooperated and developed the GeoNetwork opensource as a common strategy to share effectively their spatial databases including digital maps, satellite images and related statistics. In 2001 FAO set up FAO-GeoNetwork (www.fao.org/geonetwork) as a facility that provides various services such as global library for geospatial data; metadata catalogue; system for searching, editing and publishing geospatial information; as well as information how to integrate geospatial data from various sources on the Internet. The FAO joined WFP-VAM branch (Vulnerability Analysis & Mapping) in order to achieve broader cooperation in the further development of GeoNetwork to discover the additional user requirements and co-funded the development of the system. As a result of this activity the GeoNetwork version 1 was finished in early 2004 and the version 2 in 2005. [11]

2.2   GeoNetwork opensource characteristics

GeoNetwork opensource is standard based, free and open source catalog application written in Java. It provides creating and editing of metadata and offers search functions as well as the embedded interactive web map viewer [8]. GeoNetwork opensource can be used as a server or desktop application. It is release under GNU GPL license [10].

2.3   Selection of GeoNetwork's important features

GeoNetwork opensource provides many capabilities[4]. Some of them are listed below:
- Metadata search capabilities.
- Metadata editing and management.
- Metadata storage.
- Metadata sharing.
- Metadata synchronization.
- Metadata harvesting.
- Portal administration tool.
- Data distribution and publication.

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[3] Selection of core GeoNetwork opensource standards is described in chapter 3.2 in [2]
[4] Another features are describe in [2] and [1]

2.4   GeoNetwork opensource architecture

GeoNetwork opensource is based on Service Oriented Architecture (SOA) and Geospatial portal reference architecture [9], which is more described in [11] or [24]. GeoNetwork opensource directly supports three of four service classes: *Portal Services*, *Catalog Services* and *Data services*. Fourth service class *Portrayal services* isn't directly supported, but can be provided through mapserver. The last version of GeoNetwork opensource contains the InterMap [13]. InterMap opensource is a generic interactive map viewer application that is supported by the Open Geospatial Consortium WMS and ESRI $^®$ ArcIMS$^{™}$ WMS [8].

2.5   GeoNetwork opensource version overview

The latest available version of GeoNetwork opensource is version 2.1 (release on September 2007) [8]. All information in this paper is related to GeoNetwork opensource 2.1 (official release). Examined GeoNetwork opensource is compared with older version of GeoNetwork opensource 2.1 alpha X and 2.0.3. Functionality and usage of GeoNetwork alpha X were one of topic in [24]. Overview of important versions is listed in Table 1 bellow.

Table 1 GeoNetwork opensource - versions overview [24]

GeoNetwork version	Release date	Note
1.2.1	28. 10. 2004	
2.0	20. 12. 2005	Official release
2.0.2	18. 04. 2006	Official release
2.0.3	20. 10. 2006	Official release – fix some bugs from 2.0.2
2.1 alpha 1	21. 10. 2006	Unofficial testing version
2.1 alpha 2	03. 01. 2007	Unofficial testing version
2.1 beta	12. 02. 2007	Unofficial release
2.1 beta 2	20. 03. 2007	Unofficial pre-final release
2.1	21. 9. 2007	Latest official release

2.6   How to obtain GeoNetwork opensource

GeoNetwork opensource is possible obtain in three different ways [8]:
- *Source code*[5] – is released through Subversion (SVN) [28]. Source code is accessible only for reading.
- *Self installation package* – is built with IzPack. You can download installer for Windows or platform independent package. IzPack is Java installer's generator. It produces lightweight installers, which can run on such operating system where a Java virtual machine (JVM) is available [14].
- *DVD image* – GeoNetwork opensource 2.0.3 is possible obtain as a *DVD image*. DVD contains the usefull software to install GeoNetowk Opensource [8], [11].

2.7   GeoNetwork opensource Self installation package

GeoNetwork self installation package includes these components:
- GeoNetwork opensource core.

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[5] Best way for code compilation is use Apache ANT [1].

- GeoServer web map server – concretely InterMap [13].
- CSW 2.0.1 test client [5].
- Self installer building tools.
- Java source code and JavaDoc.
- Optionally embed Java Runtime Environment.

3   Significant technologies in GeoNetwork opensource

3.1   Java server pages

The main goal of GeoNetwork opensource is the platform independence, therefore it is based on Java for server pages (JSP). JSP is a set of technologies providing an easy way for building a web application [15]. JSP runs on the server and FAO recommends server Apache Tomcat [3]. GeoNetwork opensource can run also on the desktop through Jetty server[6] [18]. User experiences with already mentioned servers are described in [24].

3.2   Database connection

GeoNetwork uses standardized interface for connection to database - Java Database Connectivity (JDBC). JDBC enables to work with some compliant Database management system (DBMS) [16]. FAO recommends using McKoi DBMS for smaller system solution, for testing or desktop working[7] and some advanced DBMS (for example PostgreSQL [25] or MySQL [21]), for larger system solution. [24]

3.3   Jeeves system

All HTML or XML GeoNetwork's outputs are provided by system Jeeves 1.1. Jeeves is a *Java Easy Engine for Very Effective Systems*. Publishing of the simple systems on the Internet by Jeeves is possible without Java language knowledge and with little effort. System Jeeves is also developed by FAO [7; 17; 19].

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[6] After installation is GeoNetwork opensource preset for use Jetty server.
[7] After installation is GeoNetwork opensource preset for use McKoi DBMS.

Jeeves allows separation of presentation layer from logic layer. It uses XML as internal data representation and XSL to producing HTML output. Jeeves consists of the Java engine and is more describe in [17] or [24]. Basic schema of Jeeves system in GeoNetwork opensource context is in figure 1 below.
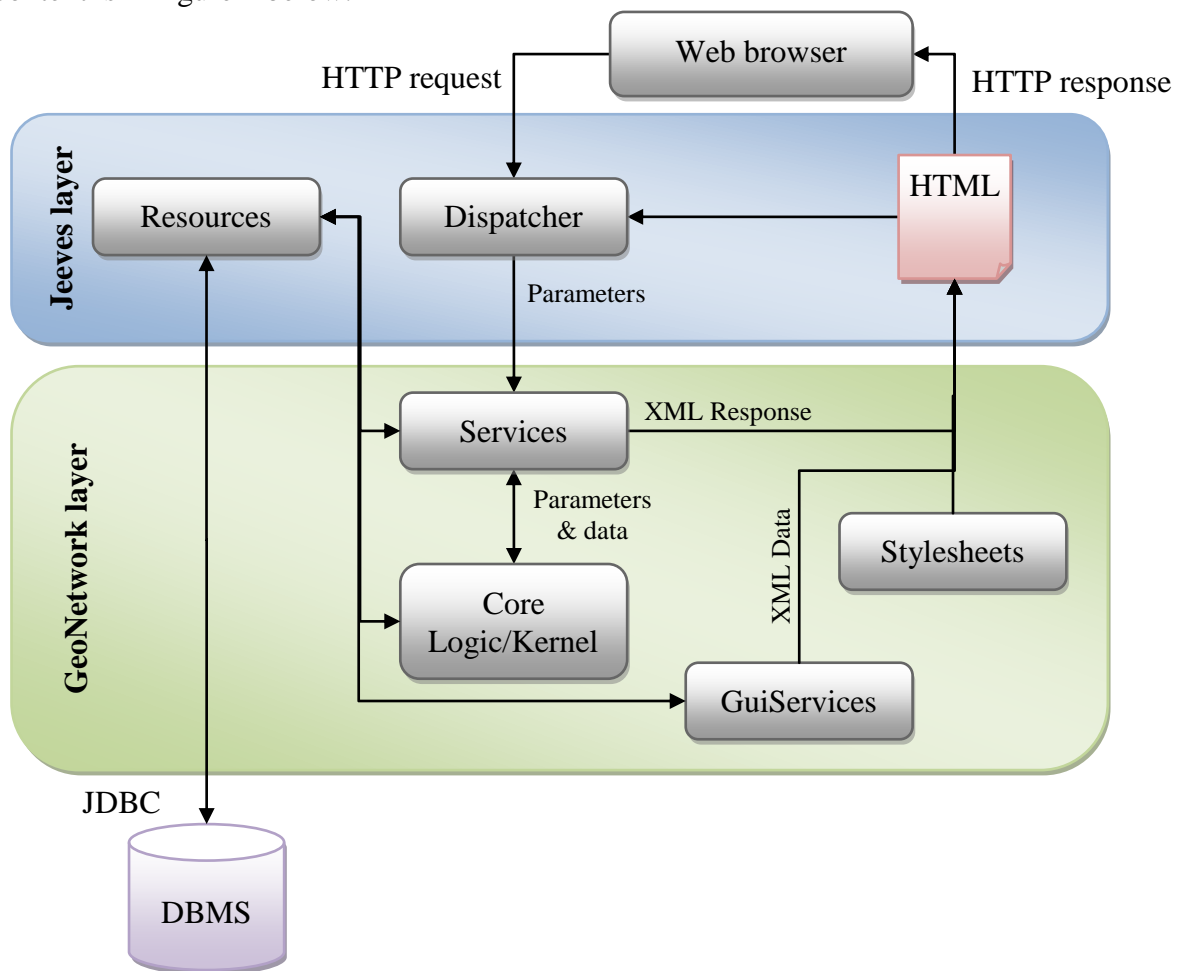

Figure 1 Jeeves architecture [4]

Jeeves provides these capabilities [19]:
- *Database access* – provides simple select, insert and update methods that can be used for no-frills database access
- *Logging management* – logging is provided for access and errors.
- *Multilingual support* – Through simple URL coding, multiple languages can be supported. Furthermore, Jeeves allows for a default language to be used if not specified by the user browser.
- *Service chaining* – Usually, the purpose of a service is to produce an output page. In some cases, though, a service needs to be called once a prerequisite service has been successfully executed (e.g. an authentication service). Jeeves supports a simple service chaining mechanism.
- *Session management* – keeping state and track of user activity on server.
- *Commit/rollback management* – Jeeves manages commit and rollback automatically. When a service returns normally, a commit is issued to the database session. If an exception is thrown, Jeeves sends a rollback.

Thanks to Jeeves capabilities is GeoNetwork opensource highly scaleable application. The user interface of GeoNetwork opensource can be adjusted, by editing XSL and CSS files. All

interfaces can be translated into the national language by editing XML files. GeoNetwork opensource was translated in English, French, Spanish and Chinese languages. Czech translation of the previous version GeoNetwork opensource 2.0.3 is available and you can ask for it from Jan Růžička VŠB-TU Ostrava.

3.4   Lucene search

GeoNetwork opensource uses Apache Lucene (powerful full-text search engine library) for indexing and search of metadata. Apache Lucene search engine library is entirely written in Java language. It is a technology suitable for almost any application that requires full-text search, especially cross-platform. Apache Lucene is an open source project released under GNU GPL [2; 10]. Apache Lucene supports following types of queries: *RangeQuery*, *PrefixQuery*, *WildcardQuery*, *FuzzyQuery* closely describe in [2].

3.5   GeoNetwork opensource and standards

GeoNetwork opensource accepts valid standards and specifications, most of them are described in [24] or [11].

4   New approaches in GeoNetwork opensource 2.1

4.1   Enhanced Essential user interface

GeoNetwork opensource 2.1 brings user new enhanced communication interface. New communication interface is more intuitive, well arranged and more interactive. Whole page is reorganized – menu with categories is emplaced to the left side of the page. In the upper left corner are a search form and a map overview. On the top of the page is the server logo and the biggest part of the whole page is reserved for the page content[8].

Figure 2 Essential communication interface of GeoNetwork opensource 2.1

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[8] Visual presentation of GeoNetwork opensource can be adjust by XSL and CSS editing.

4.2   Changes in the search form

The greatest change in search form is in the usage of Asynchronous JavaScript and XML technology (AJAX). The search interface has been completely overhauled (by using AJAX) and improved by highly interactive searching and web map viewing [8].
GeoNetwork opensource originally allows searching in two ways: The *basic search* and *advanced search*. The search form in preview version of GeoNetwork was not clear for user (more describe in [24]), but new version of search form is much more well arranged. Basic search form allows a combination of a full-text (What?) and a map overlap (Where?), which are implemented through InterMap. Advanced search form is divided into three parts:

- What? – that part of the search form allows to specify search accuracy, a title, an abstract and keywords of metadata
- Where? – that part of the search form allows to specify a map overlap
- When? – that last part of the search form allows to specify time factor of metadata

4.3   New admin application - GeoNetwork GAST

GAST is the abbreviation of *GeoNetwork Administrator survive tools*. GAST is a new GeoNetwork's management system entirely written in Java. It is a self standing application which offers these capabilities:

- *Jetty configuration* – that tool allows to change some parameters of embedded Jetty server.
- *DBMS configuration* – that tool allows to select DBMS, currently *Embedded (McKoi DBMS* [20]), *Oracle* [23]*, PostgreSQL* [25]*, MySQL* [21] and *Generic JDBC connection* are supported.
- *Database export* – export of metadata as a *mef* file to a folder.
- *Database import* – import of metadata as a *mef* file from a folder.
- *Metadata Synchronization* – each metadata contain links to the GeoNetwork's server in order to allow retrieving resources. If the server's address and port from the web interface are changed, these links will break. This capability simply scans all metadata and fixes these links.
- *ISO 19115 and 19139 conversion* – these capabilities allow converting old metadata created in accordance to ISO 19115 to the new form in accordance to ISO 19139. ISO 19115 was implemented in previous version of GeoNetwork , ISO/TS 19139 was implemented in version 2.1, which is the XML encoding of the ISO 19115:2003.
- *Database setup* – these capabilities create tables and fill database with initial data.
- *Sample data and metadata* – create some sample metadata in database – these capabilities simplify GeoNetwork testing.
- *Migrate tools* – these tools allow migrating of metadata from older GeoNetwork installation.

Figure 3 GAST – GeoNetwork Administrator Survival Tool – Migrate tool

4.4   Catalogue Services for Web TEST Client

GeoNetwork opensource 2.1 is distributed with Catalogue Services for the Web test client. Catalogue services are closely described in chapter 5. Previous version of CSW test client did not want to run in OS Windows, the current version is trouble-free. GeoNetworks's CSW test client offers these capabilities:

- Connect to server on specific port.
- Login service on server.
- Send requests and obtain results through SOAP protocol. [27]
- Send request and obtain results through HTTP GET [12] method as KVP[9].
- Send request and obtain results through HTTP POST [12] method as XML.
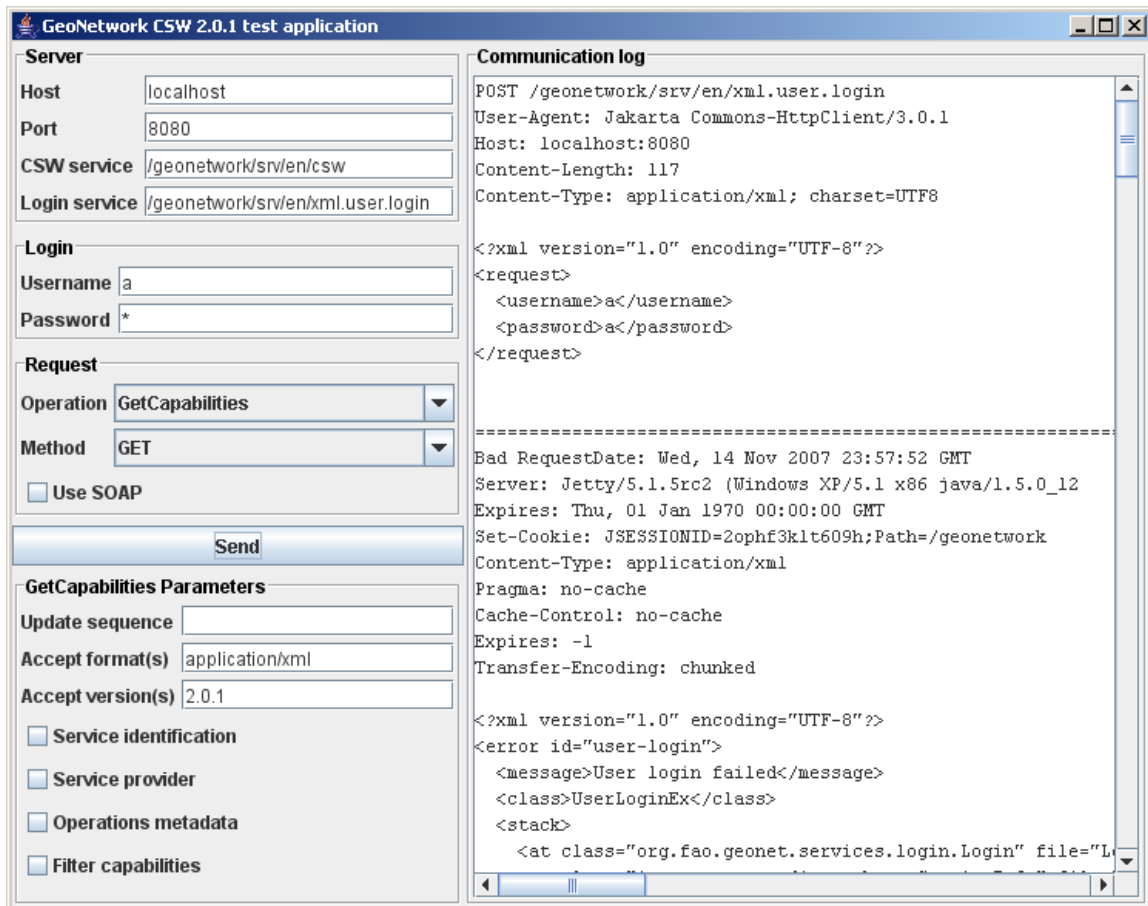
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[9] KVP is nearly describe in [5] or [24].

Figure 4 Main window of GeoNetwork CSW [5] test client

Catalogue Services for Web test client supports four operations [5]:
- GetCapabilities
- DescribeRecord
- GetRecordById
- GetRecords

4.5   New functionality administrator section

Administration section of GeoNetwork opensource 2.1 brings new functionality (e.g. Manage thesauri) for users. The list of GeoNetwork administration capabilities is below.
- *Metadata*
  - *New metadata* – Adds new metadata into GeoNetwork based on a template or directly from XML formatted metadata.
  - *XML metadata insert* – Import of XML formatted metadata.
  - *Batch Import* – Import of all XML formatted metadata from a local directory.
  - *Search for unused* – Search for unused or empty metadata.
  - *Transfer ownership* – Transfer metadata ownership from creator to another user.
  - *Manage thesauri* – Add/modify/delete and show thesauri.
- *Personal info*
  - *Change password* – Allows current user to change password.
  - *Change user information* – Allows current user to change user information.

- *Administration*
    - *User management* – Allows add, modify, delete and show users.
    - *Group management* – Allows add, modify, delete and show groups.
    - *Category management* – Allows add, modify, delete and show categories.
    - *Harvesting management* – allows add, modify, delete, start and stop harvesting tasks.
    - *System configuration* – Allows changing of some system parameters
    - *Localization* – Allows changing of localized entities, like groups, categories etc...

Another GeoNetwork configuration is still available through the XML configuration files which are located in WEB-INF folder. More information about GeoNetwork configuration panel is possible to find in [24].

4.6   GeoNetwork opensource and metadata harvesting

Harvesting is the process of getting of metadata from other nodes connected into metadata network. GeoNetwork periodically visits selected remote nodes around and ask them about new or changed metadata. If remote nodes include new or changed metadata then GeoNetwork download them into the local database. Current version of GeoNetwork allows collecting metadata from these types of nodes:
- GeoNetwork 2.1 remote node.
- Web DAV Server.
- Catalogue Services for the Web 2.0.
- GeoNetwork 2.0 remote node.
- Z39.50 remote Search.

Harvest from *Web DAV Servers* and *Catalogue Services for the Web* nodes are completely new in GeoNetwork 2.1 [8].

4.7   Trifle news in GeoNetwork opensource

All changes in GeoNetwork opensource are described in [8]. List of less important news in GeoNetwork opensource 2.1:
- Increase metadata storage capacity.
- Better metadata validation.
- InterMap add export to PDF.
- InterMap map resize by dragging right corner.
- Add the concept of metadata owner.
- Jeeves allow data caching.
- Metadata backup on delete.
- Oracle database support.
- User Guide.

5   Development in metadata network standardization – Catalogue Services

5.1   Introduction OpenGIS® Catalogue Services

OpenGIS® Catalogue Services Specification (CS) is the most important specification for building standard based metadata networks. This specification defines common interfaces how to discover, browse, and query metadata about data, services, and other potential resources [5].
For building the platform independent network is important, that CS defines interface and operations of catalogue services, but it is not limited to support query languages. CS specification is, in a fact, only standard that covers management of metadata [5; 11].

5.2   Catalogue Services specification version overview

Current version of CS is version 2.0.2 and replace deprecated version of CS. Overview of CS versions is listed in Table 2 bellow.

Table 2 OpenGIS® Catalogue Services - versions overview [22]

Catalogue Services	Release date	Note
CS 2.0.2	23.02.2007	
CS 2.0.1	20.05.2005	
CS 1.1.1	2002	Deprecated
CS 1.0	1999	Deprecated

5.3   What is new in Catalogue Services 2.0.2

All changes are described in document [26]. Catalogue Services 2.0.2 includes many additions and changes, most increasing clarity or fixing errors for CSW protocol binding. The most important changes are:

- Many instances of "must" or "should" ware changed to "shall" – shall verb form is used to indicate a requirement to be strictly followed to conform Catalogue Services Specification.
- The CSW GetRecords operation example was updated to a reference proper schemas and namespaces consistent with the schemas included with Catalogue Services 2.0.2.
- Catalogue services 2.0.2 clarified the use and syntax of *Brief*, *Summary* and *Full Elements*. Returnable element sets is now well described.
- Parameters name in all Key Value Pair (KVP) encodings shall be handled in a case insensitive manner, values shall be handled in a case sensitive manner.
- Clarified the behavior of exception handling in the CSW.
- The namespace parameter in DescribeRecord was changed from Mandatory to Optional.
- In GetDomain operation is clarified consistent case handling of keywords and values
- Provided an explanation for the context and use of the requestId parameter in the GetRecords request.
- The namespace in CSW schemas XML was updated from http://www.opengis.net/cat/csw to http://www.opengis.net/cat/csw/2.0.2.
- Some corrections were making in BNF syntax.
- Entire examples are correct and updated and reflect current version.

- In all examples of request and responses where a version parameter is show, the version is updated to 2.0.2.
- The startPosition parameter in GetRecords operation was set on non-zero positive integer.
- Changed outputSchema parameter default value from "OGCCORE" to the URL http://www.opengis.net/cat/csw/2.0.2.
- Output schema parameters in examples was matched in KVP and XML.
- In harvest operation was changed ResourceType to mandatory (minOccues=”0” removed).

5.4   The General Catalogue Interface model

The General Catalogue Interface Model provides a set of abstract service interfaces that support the discovery, access, maintenance and organization of catalogues of geospatial information and related resources. The interfaces are intended to allow users or application software to find information that exists in multiple distributed computing environments, including the World Wide Web (WWW) environment. The General Catalogue Interface Model is closely described in [5].
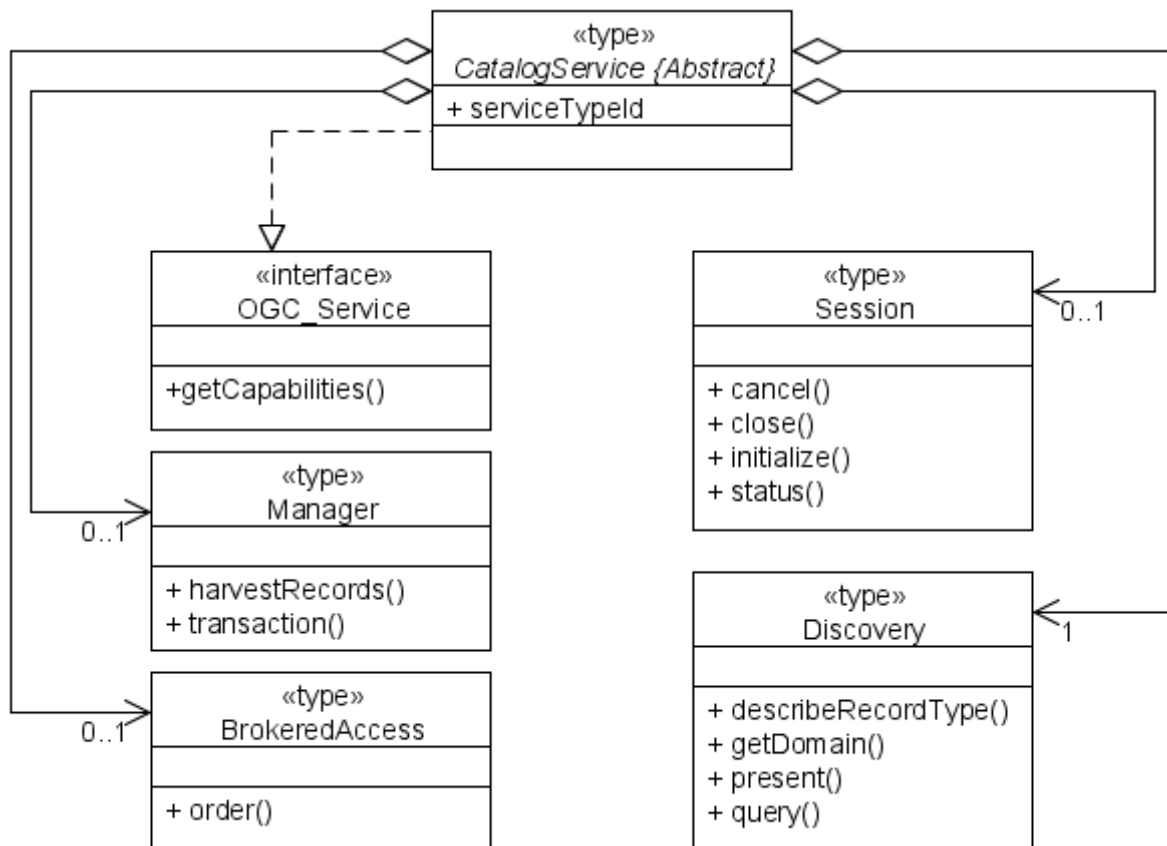

Figure 5 General OGC catalogue UML static model [5]

5.5   Catalogue Services protocol binding

CS specification describes three protocol bindings [5]:
- Z39.50 protocol binding.
- CORBA/IIOP protocol binding.

- HTTP protocol binding.

Each protocol binding includes a mapping from the general interfaces, operations, and parameters specified in this clause to the constructs available in a chosen protocol. The HTTP protocol binding is also called *Catalogue Services for Web* (CSW).

5.6 Catalogue Services for Web 2.0.2 – CSW 2.0.2

Catalogue Services for Web (CSW) is HTTP [12] binding of CS. The overall goal of CSW is interoperability support, in that purpose OGC define minimal set of query-able properties (*CSW core query-able properties*), those properties enable cross-catalogue discovery. Each catalogue implementation shall support predicate language *Common Query Language* (CQL) and *Filter* [6]. These conditions allow cross catalogue querying - the same queries can be executed against to any catalogue service without modification [11; 5].

CS specification [5] define interaction between client and server and list of operations. Every single operation is mapping to the *General Catalogue interface model*. All CSW operations are listed in Table 3 below [5].

Table 3 Summary of CSW operation [5]

Operation name	Implementation	Note
GetCapabilities	Mandatory	Allows a clients retrieve service metadata from a server.
DescribeRecord	Mandatory	Allows a clients to discovery elements of the information model supported by target catalogue service.
GetDomain	Optional	That operation is used to obtain information about the range of values of metadata record element or request parameter.
GetRecords	Mandatory	GetRecords operation is used for resource discovery – search and obtain metadata from catalogue.
GetRecordById	Mandatory	That operation is used for request the default representation of catalogue records using their identifier.
Harvest	Optional	Is an operation that "pulls" data into the catalogue.
Transaction	Optional	Transaction operation define interface for crating, modifying and deleting catalogue Records.

More information about CSW is possible to obtain from [5] or [24].

6   GeoNetwork opensource and CSW 2.0.1 support

GeoNetwork opensource 2.1 offers support of OGC Catalogue services version 2.0.1 [5]. That technology is important for building standard based metadata networks. Table 4 below compares specification requirements and GeoNetwork opensource capabilities.

Table 4 Compare CS specification requirements and GeoNetwork opensource capabilities

Operation name	Implementation	GeoNetwork opensource 2.1 support
GetCapabilities	Mandatory	Full support
DescribeRecord	Mandatory	Full support
GetDomain	Optional	Not support
GetRecords	Mandatory	Full support
GetRecordById	Mandatory	Full support
Harvest	Optional	Not support
Transaction	Optional	Not support

GeoNetwork opensource 2.1 supports only mandatory CSW operations. GeoNetwork does not support two ways CSW harvesting, the current version of GeoNetwork allows only one way harvest, from CSW nodes into GeoNetwork, the opposite way is not supported. Piece of knowledge from testing GeoNetwork opensource 2.1 Alpha X CSW implementation are available in [11].

7   Conclusion

The system GeoNetwork opensource is released under the GNU GPL license [4] and can be used as a server or a desktop application. It can be implemented either as a local metainformation system for creation and administration of metadata of geoinformation resources or as a portal solution, which provides the access to other nodes (metainformation systems and catalogue services). GeoNetwork opensource requires no acquisition costs, therefore it is necessary to understand that every information system in organization requires to ensure the service and the administration. Due to its architecture and used technologies it is possible to bring down the costs.

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