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Adaptation of the Creative Commons Approach and the Roaming Concept to Spatial Data Infrastructures (SDI)

by

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Abstract

The Spatial data infrastructure (SDI) has been developed for nearly 17 years. However, it still fails to support professional and cross-provider seamless usage. In year 2000, after the introduction of the OGC Web Mapping Service Specification, OGC/ISO TC 211 publishes more than 40 drafts or final standards, which provide basic rules for the geospatial implementation industry. Besides these, the release of the INSPIRE law in 2007 is also a major milestone in the development of SDI. While, the coverage of the SDI providers is still very limited due to the national or natural boundaries which make the SDI can not be largely used in some professional areas. Therefore, a legally-protected business environment is necessary.

To pursue an effective and innovative operational model, the roaming concept of GSM was mitigated to SDI named Roaming Enabled SDI(r-SDI) (Roland M. Wagner, 2006). In order to make this innovative idea into reality, the first and must step was to find specific issue – Geospatial information licensing which was also an urgent problem to the normal SDI as well as rSDI.

In this paper, firstly, a Creative Commons licensing approach was adapt in the Catalogue Service (CSW) which enabled the clients to get the advanced query results according to the license types. The rights management was successfully enhanced. Secondly, a suitable structure for the operation model in rSDI was conducted, moreover, 5 business use cases were proposed to CSW in different specifications sets. The contractship concepts were applied to the metadata level. Finally a demonstration designed on “deegree” – a free SDI software and web service theory was conducted, by which users can query metadata documents by title, product type, service type, license type, even in a roaming environment. Meanwhile, with the comparison between OGC and INSPIRE documents, some limitations of those standards were exposed. The pilot experiment of the demos proved it provided an effective solution to combine the right management and roaming concept demo with present CSW. The logic and concepts are well implemented in this research work.

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Abbreviations

CC

Creative Commons

CSW

Web Catalog Services

CSW ISO AP

OpenGIS® Catalogue Services Specification 2.0 (– ISO19115/ISO19119 Application Profile for CSW 2.0)

FE

Filter Encoding

GeoRM

Geospatial Rights Management

GI

Geospatial Information

INSPIRE DT DSS

INSPIRE the Data and Service Sharing Drafting Team

INSPIRE DT MD

INSPIRE Metadata Drafting Team

IPR

Intellectual property rights

rSDI

Roaming-enabled SDI

XML

EXtensible Markup Language

XSLT

Extensible Stylesheet Language Transformations

1 INTRODUCTION

1.1 Context

1.1.1 Spatial Data Infrastructure (SDI)

Geographic data are becoming more and more valuable as GIS technologies are adopted into diverse domains all over the world. Therefore the demand for a more efficient way and high ability to share and operate the data is never stopped, benefitting from the computer networks, the internet and World Web Wide developments. Since the early 1990s, the notion of a coordinated national SDI was proposed in the USA. Driven by the need of SDI, many governments or organizations have already built their own geospatial data infrastructure, such as National Spatial Data Infrastructure (NSDI) in the United States, the Spanish National Spatial Data Infrastructure (IDEE), INSPIRE initiative from European Commission which is based on the aim to build a European SDI beyond national boundaries, and also the GSDI Association, whose purpose is to promote international cooperation and collaboration in support of local, national and international spatial data infrastructure developments. At the beginning of 21st century, China has started the establishment of Spatial Data Infrastructure, which is named as National Fundamental Geographic Information System of China (NFGIS).

A spatial data infrastructure (SDI) is “a framework of spatial data, metadata, users and tools that are interactively connected in order to use spatial data in an efficient and flexible way”.(Spatial data infrastructure, Wikipedia,2009) SDI concludes the technology, standards, policies, human resources, and related activities which are necessary for acquiring, processing, distributing, using, maintaining, and preserving spatial data.

Due to the data dependence of the Geographic Information System and thousands of formats of data, millions of places to search for the data, it is quite difficult and laborious to locate, reformat, and exploit the geo data. Moreover the traditional operating way of the geo service agencies does not support contemplating, reusing or sharing data. By good luck, SDI appeared and gave a feasible way to improve the situation. The SDIs allow nations to better address social, economic, and environmental issues of pressing

importance, and facilitate a standardized and easy access to geo data for the GI (geoinformation) users .On the other hand, the SDI can be global, regional, national, local, etc. for the GI providers, those who can be organizations, agencies, firms, and even individuals, The SDI conducts a better connecting among the geo providers and users.

To reach a stable SDI first generation, all five PESTL (Political, Economic, Social, Technological, and Legal) dimensions of the analysis need to deliver positive results. Because SDI is driven by the Internet, technical developments started first; Developments in Legal and Economic dimensions are missing. Figure 1-1 shows the gaps and the goal of INSPIRE context.

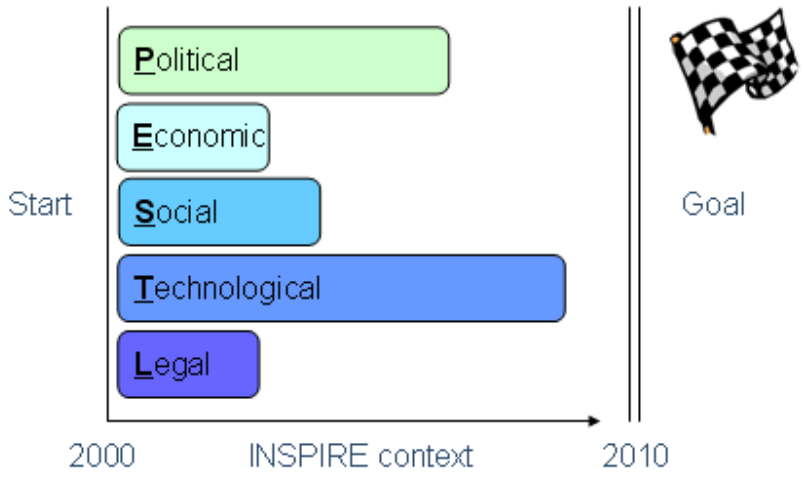


Figure 1-1 Gaps in SDI Development

However with the SDI's further evolution, which keeps track of the future internet, those challenging issues such as security, privacy, hardware and software compatibility, translation, rights to information, identity management, rights management, competition, and governance need to be dealt with. Nevertheless, Current SDI task focuses on the exchanging of spatial data, while information infrastructure largely concentrates on the provision and usage of services according to users needs. Thus for future SDI research it was suggested that the "focus should be more on users' needs and the design of appropriate geoinformation services and service architectures to satisfy these needs" (Granell, C., M. Gould, et al. 2009)

1.1.2 SDI-related Standards Organizations

A standard can be a norm or a requirement, and it is usually a formal document that establishes uniform engineering or technical criteria, methods, processes and practices. Standards act as a necessary control to prevent the chaos in the infrastructures and the mature industries. There are two types of standards, official (de jure) standards, such as electrical plug adapters manufactory and non-official (de facto) industry-led standards setting basic rules for a custom, convention, company product, corporate standard, etc which becomes generally accepted and dominant. So standards also enables competition and development. Actually, SDI components are wrapped in, controlled by, guided by international standards, as well as some de facto industry agreements and other more formal, de jure rules.

Two main sources of SDI standards are ISO/TC211 and Open Geospatial Consortium (OGC). ISO is a (de jure) international standards organization. TC 211 is the ISO technical Committee which focuses on providing international standards that enable interoperability. Most part of the ISO 19100 series of standards are modeling the various aspects of the geospatial information domain, for instance, an abstract model for geometry, features, navigation, and so on. Membership in ISO Technical Committee 211 ("geographic information") is based on countries, not individual employers. Correspondingly, members of OGC (OGC has 371 active members) are organizations not centuries, for instance, universities. In order to publish a specification documents at the public OGC website, the draft versions of the document must be edited and voted for a long time. Once the document has been published, members and non-members are entitled to download freely. The version 1.0 specification came out on the public web site, OGC members have worked for 6-18 months. In total, OGC Members work collaboratively to define implemented interface and encoding standards, which is the reason the OGC documents are called Implementation Specifications and most of the part in OGC standards are based on the ISO documents. (OGC public forum, 2009)

In a nutshell, the relationship between the OGC and ISO is beneficial and complementary. They have common, synergistic goals without competition. Thus, under some agreement,

OGC is also allowed to use certain ISO 19100 documents as part of the OGC Abstract Specification. For example, ISO19115 (metadata) and ISO19119 (Catalog Services) were taken as part of the OGC Abstract Specification. On the flip side, an OGC specification can be submitted to the ISO process for potential approval as an International Standard. And those standards give SDI a connection environment that is the rules for connection**.** There are several completed or in draft stage standards that are essentially equal to OGC specifications. For instance, 19125 Simple Features access, 19128 Web Map Server interface (WMS), 19136 Geographic Markup Language, 19142 Web Feature Service interface (WFS).

1.1.3 INSPIRE

In fact, there have been some other regional or thematic standards organizations since the 1980s, including the European CEN Technical Committee 287, the US Federal Geographic Data Committee (FGDC), and the European INSPIRE initiative, which adopted some ISO plus CEN standards. “INSPIRE (Infrastructure for Spatial Information in Europe) is a recent initiative launched by the European Commission and developed in collaboration with Member States and accession countries. It aims at making available relevant, harmonized and quality geographic information to support formulation, implementation, monitoring and evaluation of Community policies with a territorial dimension or impact.”(INSPIRE GIS WIKI, 2008)

The project context of this paper is set up under the INSPIRE environment, which is the ESDIN work package 4 (Geo Rights Management: Data Access and Licensing Policy) and package 11 (Interoperability services). ESDIN is the abbreviation for European Spatial Data Infrastructure with a Best Practice Network, which is a project supported by the eContentplus program, and it will bring a bridge between the theory and the practice, (ESDIN project website) i.e., from the INSPIRE Directive towards implementation and usage of interoperable geographical data by spatially enabled Societies.

1.2 Motivation

1.2.1 Trends for Geoinformation Market

Nowadays, car navigation, a mass market that has already possessed a lot of users, is being noticed by several stakeholders. Personal mobile navigation might be the next field. In Germany, 2006, users of car navigation increased over 300 % than the last year, a total of 3 Millions devices were in use for this function. Along with some costs has declined, for example, the spatial data capturing method is well developed, such as GPS support and digital cameras for aerial photographs. So the major players (Google Maps/Earth, Microsoft, etc.) have already started to realize the geospatial potential and started investments.

For a long time, geoinformation is developed facing to “Expert Market”. The main user groups are professionals or domain experts. However, the boom of mass market seems point out a new trend for the development of geoinformation technology. Till the year 2007, the number of Google Earth users has reached 250 Millions, as far as October 2008, KML/KMZ Files that can be searched were about 4 Millions. The success of Google Earth indicates that the whole market is turning from “expert dominated” to “mass dominated”. As is mentioned above, although many SDI specifications, components and products are now available (e.g. for WMS, WFS, GML, CS-W 2.0 AP and so on), unfortunately, no major and stable SDI in operation yet.

This situation troubles the original large players like the map agencies. Now, although they have their advantages such as they own very professional and authoritative data, as the time goes by, they are less dependent on the governments or sponsors. It is urgent to find a better way to survive in the current competition to gain more benefits.

1.2.2 Geo Rights Management

On one hand, value chains bridge the creating and the consumption with a downstream of products and with an upstream, which can be stable, only if the interests of linked players can be balanced. On the other hand, geoinformation (or spatial information) is the information for a large variety of applications. And as the creation and maintenance is

costly today, some abilities of the value chains are needed. The best managing mechanism is Rights Management (RM) to define the conditions for the downstream, which is similar to the traffic lights defining the conditions with red and green. But Rights Management is more used for digital formatted data and information. Normally, the interests of the roles that appear in the chain can be categorized into political, economic, social, technological and legal aspects. Commercial players have a strong interest to have explicit rules to ensure a stable supply (such as, separation for private, public, commercial and emergency use intention).

Rights Management (RM) is an umbrella term that refers to licensing, pricing, access control technologies used by publishers and copyright holders. It is used to offer different usage of digital media or devices. According to INSPIRE Annex I, the geospatial data is quite different from other digital data, so the Geospatial Rights Management(GeoRM) should also supply new applications and usage based on the characteristics of spatial data. OGC and INSPIRE have taken RM model into consideration or on construction. Geospatial Rights Management (GeoRM) enables the electronic licensing of geospatial resources to manage and protect IPR is a key enabler to building sustainable networks of information. (Mohamed A. Bishr, 2006)

1.2.3 Creative Commons (CC)

The Creative Commons (CC) is a non-profit organization devoted to expanding the range of creative works available for others to build upon legally and to share. The organization has released several copyright licenses known as Creative Commons licenses. (Creative Commons, 2008).The core of Creative Commons is about supporting global participatory culture since it was founded from a U.S. non-profit corporation in 2001. Creative Commons has provided free tools to let authors, scientists, artists, and educators easily mark their creative work with the freedoms they want it to carry, by using CC to change their copyright terms from "All Rights Reserved" to "Some Rights Reserved."

Creative Commons licenses are several copyright licenses first released on December 16, 2002. These licenses are currently available in 43 countries with under developing in

another 19 countries. Now the version 3.0 has already been updated. They are baseline licenses and comprise 4 conditions, i.e., Attribution (by), Noncommercial or Commercial (nc), No Derivative Works or NoDerivs (nd), and Share Alike (sa), although users can compose them by themselves, it also has 6 regularly used licenses. (Creative Common licenses, Creative Commons, Attribution 3.0, License 2008)

In this digital age, work licensed under a Creative Commons License is protected by copyright applicable law. This allows Creative Commons licenses to be applied to all work protected by copyright law, including: books, plays, movies, music, articles, photographs, blogs, and websites. Even a lot of search engines include the rights usages option for the user to choose to directly get the results according to their needs to share, reuse, and remix the data. The most well known one is Google advanced search. The foundations of the references and filters are these CC licenses.

In geospatial field one of the precedents is the OpenStreetMap, but more and more venders are considering introducing CC licenses to their geo products. The license categories in INSPIRE, are similar to the CC concept. It was considered in the INSPIRE DT DSS. Three types of licenses are in development. Within the ESDIN project, some experiments were conducted to apply the concept.

1.3 Problem Statement and Objectives

- A “Classic” spatial data supplier often has only a limited (customer/commercial accessible) coverage, which is often bounded by national or regional administrative borders. On the other hand, the users requirements are always more and different, but no mater how, End-users and investors do expect good quality, up-to-date data, and large coverage (worldwide, continental) information products from geospatial information suppliers. Therefore the quality and quantity of the SDI applications is still not good enough so that the market of SDI is still not prosperous enough. Comparing with Google, those classical geospatial data suppliers such as map agencies are losing their predominance, short of users and more market-dependent.

- Further investments and operations costs are expected to set-up and run SDIs to supply top quality spatial data with a large accessible coverage, and it is already in the critical phase. Facing the corner, how can these suppliers balance interests, opportunities, investments and risks to change their situation remains unclear. Cooperation must be a good answer, but how to balance the interests and to make a satiable down stream value chain requires to be pointed out. This research will figure out how to apply the roaming concept to SDI to test, verify and proof its practicability.
- Licensing is heart of rights management (RM), which is a translation of a contractual agreement over IPR (Intellectual property rights) between two interested parties. One party ("licensor") gives certain rights over an asset to another party ("licensee").The ways for a licensing process can be click-through license for downloading, mass licensing of software, brand licensing and so on. But now in present SDI, from a provider-customer relationship view, there is either no licensing applied, or quite different licensing.

1.4 Structure of thesis

This thesis is divided into six chapters:

Chapter two reviews the related business cases which have introduced roaming concepts to the real world practices. The examples involve electronic money infrastructure and mobile telecommunication infrastructure. Based on the analysis of current roaming business models, we analyzed the probabilities of using roaming component to meet the requirements from geospatial domain (approach One). Then based on GDI.NRW Reference Model elements, we related the business model and implementation model to form a development structure for a roaming-enabled SDI (approach Two). Moreover, attempts of introducing Right Managements and its subset Licensing, Pricing to the geospatial domain are systematically reviewed in this chapter.

Chapter three analyzed the scenarios and business use cases in an rSDI. It includes “customer - Home provider”, “customer - contract provider”, and “customer - non contracted provider” three main cases. This chapter carefully described the basic organization of these cases and discussed the possible scenarios that the cased could be observed.

Chapter four introduced a practical application that applies my roaming and Creative Commons concept to CSW. Plenty of analysis and deduction are based on ISO 19115

metadata /ISO 19139 metadata implementation specification, and ISO 19119 catalogue service specification, etc. Simultaneously INSPIRE implementation rules metadata and discovery service were referred. To implement this platform, we modified the degree CSW server by adding a new component to execute roaming and license based transaction managements. The components are basically composed of XSLT filters.

Chapter five and six refined the experimental results and proposed some useful conclusions that guide the future development of Creative Commons - like licensed and roaming enabled SDIs. Moreover, the drawbacks of the experiment and the operation model are listed to pursue an improvement in the future.

2 APPROACH

Roaming is a general term in wireless telecommunications that refers to extending connectivity service in a location that is different from the home location where the service was registered. (Roaming, Wikipedia, 2009)

2.1 Successful business cases in other domains

Typical patterns to balance interests and risks can be derived from Electronic Money Infrastructure and Mobile Telephones, GSM Infrastructure. The approaches behind them both depend on Standards, Mass market, the Roaming concept and roaming operation model.

2.1.1 Roaming concept in Electronic money: VISA

In 1970s, as a result of the limited coverage of single bank institute, the invention of electronic money came up with many advantages. Before the use of electronic money, consumer and business people could only be connected with single-bank approach due to limited trust and efforts, at the same time, large financial investments with major risks expected to change the tough situation in financial industry At present, great changes have taken place. The consumer who hold a visa (master) credit card, for example, can purchase in most shops in the world which have the contracts with the international or regional banking groups (Visa, EC…) only with their credit card, no cash forced. Moreover, they can withdraw cash from ATM machines, even if from the Bank which

their account do not belong to. Electronic money is also called digital cash, which can finish the purchase via internet. (Jenkins, Gareth, 2004)

Typically, this involves use of computer networks, the internet and digital stored value systems. Also, it is a collective term for financial cryptography and technologies enabling it. The famous VISA shows technical and operational compatibility. Although the operators (e.g. banks), to some extends, share their customer groups, but they also possess their independent market presence, which rely on their legal relationships Customer to Operator (Bank), Operator to Operator. One of the advantages of this infrastructure is that any backyard player is intentionally not visible so that they can avoid conflicts and the banks keep their individual occupied markets.

2.1.2 Roaming concept in GSM: mobile telecommunications

Another infrastructure once faced a similar situation was that of mobile telecommunications. It is an infrastructure with technical and operational standards too.

In 1983, new technologies brought new opportunities in telecom sector, because of new digital radio transmission, but limited frequencies, which are distributed to the operators (telecom companies). Therefore large coverage services, which can be used almost in all sectors, are required to reduce the investment and share a large coverage. From the other aspect, there were high risks for manufactures of telecommucation equipments and for operators, because of the mass market. However, now the GSM consumers were able to use their mobile phone, not only in their home network, but also in foreign networks (breaks the operator and country barriers). But extra payment was charged as the roaming fee. A typical example is when we go abroad we find the operator in the cell phone screen was replaced by other local service providers, but the changes will not be aware by any of our friends while they were calling us, or them who are abroad together with you will be navigated to other companies, not exactly the same service provider shown on our phone. This case indicates that, different mobile company cards might have different business contracted partners in the same foreign country. The same as the electronic money, each operator has independent market presence. Customer to Operator (end user

agreement), Operator to Operator (roaming agreement) are included in legal relationships which also contained in GSM industry operation model.

2.2 Hypothesis

2.2.1 Solve coverage via an Roaming enabled SDI (rSDI)

Adapting the roaming concept, roaming business network and the roaming operation model will be a good resolution to the similar predicament for current SDI. A roaming enabled SDI (rSDI) - Balancing interests, opportunities, investments and risks - was introduced by Roland M. Wagner in 2006. His paper modeled the relationship between provider, end user and provider to provider relationship. The paper also depicted the workflow and introduced the roaming concept with definition of the roles and deployment examples. Even if this roaming mechanism is quite new to SDI, it can bridge user's needs and the provider's ability together, with the best available spatial information beyond only single provider. By sharing the coverage, the spatial products become valuable, which not only solve the limitation problem, but also give more chances and interests to the investments with the positive increasing users. Table 2-1 summaries the above scenarios and indicates their potential business values.

Roaming is an organizational model more than a new technology. Therefore, it is more likely an operation model but not a business model. From the business aspect, rSDI should have not only shared start with the sharing functions (access control, pricing and licensing mechanism), but also allow later independent operations if needed or wanted. Transparency of responsibilities in rSDI is important to balance interests. For example, in the VISA case, when many banks join the visa network, they do not need to know all other partner banks, nevertheless, in the GSM case, the telecom providers is free to choose and select their contract partners. Here, as an initial adaptation the critical phase I figure out how to apply the provider-user and provider relationships.

Table 2-1 Roaming in Different Domains

	Main Operator	**Product**	**Application**	**Main contract relations**	**Transparency in provider-provider relationship(from 1 to 3)**
EM	Bank	Electronic account operation, electronic money and world wide coverage usage of a single account, etc	Credit Card	Provider to provider, customer to provider	3
GSM	Telecom provider	Home and Foreign network signal coverage, and corresponding service, etc	Cell Phone	Dittos	2
rSDI	SDI provider	Spatial data supply, ,regional continental , even global SDI Services,	Spatial data, spatial data service, etc	Ditto	1 (need to be discussed, as it is still unsure what shape the final SDI will take)

2.2.2 Solve the adaption with metadata catalogue service

Services that a normal SDI often provides are shown in the following figure, for instance, WMS (Web Mapping Service) WFS (Web Feature Service), WPS (Web Processing Service), WCS (Web Coverage Service), and CSW (Web Catalogue Service). In this 3-tier structure (Figure 2-1), the metadata catalogue service is the intermediary to help clients to discover the products they need then to access those data. At the same time providers need to archive, organize, update and distribute their data collections. Metadata are absolutely critical for both data providers and consumers.

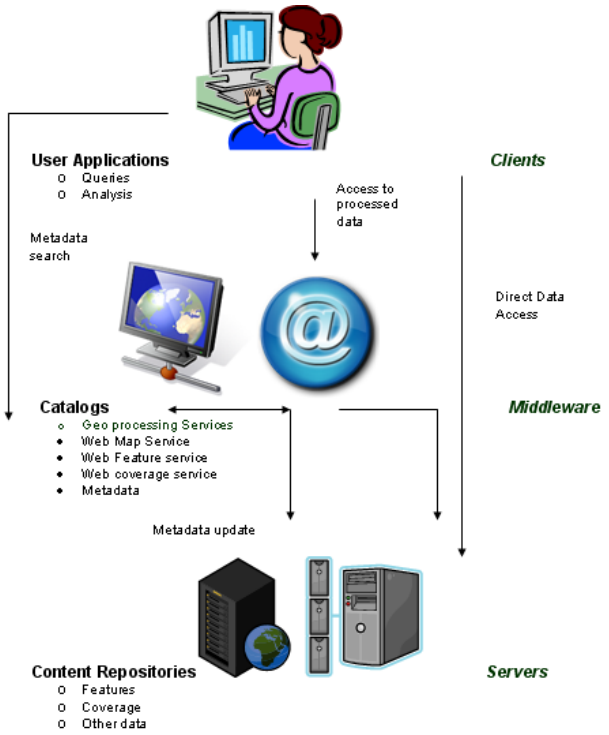


Figure 2-1.A 3-Tier SDI Structure, adapted from FGDC-NASA Geospatial Interoperability Reference Model, (FGDC 2003), (Granell, C., M. Gould, et al. 2009)

Considering INSIPRE Basis Process publish-find-agree-bind, find phase is very important. In addition, the Agree Phase exploitation will also be helpful to me to realize the elementary roaming in SDI.

So my idea is to adapt roaming concept in to CSW, which is the main task to be achieved.

2.2.3 Solve range of licenses via categories similar to Creative Commons

License categories are necessary and beneficial to help to manage the rights and usage. For the roaming sharing function case, the user identity is needed, which enables some rights managements to be automatically controlled by programs or machines. Moreover, with the licenses category, additional legal conditions can be added to the geospatial data In addition, with the CC license categories similar approach, the user were conferred legal usage rights to data when accessing the geo data, for instance, for private purpose or commercial use. Also in practice, with same license types, resources can be integrated into one single view to provide clients more convenient discovery functions. Specially,

the CC licenses URIs can be referenced to allow the access to the human-readable versions of the CC semantic, which is easy to be inserted to metadata documents. And also from the product view geo data maybe valuable, marketable, and an investment, some data even can be confidential, critical. Thus according to the product type, providers' requirements, data attributes and the license need to be attached to individual product. One of the goals in this research is that the customers should be informed about usage rights as text and Creative Commons Licenses.

2.2.4 Solve range of products via INSPIRE Annex product categories

By far a key problem existed in the geospatial domain was the lack of major and wider accepted product categories. Geospatial data is different kind of products from other information products. Some mapping agencies had some national GI product definitions, while some NASA dataset had a worldwide coverage, but most thematic domains had no or very incompatible product definitions (from a common spatial point of view). For example, Tele Atlas and Navteq are de-facto product specifications, but there is only a single source.

Every GI organization created its own product, and then the value chains were relative short. But with INSPIRE, the first major introduction of normative and multiple source data product standards with clear categorization and the obligation, the situation is changed to deliver the data at least EU wide. INSPIRE Data Specifications Annex I-III specified 34 themes (product types). And the definition in INSPIRE themes are categorized to the metadata element Topic categories in Draft Implementing Rules for Metadata document, which assist the client users make advanced search by the metadata themes. So the rSDI data and service sharing common market can have an order with those categories. Roaming conception cannot be adapted, if the products are not compatible, even they are the very same type but maybe in a different geographic location. Therefore the definition of spatial products in the INSPIRE realm can be a key precondition for the roaming model. From the client side, whether they can make use of these categories can proof the roaming concept and licensing adoptions success.

2.3 An overall model for a rSDI development

GDI.NRW Reference Model (Figure 2-5) is a pattern from IT development for an overall infrastructure. (Roland M. Wagner, 2005). The Actor Model comes up with the defined roles. In the following chapters I discuss relationship between our roles and ISO metadata roles in rSDI.

The fundamental of Process Model is a publish-find-agree-bind process, normally sub process also needs to continued. For example, the click-through license for explicit contract is widely used is this process, if no contract available, a new contract that might be established for a new sub process or new business relationship. Architecture Model can be referenced to the enhanced INSPIRE architecture (Figure 3-6) and be introduced in chapter 3.

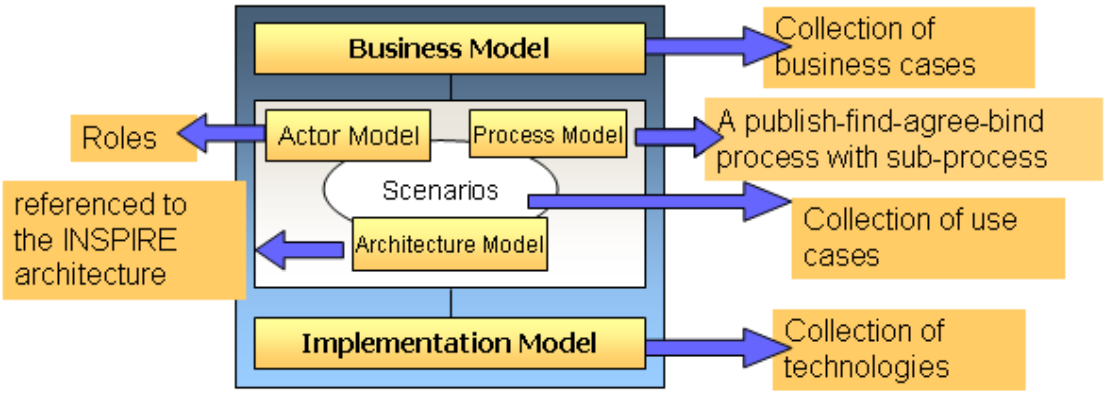


Figure 2-2.GDI NRW Referencing Model (Greve et al., 2002)

The definition of roles helps to communicate and understand the roaming concept. Different operation models for the domain part and also for the SDI part can be applied to ensure some degree of freedom in SDI overall operation model. The roles/responsible parties may be grouped into legal organizations or might be out sourced or even shared between competing partners. It depends on the real business cases. The actor roles descriptions in our roaming SDI are given in Table 2-3. Based on the actor model,

process model and architecture model, the scenarios which are the collection of use cases can be derived. The business model and Implementation model relies on each other.

2.3.1 Basis Process: publish-find-agree-bind

A fundamental business process in SDI is the publish-find-(agree)-bind process, which is indicated in Figure 2-3.

The initial business process is derived from the Service-Oriented Architecture approach (SOA), in the publish phase, a provider provides metadata or data descriptions for publishing geo data, geo services, and the combination of geo and geo services. In the find phase, users search and find of product descriptions with fields for spatial extent, time, quality, formats, URLs, Licenses, and so on. In agree phase, users reach agreements with the providers on all the conditions (Licensing, Pricing, etc.) An agree phase is needed for Geo Rights Management in professional SDIs, but it is still required to be discussed and integrated to the real operation processes. In bind phase, users access to resources or download to resources with Web Services, URL direct link or manual request and delivery via mail.

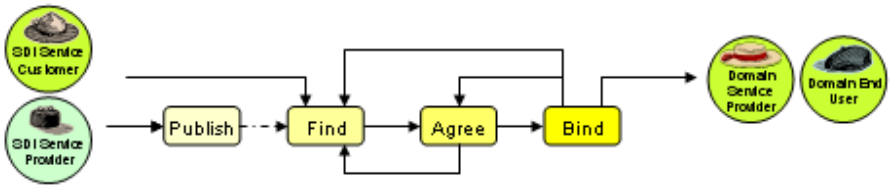


Figure 2-3 Process Model (not finally defined)

The process model is not finally defined. However, catalog service (CSW) / INSPIRE Discovery Service is a very critical part in SDI, which is an intermediary to connect the providers and consumers. Other parts are in development in INSPIRE (DT NS), ESDIN (WP5).

INSPIRE DT DSS has already consider to use CC like INSPIRE license types in the Agree phase as the similarities between these two kind of licenses are all categorized and their referencing are all URIs.

2.3.2 Architecture: INSPIRE

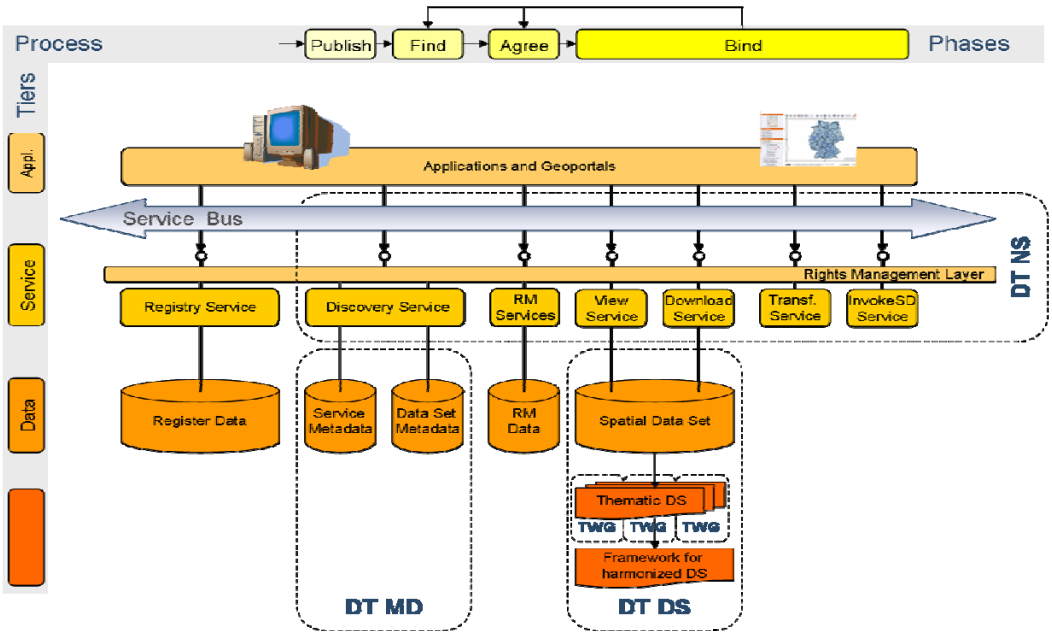


Figure 2-4: INSPIRE Architecture with All Elements

INSPIRE SDI is based on Web Services and pre-WS definitions, for example HTTP GET, and Service Oriented Architecture (SOA). The tiers in Figure 2-4 (INSPIRE Network Services Architecture, version: 3.0) are all standardized: application tier (undefined) for view and control use, service tier for service models such as napping, feature, coverage service, while a data tier is designed for data models like GML data, and data schema tier (semi-standardized) is for (harmonized) model definitions, for example AgroGML, CityGML, and in future INSPIRE Annex I-III etc. The discovery service in the service tier is equal to catalog service, which supports publishing and finding sources via meta data offers different levels for search.

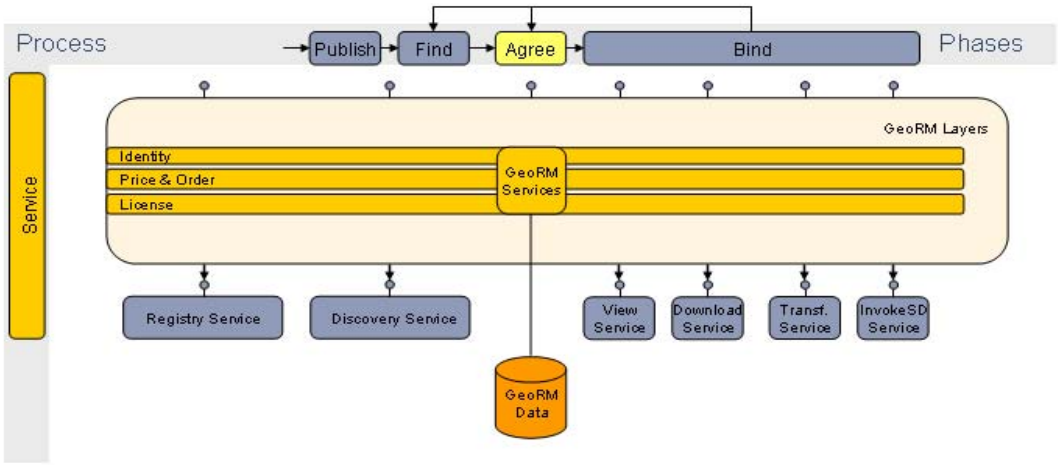


Figure 2-5 Rights Management layer in INSPIRE Architecture

Figure 2-5 illustrates the GeoRM Layers (Implementation Model) which are essential for the perspective of INSPIRE future, and include identity, pricing and license, as well as some other business functions. Although many components are matured enough, components for rights management are missing and an overall operation model is still undefined. These services should allow the users to identify and access spatial information from a wide range of sources.

Electronic business functions are available, for instance: ecommerce, the licensing with categories, pricing… etc, But most providers are using only subsets. Therefore a consistent framework is needed. The key issue is that the rights management components must be integrated to the process and protocols.

2.3.3 Roles: INSPIRE

In INSPIRE Metadata Implementation Rules, version 3, the metadata element "Responsible party role" defines 11 roles of the responsible organization. Among the 11 roles, 10 have the identical meaning with the OGC ISO19115 metadata CI_RoleCode list of CI_ResponsibleParty. Table 2-2 lists and compares the related roles of INSPIRE and ISO 19115.

Table 2-2 Responsible Party Roles in OGC and INSPIRE

Role	Definition	INSPIRE	ISO TC211role code list
Resource Provider	party that supplies the resource	1	001
custodian	party that accepts accountability and responsibility for the data and ensures appropriate care and maintenance of the resource	2	002
owner	party that owns the resource	3	003
user	party who uses the resource	4	004
distributor	party who distributes the resource	5	005
originator	party who created the resource	6	006
Point Of Contact	party who can be contacted for acquiring knowledge about or acquisition of the resource	7	007
Principal Investigator	key party responsible for gathering information and conducting research	8	008
processor	party who has processed the data in a manner such that the resource has been modified	9	009
publisher	party who published the resource	10	010
Author	Party who authored the resource	11	nil

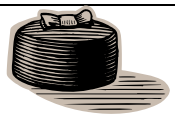
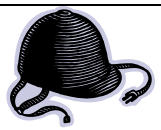
2.4 Adapting Roles to roaming enabled SDI and INSPIRE Architecture

Importing the domain concepts can make the providers share consumers in different business and industries, for instance, agriculture domain, real estate domain, etc.

Accoddingly, in this example, the domain service providers can be a agriculture software company and a real estate agency.

Table 2-3 ESDIN Project Roaming SDI Role Definition

	Role	Definition	Additional description
1	 Domain End User	Domain End User consumes domain product. Normally it is individual person.	
2	 Domain Service Provider	Domain Service Provider offers domain product	In some cases the domain service provider offers a service to known or unknown domain end users. And it is also the SDI Service Customer. An example can be a real estate portal.
3	 Domain Software Supplier	Domain Software Supplier creates domain software	In some cases, the software supplier offers an add-on SDI service for his software and pays an SDI provider
4	 SDI Service Customer	SDI Service Customer consumes SDI product and service. And might differ from the end users, it is always not a person but an organization. It can be Domain End User, Domain Service Provider, or Domain Software Supplier, even the combination of the 3 roles. Also refer to Fig 6	In some case we the SDI service customer and end user can be the same: An example case might be agriculture with only national wide domain software suppliers, but millions of farmers, buying the software only, but having a supplier contract with an SDI provider. Now the software is a stand-alone solution without internet based portals.

5	 SDI Service Provider	SDI Service Provider offers SDI Services	A contract party for its home consumer. But maybe the term SDI content provider is more appropriate.
6	 SDI Committee	SDI Committee organizes an SDI node ; Provider is member of Committee	
7	 SDI Agency	An SDI Agency maybe contracted to support the SDI Committee and offers a legal body.	
8	 IPR Owner	An IPR Owner owns the all necessary rights of a product; He contracts the usage to a SDI service Provider	
9	 SDI Software Supplier	An SDI Software Supplier creates tools to run an SDI.	
10	 Advertiser	An Advertiser is contracted to publish products via a catalogue	
11	 Sales	Sales is needed to establish new contracts to SDI	
13	 Account Manager	The Account Manager manages identity, licensing and pricing. Maintains the accounts for the providers and the costumers.	

14	 Delivery	The Delivery ensures the delivery of products via web services	A SDI provider provides the contents, but can have more than one delivery.

Figure 2-6 was produced in the ESDIN project, which shows the whole actor model.

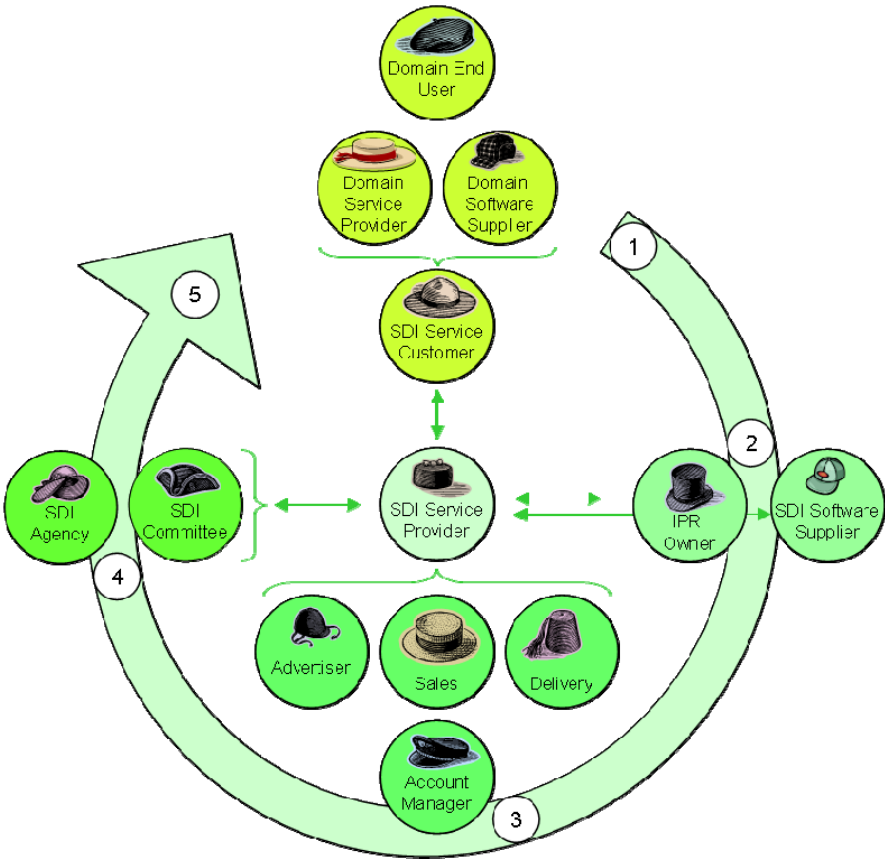


Figure 2-6 ESDIN: Actor Model and Roles Relations

Integrating the roles to INSPIRE process and architecture are shown in the follow Figure 2-7, different color show different groupings. In publish phase the SDI service providers publish their product metadata documents by the registry service, and a SDI committee

can organize some different SDI service provider under his organization. More than one SDI committees are possibly existed. So the SDI service customer, may discover the product they want, then go to the agree phase, in which the business cases as different and the legal contracted relationships are complex. 5 business cases will be discussed in the follow chapters.

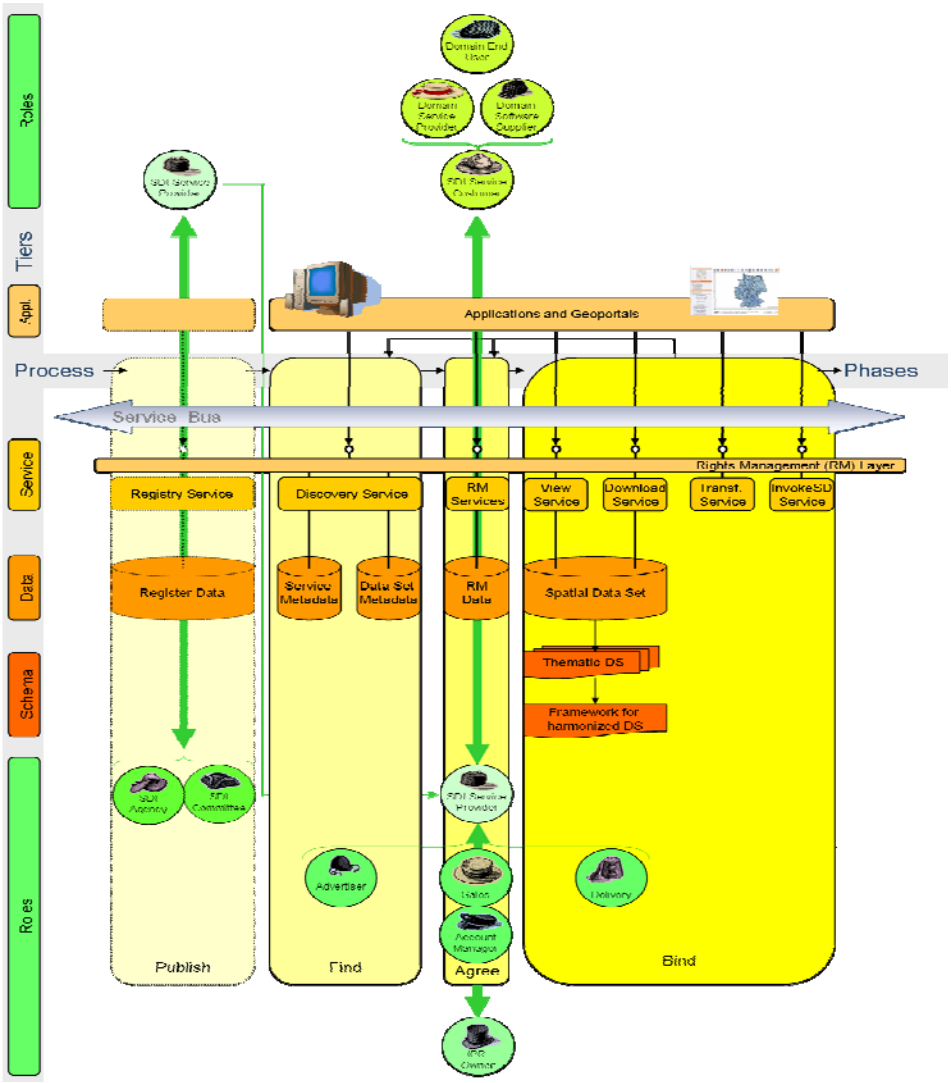


Figure 2-7 ESDIN: Identified Roles Together with the Basic Process

2.5 State-of-the art

GeoRM overview and requirements were introduced by Wagner. The overview exposed that the interoperable solutions for a trading-enabled SDI are required. There are some factors, such as identity, pricing and ordering, highly affect interoperability. A GeoDRM Framework approach was suggested as a feasible and suitable solution for stable GeoRM (Wangner 2005).

The aspects of authorization for Geospatial Digital Rights Management were introduced by Matheus, A. (2005). In his paper, he proved one key aspect of establishing Digital GeoRM for digital geographic content, was the declaration and enforcement of access rights. For the licensing of digital geographic content, it is important to assume online access to geo data through a Spatial Data Infrastructure. His results in interoperability

requirements are provided on three different levels: data model level, service level and access control level. The interoperability on the data model and service level can be achieved by standards of the OGC.

In October 2006, Wagner presented “GeoDRM: Creative Commons concept” at the 58th OGC meeting which was held by the OGC Working Group "Price and Order Processing” and aims at discussing creative commons. In the same year, Wagner introduced, the Roaming-enabled SDI concept, a very important step of improving the business model in GI field.

In Cambridge Conference Workshop (2007), Graham Vowles proposed “Models for Rights Management” in which the suggestion of using the CC licensing “Stickable” Symbols was distributed to the GeoRM researchers. In OGC meetings held in the same year, he produced the “GeoRM User Scenarios” of “Flat Representation of House with Doors”, ending with a discussion -whether the Rights Management Use Cases should be built on Creative Commons. In September, he presented that they had developed an example licensing model built on the terms defined by Creative Commons. (Graham Vowles, 2007)

A great amount of work has been done in the area of data ownership and rights management in OGC. The mission of the GeoRM Working Group of OGC is to coordinate and mature the development and validation of work being done on digital rights management for the geospatial community. (Geo Rights Management (GeoRM) WG, OGC). In December 2008, GeoRM Common Specification has been approved.

Many Geospatial communities and providers are interested in GeoRM, nevertheless, they are still using the subcomponents, and have not integrated these components into a common mechanism. Particularly, none of the originations has a mature licence control in practice level.

Together, the research on business model in GI filed is rare. Even the OGC and INSPIRE currently do not give any recommendations for business operators. Therefore, a lot of work should be devoted to this field of research.

2.6 Relevant Specification

"The good thing about standards is that there are so many to choose from." (A. Tanenbaum)

Geo data servers are at the bottom of the 3-tier stack and are able to receive and understand requests (commands, petitions) from a wide variety of possible clients and intermediate services. Thus, geoservers need to adopt half of the relevant interface specifications. Clients and intermediate services need to adopt the other half of the same interface specifications.

Metadata are descriptions of a resource which explains the content, location, intended user, quality, etc. The resource is normally a dataset (satellite image, shape file, DGN file, etc.), but may also be a data series (collection of datasets, such as terrain files -DTM covering a nation), or at the other end of the scale they may even be individual features (road segments, houses) within a dataset.

Spatial metadata also includes service metadata, which describing the SDI service.

2.6.1 Range of Profiles: OGC CSW, INSPIRE CSW

ISO19115 (exact title is Text for DIS 19115 Geographic information - Metadata, as sent to ISO Central Secretariat for issuing as Draft International Standard) is the abstract definition of the required and optional metadata elements to be created, which also describe the metadata in UML diagrams.

ISO 19139 (Geographic information metadata Implementation Specification) details the implementation of these elements in XML and XML Schema.

ISO19115/ISO19119 Application Profile for CSW 2.0 explains how Catalogue Service are organized and implemented for the discovery, retrieval and management of data metadata, services metadata and application metadata.

Draft Implementing Rules for Metadata (version 3) is a commission draft proposal for implementing rules to metadata (version 3) that opens to public consultation, which describes the metadata elements required and in which tables showed the metadata elements for datasets.

Draft Technical Guidance Document for INSPIRE Discovery Services is a technical guide with the recommendations and implementation guidelines for Discovery Services to fulfill the INSPIRE directive.

2.6.2 ISO 19115 Metadata

The UML in ISO19115 specification metadata include 11 main classes. In each class there are several metadata required elements and shall be provided by the implementation, for instance, the resource, title, abstract, unique resource identifier, etc. Some elements have their own defined value domain like CodeList of Topic Categories, some are free text. Some metadata elements are as queryables in CSW, which is required to use FE to send request and get the search results. Elements shall be considered mandatory, conditional or optional as specified in the applicable profile. The adaption followed the metadata specifications.

3 ANALYSES SCENARIOS AND RESULTS

3.1 Provider types and business use cases

In the roaming operation model, there are multiple providers and each provider has its own clients. Among providers, two simple relationships are assumed - contracted and none contracted ones. The pricing function needs to be applied to rSDI which is similar to GSM roaming price mechanism.

In GSM case, when the customers buy SIM cards, they automatically become the customers of the company where their SIM cards are provided. In the rSDI case, we call this type of provider a home provider, which already has a contract with the customer. Under the defined contract conditions, the customer is allowed to access and use data or service from the home provider freely. The second type is a partner provider, which is based on the relationship between a customer and its home provider's contracted business partner. If the customer wants to use the data from the partner provider, it depends on the contracts between this partner provider and his home provider, to decide whether a little additional fee should be applied. The third provider type is non contracted provider, which means the provider has no contracted with this designated customer's home provider. So the customer is not entitled to use the data from this third party provider, therefore, no access is usually possible. An additional conclusion that could be made is that roaming enabled SDI must be carried out naturally with rights managements. Otherwise, a real roaming mechanism cannot be established and executed. The following part modeled five commonly observed use cases.

Case 0:"no rights management"

Case 1:"home provider has product requested"

Case 2:"home provider does not have product requested, but partner provider has"

Case 3:"Neither home provider nor partner provider has the product requested, but non-contracted provider has product"

Case 4:"none of the three types of provider has the product"

Case 5:"All cases including different license types"

The other key relationship is the Provider - Provider relationship:

SDI Service (Home) Provider – SDI Service (Partner) Provider

In this thesis we defined it as SDI service provider and SDI service provider partner.

3.1.1 Customer-Home Provider (Case 1)

If in the customer require a product, and get the answer that its home provider has it, and if existed contract has already established, the account manager will realize the customer should be a legal user and therefore allow the customer to get the product, it is free in this case, because the customer already has the legal usage. Figure 3-1 shows use case 1, customer can get product from his/her home provider, without other roles from another SDI organization involved.

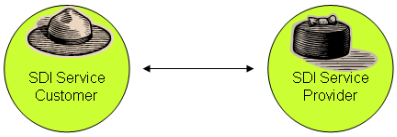


Figure 3-1 Use Case 1: customer-home provider

3.1.2 Customer-Partner Provider (Roaming Provider) (case 2)

In Figure 3-2, the green colored provider is the home provider of the customer with the same green color. Figure 3-3 shows the process how the customer can get product from a roaming provider. If a customer is not able to find needed product from his home provider, he might be navigated to the partner provider. If the partner providers' catalogue has the product he is requesting ①, he send request to the partner provider's delivery and ask for the product. The account manager then gets this customer's identity and checks his user account③. The two providers share their network so that this account manager has rights to ask the home provider's account manager ④. Then he gets the confirmation of the users' credibility. As a result the delivery of the partner provider is ordered to delivery this product to this partnership customer.

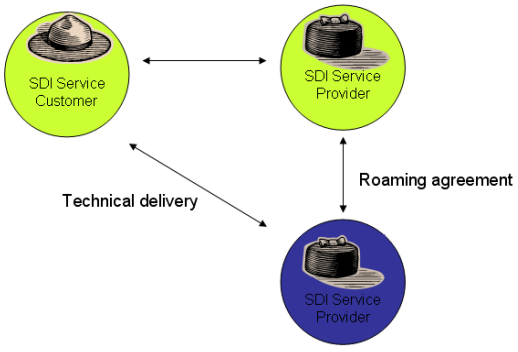


Figure 3-2 Use Case 2: Customer-Partner Provider

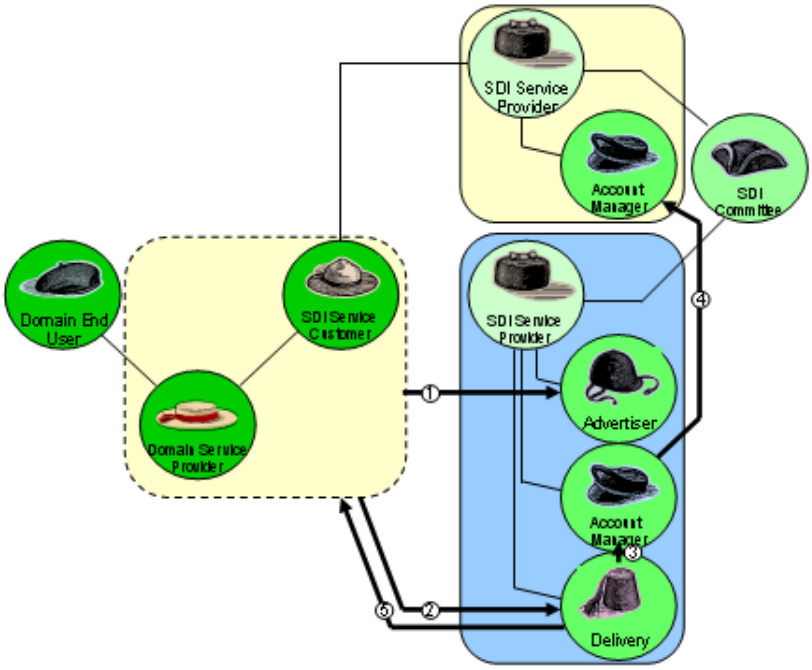


Figure 3-3 ESDIN: A Roaming Case in SDI

3.1.3 Customer-Non-contracted Provider (unknown provider) (case 3)

In this case (Figure 3-4), the account manager can not find any relationship with the unknown customer and the delivery will refuse the customer's attempts of getting the product. The exception report will contain information how to establish a new contract (e.g. a click license), or manual negotiations.

Figure 3-4 Use Case3: customer-non=contracted provider

3.2 Design of a Roaming component

A Roaming Component is normally deployed between the client side and CSW side. Since a roaming component takes charge of filtering service requests by validating their identifications, it is normally deployed between the client side and CSW side so

that the client side requests can be analyzed before forwarded to CSW server. Figure 3-7 represents the basic workflow while using roaming component to control the roaming process. A Roaming component is significant to expose the type of the client's provider so that the client will be informed whether its provider is a home provider of the requested resource. If not, the client has to pay related fees to get the resource, because it is just partner (in this situation resource may also be free) or even non-contracted provider. Using roaming component, clients get more valuable information and more flexible approaches to help them to get metadata.

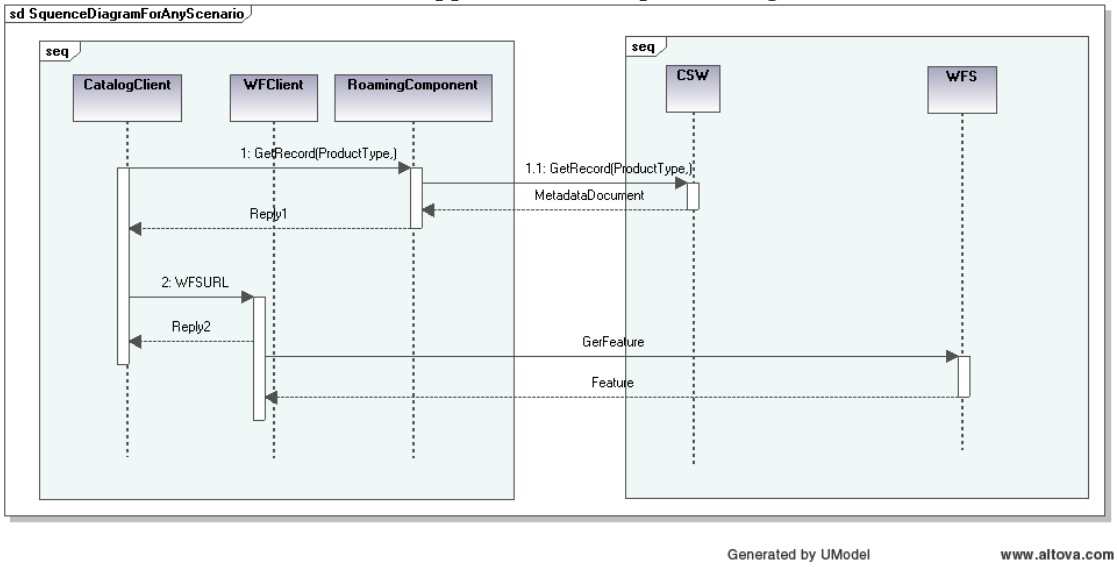


Figure 3-5 Roaming Component in SDI Services

By adding this component we can enhance the INSPIRE architecture, and Figure 3-6 indicates the position of roaming component which is under the application interface, but above the CSW interface.

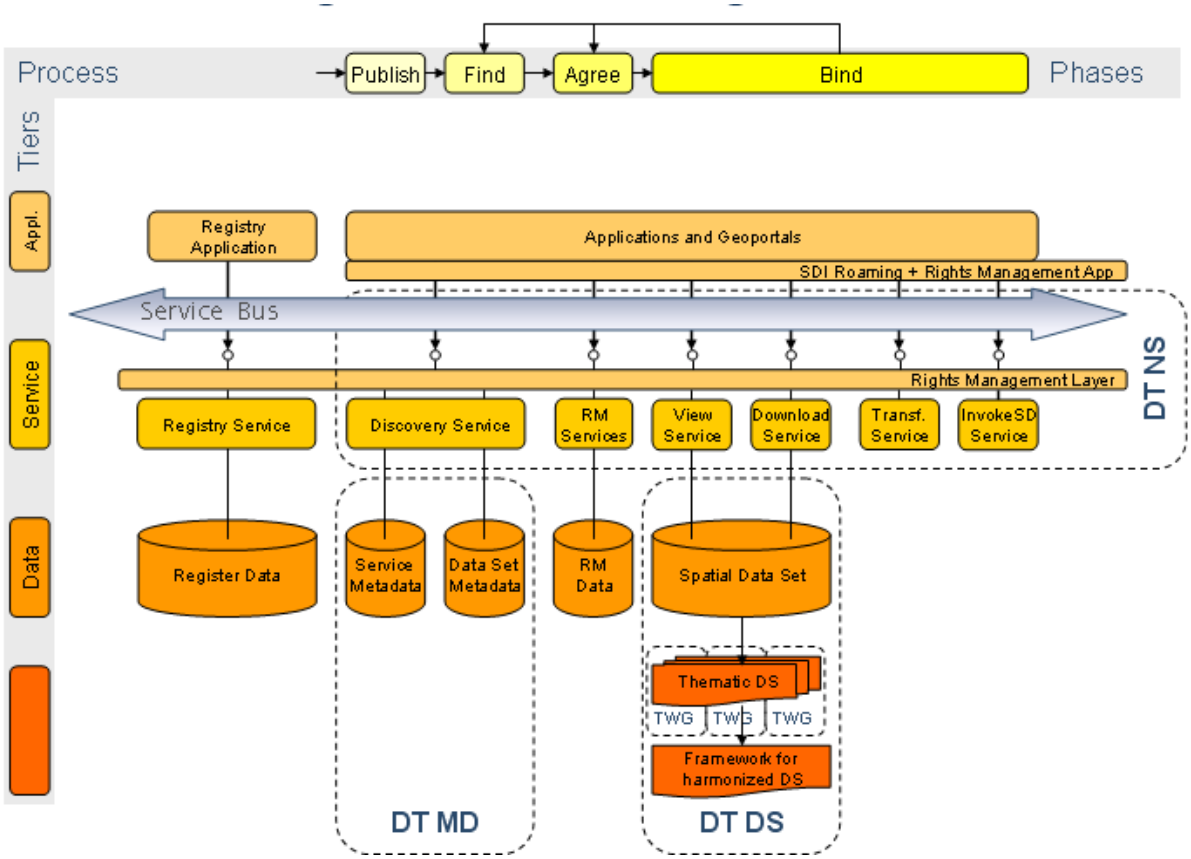


Figure 3-6.Enhanced INSPIRE Architecture with Roaming and Rights Management Layers

Moreover, how much the roaming component can be integrated into the CSW side are sorted by 4 cases, which is introduced herewith.

The filter is an XML encoding of the OGC Catalog Specification Common Query Language**.** The OGC Filter Encoding standard (FE) defines an XML encoding for filter expressions. Although FE allows querying all data fields, the OGC Catalogue CSW interface defines only a sub set for querying, because of performance and compatibility reasons (Figure3-7 Case A).

For most of the catalogue services nowadays are built on the OGC/ISO standards (19115, 19139). Because of the reduced CSW interface an additional roaming component is added outside CSW interface. (Figure3-7, Case C). Another reason is that customer specific data, e.g. password has to be kept at the user application side anyway. The

degree of logic, which needs to be processed is depending on the applied catalogue specification.

The Draft Technical Guidance Document for INSPIRE Discovery Services identifies the additional queryables that are not supported by [CSW ISO AP], but required by [INSPIRE MD]. So if the catalogue service is built according to more functional INSPIRE specifications, more logic can be managed at the service site. (Figure3-7, case B)

In case D (Figure 3-7), there might be other CSW implementation profiles in domains or in future, having less queryables, according to the logic mentioned above, the roaming component need to process more roaming logic.

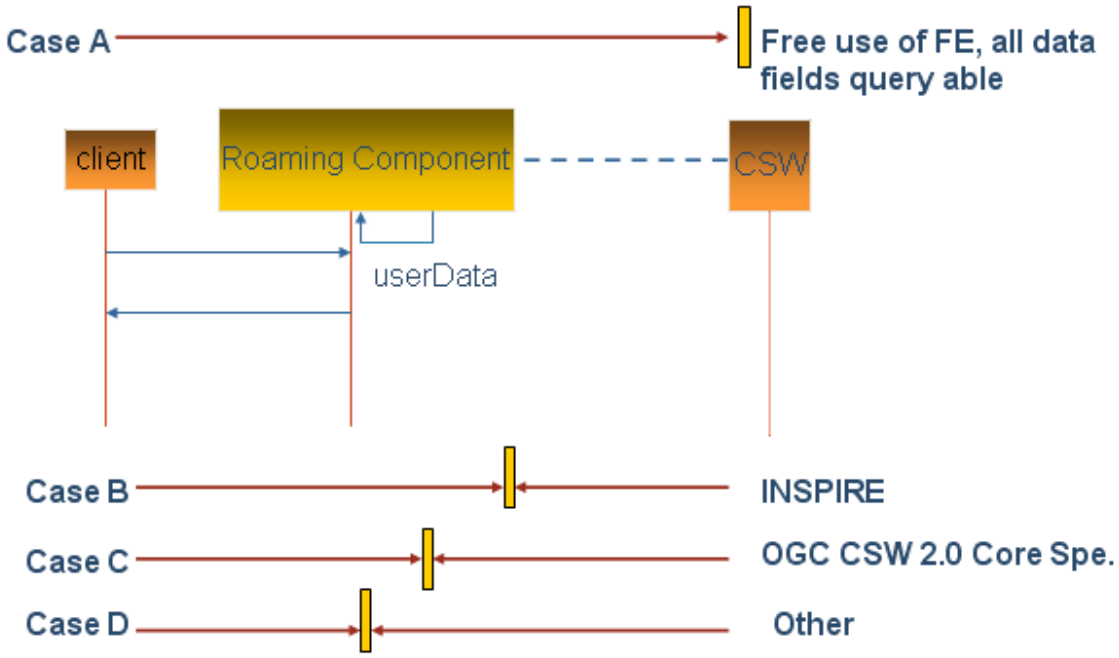


Figure 3-7: Moving Logic between Client and Service

By composing implementation aspects (profiles) and business variations we can get the table 3-1, in which the blue squares shows the most interesting combinations. The pink square circles the combinations that have been tested with the demonstration as a contribution of this thesis together (RMDemo).

The first column of table 3-1 are not taken into the consideration of this research, because some functions can be easier added and used more then FE. Case 5 (the last row of table 4), including the all above business cases with license types, is expected as a flawless model for all the cases no mater roaming or non-roaming, and become most important. The pink square concludes the roaming SDI case with different profiles and specification sets. Those combinations are the most interesting ones. A successful implementation as a RM Demo, which is the final results of this paper, can be taken as a proof to the feasibility of the roaming SDI operation model in the find phase.

Table 3-1 Matrix of Business Cases and Standards Sets

	Case A	Case B	Case C	Case D
case0				N/A
case1				N/A
case2				N/A
case3				N/A
case4				N/A
case5				N/A

4 IMPLEMENTATION AND TESTS

4.1 Tool overview

To accomplish those adaptations, we need to make use of OGC CSW19115/19119, CSW ISO AP 19139 INSPIRE MD and FE.

In order to evaluate the feasibility of applying roaming and licensing concepts into SDI, we test the concepts and logic with deegree free software and created a deegree-based demo application.

Deegree is a family of free software that supports the OGC Web services, in which Deegree Catalog Service 2.2 provides a complete implementation of ISO CSW2.0.2. (Deegree website, 2009).

4.2 Adaption of Creative Commons licensing

4.2.1 Application of metadata specifications

The OGC / ISO metadata specification offers some sub metadata, which is called constrain information, that can be used for access control. Moreover it also defines legal rights. The UML diagram (Figure 4-1) is taken from ISO 19115, and the highlighted metadata entity MD_Constrains, has the element useLimitation, of which the value format is CharacterString. Furthermore, in this constraint information UML diagram, there is a subclass of MD_Constriants named MD_LegalConstraints, which fits in with the licenses' legal efficiency, so we decided to utilize this MD_LegalConstraints for our licensing.

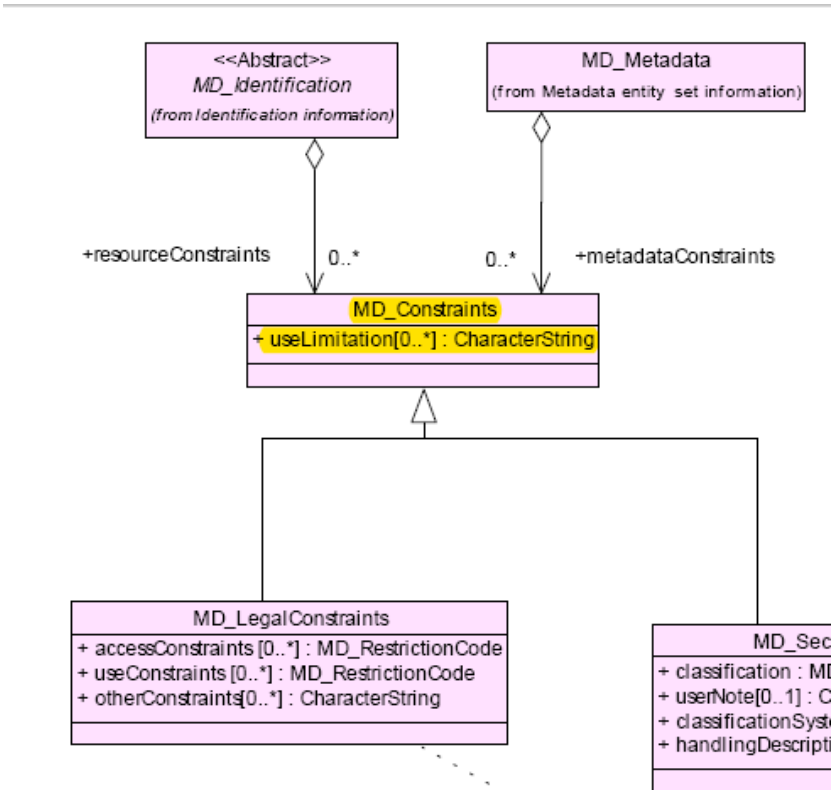


Figure 4-1: Constraint Information UML Diagram

Since the CC license referencing are URIs and each URI can represent one license type, the CC URI can be inserted into the metadata by using the following format:

+resourceConstraints

.MD_LegalConstraints

.useLimitation: http://creativecommons.org/licenses/by-nc-sa/3.0/

The metadata XML format example can be:

<gmd:resourceConstraints>

<gmd:MD_LegalConstraints>

<gmd:useLimitation>

<gco:CharacterString>http://creativecommons.org/licenses/by-sa/3.0/</gco:CharacterString>

</gmd:useLimitation>

<gmd:otherConstraints>

<gco:CharacterString>None</gco:CharacterString>

</gmd:otherConstraints>

</gmd:MD_LegalConstraints>

</gmd:resourceConstraints>

4.2.2 CC license type and INPIRE license type

Three types of licences are proposed under the ESDIN project as part of an Implementation Rules (IR), that is, Basic INSPIRE Licence, Specific INSPIRE Licence, and Framework INSPIRE Agreement for different usage. The license categories are still under developing. A potential solution will be CC-like licensing. Because for both of them the references are URIs. We choose three CC licences and list them in table 4-1 for demonstration and test.

Table 4-1 CC Licences used in Demo

CC URI	License type	usage
http://creativecommons.org/licenses/by-sa/3.0/	Attribution-Share Alike 3.0	Free to use share or modify
http://creativecommons.org/licenses/by-nc-sa/3.0/	Attribution-Noncommercial-Share Alike 3.0	Free to use share or modify, (no commercially)
http://creativecommons.org/licenses/by-nd/3.0/	Attribution-No Derivative Works 3.0	Free to use or share even commercially, (no modify).

4.2.3 Query by license type

We expect the license types should be queried (by using <csw:GetRecords> request) like the Google advanced search, with which people can get quick search by the usage rights. But in ISO 19115/119, useLimation is not a queryable element. Fortunately, in INSPIRE

implementation rules for discovery service, The INSPIRE drafting team improve the situation so that useLimation are grouped as INSPIRE additional queryables.
As deegree is open source software, the mapping.properties file was extended to enable query by useLimitation. To some extent, we can assert the INSPIRE implementation rule are integrated with existed OGC based geoserver. The Xpath that extends query by useLimitation is demonstrated in Appendix A.

4.3 Adaption of roaming concept

4.3.1 Application of metadata specifications

We assumed in our catalog service the roaming concept shall be applied on product level, which means provider may share only a subset of their products, the roaming relationship must be available on the product description (product metadata). How to apply 3 types of customer-provider relationships will be the key issue for the application. However, a simple List of distributors without additional provider/non-provider information in the metadata is not enough, because additional fees (roaming fees) may apply, the customer must be aware of already in the FIND phase.

In the distribution information package of ISO19115 metadata specification, the metadata entity MD_Distribution describes information about the distributor of and options for obtaining the resource. MD_Distribution might contain one to many MD_Distributor, which can be multiple and describe the information of distributor. The distributorContact element of MD_Distributor expresses the party from which the resource may be obtained. The value domain of this party is the entity CI_ResponsibleParty. The information can be referred to figure 4-2.

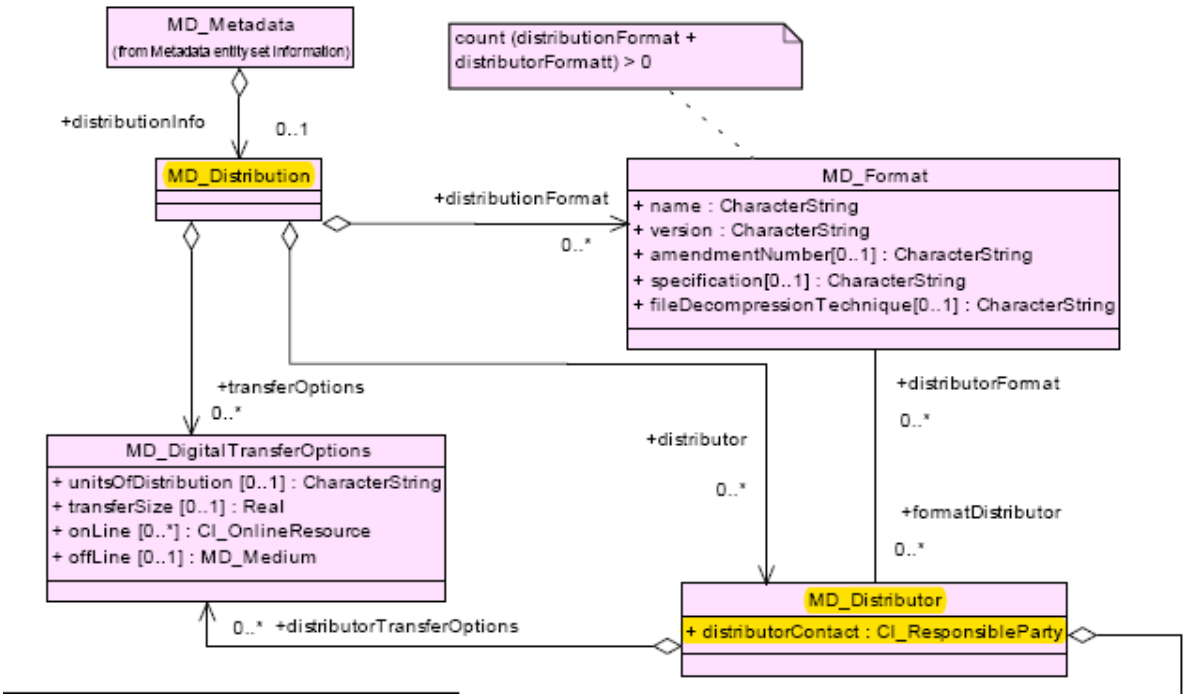


Figure 4-2 Distribution UML Diagram

CI_ResponsibleParty belongs to datatypes package, and it contains the identity of persons, and/or position, and/or organizations associated with the resource. Refer to the Fig 4-3. The metadata element OrganizationName can be adopted for the roaming SDI service providers' names or URIs, while the another element role defines the function performed by the responsible party, whose value is CI_RoleCode Codelist.

Codelists and their values provided in OGC standard are normative, and according to ISO 19115 users are allowed to add values to the existing codelist following the rules as described in annex C and ISO/IEC 11179-6. ISO/IEC 11179-6. This CI_Rolecode list contains 10 types of roles, which has been listed in table 2-2, although INSPIRE even has 11 type of roles but after comparing to our roaming roles (table 2-3), and checking their concepts, we realize their classification and range are quite different, which does not meet our roaming requirements. The way of presenting the contract relationship between two providers needs to be figured out.

Three approaches are proposed to solve this problem.

- Codelists and their values provided in OGC standard are normative, and according to ISO 19115 users are allowed to add values to existing codelist following the rules as described in annex C and ISO/IEC 11179-6. ISO/IEC 11179-6. So we may add the SDI Service Provider and SDI Service Provider Partner to the CI_RoleCode list. Then we can query the providers, to detect the roaming relationship. However new problem might occur: The meanings of new roles are somehow overlapped to the definition of existed roles. In details, there might be a potential ambiguity, because under some circumstances, two roles in role code list might represent the same meaning, thereby confusing users.

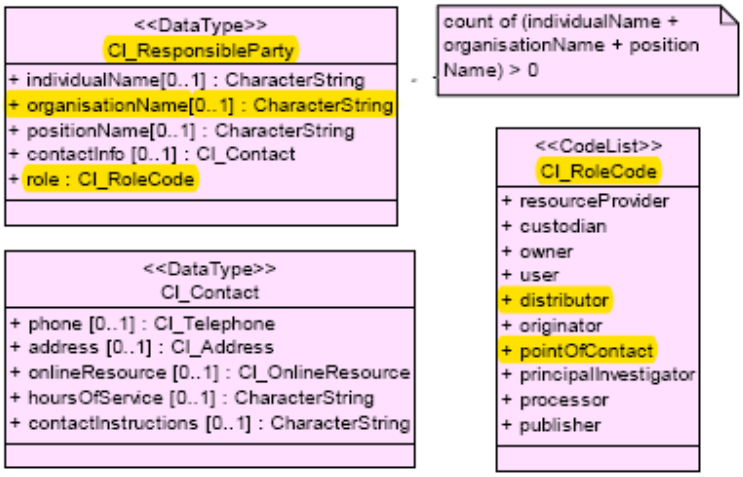


Figure 4-3 Responsible Party UML Diagram

The second approach is mapping, which means we try to choose two existed roles in CI_Rolecode list. The selection criterion is looking for the existed roles, which can maximally represent our roaming concept “Home Provider” and “Partner Provider. Finally, we found point of contact (pointOfContact), which has a similar definition of “Home Provider” - the owner of a product. Meanwhile, we realized “distributor” is an appropriate role to indicate the partnership, which does not own a metadata, but can use it under the contract with the owner of the product. Thus, we established a mappingCI_RoleCode_pointOfContact for SDI Service Provider,
CI_RoleCode_distributor for SDI Service Provider Partner.

This method works better than adding new roles, but still have disadvantages. Mapping does not replace the real concept of existed roles. The only changes is while using the roaming mechanism, the roles “pointofcontact” and “distributor” have a new definition, which is equivalent to provider and partner provider. The changes is only limited to the roaming context. Therefore, when users find out a responsible party, who is a “pointOfContact” or “distributor”, it takes some extra efforts to decide whether it represents “the original provider” and “contracted partner provider”. Another reason for this choice is that by this approach MD_Metadata can be binded with unlimited distributor, and with the ever increasing collaborations among different real-world companies, a large number of original providers’ contracted partner provider has to be declared to share a metadata. Therefore, by using the existing distributor, it becomes very easy to extend ISO 10115 to declare the provider roles.

- The third one is the best in the three considered approaches, if we take the roaming concept into the next version of those standards, we can define the new CI_RoleCode list instead to fulfill our demands

At present, degree GeoServer supports OGC standards, which does not set up a roaming related role set. Therefore, as a trade-off, we decided to take the second approach for further research.

The following example shows the organization name “IFGI”, who is the SDI service provider of this metadata, if the rolecode number is 05. That means IFGI have a contract to provide this data to customer as a SDI Service Partner of the original provider.

+ distributionInfo

.MD_Distribution

.MD_Distributor

.CI_ResponsibleParty

.organizationName:IFGI

. role:07

An example for the using point of contact as SDI service provider in XML format:

<gmd:role>

<gmd:CI_RoleCode
codeList="http://www.isotc211.org/2005/resources/codeList.xml#CI_RoleCode"
codeListValue="pointOfContact"/> <!—if codeListValue=distributor, this organization is a contract partner of this product-->
</gmd:role>
</gmd:CI_ResponsibleParty>
</gmd:distributorContact>
</gmd:MD_Distributor>
</gmd:MD_Distribution>
</gmd:distributionInfo>
</gmd:MD_Metadata>

4.3.2 Query by three types of providers with roaming component

In additional to the core queryables, the CSW AP ISO19115/19119 profile defines other queryable properties, which must be mandatory supported by any implementation of ISO19115/19119. OrganizationName is an additional queryable in OGC profile. But the INSPIRE profile moves it to the core queryable element. Therefore, even in a non-roaming SDI, querying by provider name should still help client to conduct a professional search. The xpath and FE are shown in appendix A and B.

In our roaming case, a product may have SDI service providers, and each provider may also have their individual partners. Therefore by querying a distributor in a metadata, we can discover all the companies that are related to a metadata record, while the role of the distributors will indicate their ownerships (point of contact for provider / distributor for provider partner). According to the business cases 1, 2and 3 (table 3-1), our roaming component implementation should help the client query by his home provider, partner provider and non-contracted provider. We assumed the client's home provider should be known (and stored at the client's site) when he sent the requests to discover the needed product metadata. The function is very similar to GSM in telecommunication field (SIM card).

Accordingly to logic in business cases, after the queries, if the home provider is in the distributor list and the role is point of contact, client should get the product directly. If not,

a sub query and process may apply to find the product from his partner provider. If still no results returned, the third step is to search for unknown provider, who might this product. If succeed, the users are required to establish a new contract to use this product. If all the three steps do not return any result, we can conclude that no compatible product required by client is saved in our CSW. Then the client will be notified. Business case 4 illustrates the scenario.

With the assistance of roaming component, we can design different architectures by using Filter encoding (FE) and use programming to implement the logic by multiple queries from providers directly.

But on implementation level, another operation process according to the metadata documents maybe more applicable to realize the same logic in business model. CSW interface returns entire metadata XML file with all the providers as a distributor list with different roles. A way is to use an XLST file to analyze the returned metadata, detect the roles of distributors in distributor list and the role of a provider (Home/Partner or Non-Contracted provider). The processes are described in next chapter.

4.4 Demonstration of the Implementations

In order to evaluate the feasibility of applying roaming and licensing concepts into existing SDI, we created a deegree-based demo application. Admittedly, ISO CSW standard implements some properties that indicate the right related information. For instance, several role codes are established to represent the real relationship between a contact entity (responsible party) and a resource (metadata). Moreover, use limitation, an attribute of legal constraints is declared to announce some restrictions while using the resource. Even though the mechanisms helps the representation of roaming and licensing concept, a practical mechanism that conduct the roaming and access control by licensing is still missing. Therefore, to demo my new model, which applies roaming and licensing, a modification is made to Deegree CSW2.2. The basic modification mirrors the changes on the model level. For example, the “mapping.properties” file was extended so that use limitation becomes a queryable property (according to INSPIRE MD). More important, a

roaming component, which consists of some JSP and XSLT files are added to an intermediate web server. XSLT (XSL Transformations) is a language for transforming XML documents into other XML documents. It can analyze the input XML file and also reformat it to a new output XML file. While handling service requests from clients, the roaming component compares the contracted SDI service provider (home provider of clients) with the real providers in the product metadata document to check whether his home provider acts in the metadata as original provider or the original provider partner which listed in the returned metadata. A filter is then formed to decide whether the clients are entitled to get the requested metadata. Related operations are triggered according to the identified relationship of client with the metadata providers. For example,

Case 1: if the client's home provider is in the distributor list and act as a role of point of contact, return the metadata to client.

Case 2: if the client's home provider is in the distributor list and act as a role of distributor, which indicates the metadata product is from the partnership provider of his/her home provider, so the client should be aware that fees may apply to get the product. But metadata documents are free to check.

Case 3: Client's home provider does not appear as the two roles in distributor list, that means the data is from a unknown provider (subcontracted provider) of the client, so before the client access the metadata, he should be noticed, a new contract need to be established between him and this provider to access this data (get the product).

4.4.1 System Architecture and functions

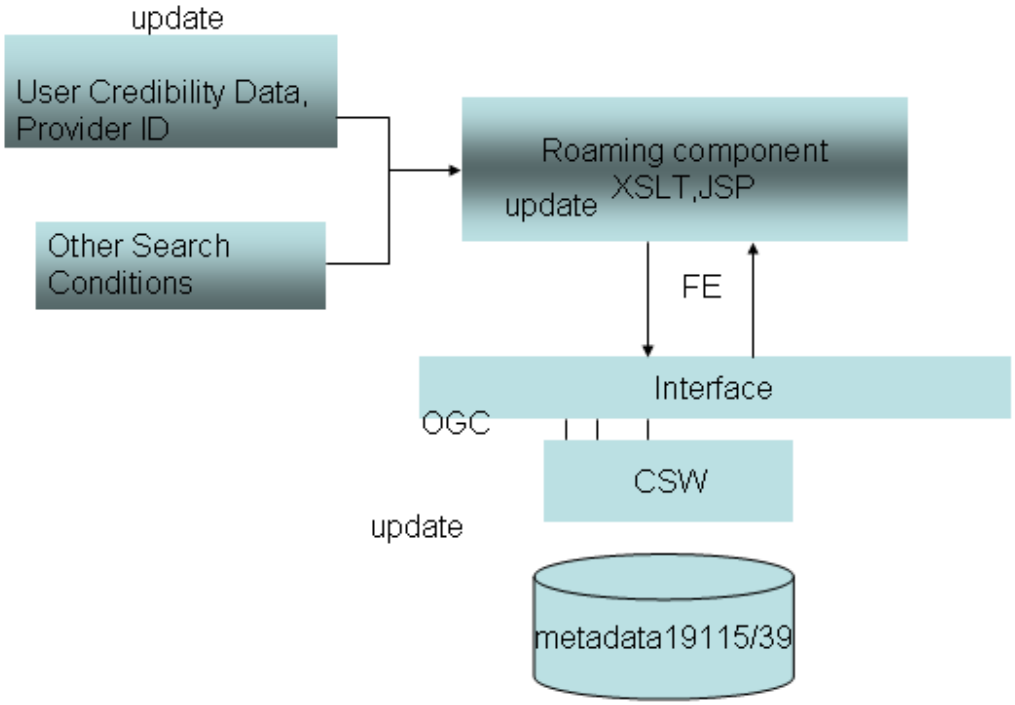


Figure 4-1 Demonstration System Architecture

Figure 4-1 shows the basic architecture of the demo application. According to our design, the real SDI web service, should maintain a user identification database, which is connected with a user's profile. Therefore, having successfully logged into the SDI system, the server will know who the contracted provider of the client is. However, in order to simplify the demo, we skipped the user profile database, and ask users to select a provider from the drop down menu.

Figure 4-2 Main Page of RM Demo

Figure 4-2 is the main page of our RM Demo, from where the user can send request under the combinations of different search conditions:

1. Query by metadata product title by name using letters, and also supports of fuzzy queries.

2. Query by license, which we select from CC license type (table 4-1) and inserted to the deegree CSW-2.2 database. With this interface, user can choose 3 licenses and "not filtered by license" option for advanced search.

3. Query by product type, which is based on the INSPIRE Annex. In fact it is the query for topicCategory elements. The topic category is a classification scheme to help grouping and topic based search of available data resources. INSPIRE adopts the same topic category list from the OGC/ISO19115ISO19119 CSW Application files. Moreover, INSPIRE also indicates the INSPIRE Themes which these category applies, for example,

Transportation category applies to INSPIRE Themes: Transport networks (I.7)
Boundaries category applies to the following INSPIRE Themes: Administrative units (I.4) and Statistical units (III.1)
Geoscientific Information applies to INSPIRE Themes: Soil (III.3), Geology (II.4) and Natural risk zones (III.12)
The product types can refer to the theme domains, and here we took 5 topic categories and "all products" as demo options.

3. Query by providers. As the roaming concept was adapted to this demo, so we considered to operation models as roaming and non-roaming. When select “disable roaming”

The system will only query the distributors’ role as point of contact.

Without checking the “disable roaming”, the system will start searching in roaming environment, then the roaming component will be switch on, and it give the 3 type product lists, which is categorized by the client’s home provider, partner providers, non contracted providers.

These lists are also the implementation demo for the 3 business cases accordingly. The structure of the roaming component in our demo will be explained in the following section.

The demo options are 5 provider names and “no provider”

4. Query by service type. Service Type is an element of service metadata. Checking the “search only by service type” will disable all other functions. Service type query should be targeted to service. And for dataset metadata and service metadata, their providers have different meanings. So some elements of these two kinds of metadata can not be query together. Metadata entity XML descriptions for service metadata are also different. So using this function, the client will get service metadata in XML directly.

Without checking that option, system will first retrieve the service metadata then by using service type query condition. Then the system will analyze the returned service metadata, collecting any dataset metadata which are connected with the service metadata by using operateOn relationship.

The demo options in dropdown menu for select service type are “WFS”,”WMS” and “Not Filtered by Service Type”. We will discuss this in section 4.4.4.

4.4.2 Search by non-Roaming function

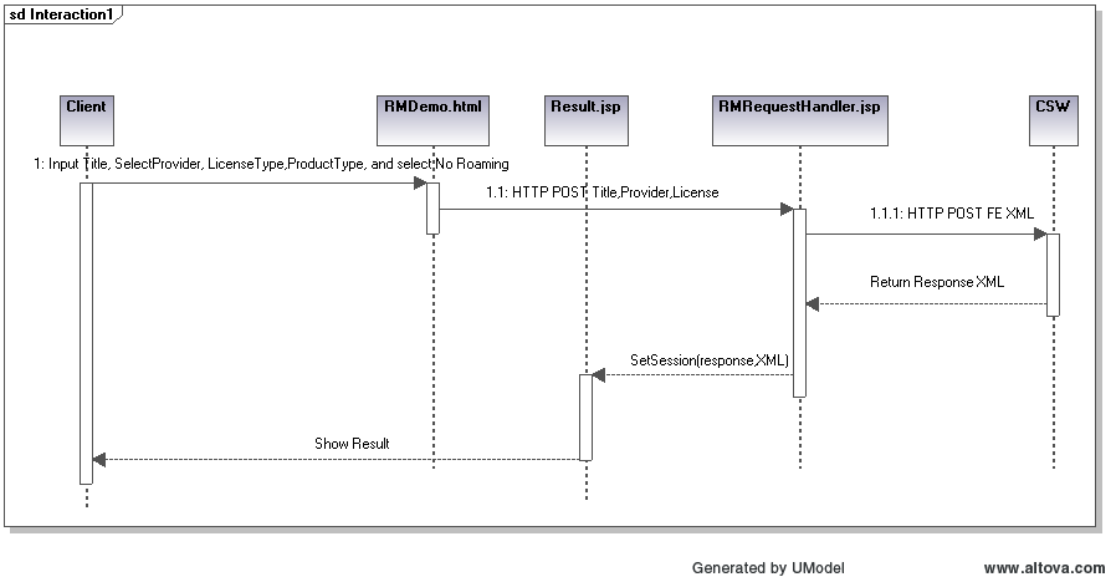


Figure 4-3: Sequences Diagram of Search by Non-Roaming

Figure 4-3 represents the roaming process of our model. To start up roaming, the client side log into the RMDemo.html and compose the query condition. The possible query conditions involve title, provider, license type, and product type. By using HTTP POST, RMDemo.html forwarded the query conditions to RMRequestHandler.jsp file in which, different cases are categorized and handled.

4.4.3 Search by Roaming Function

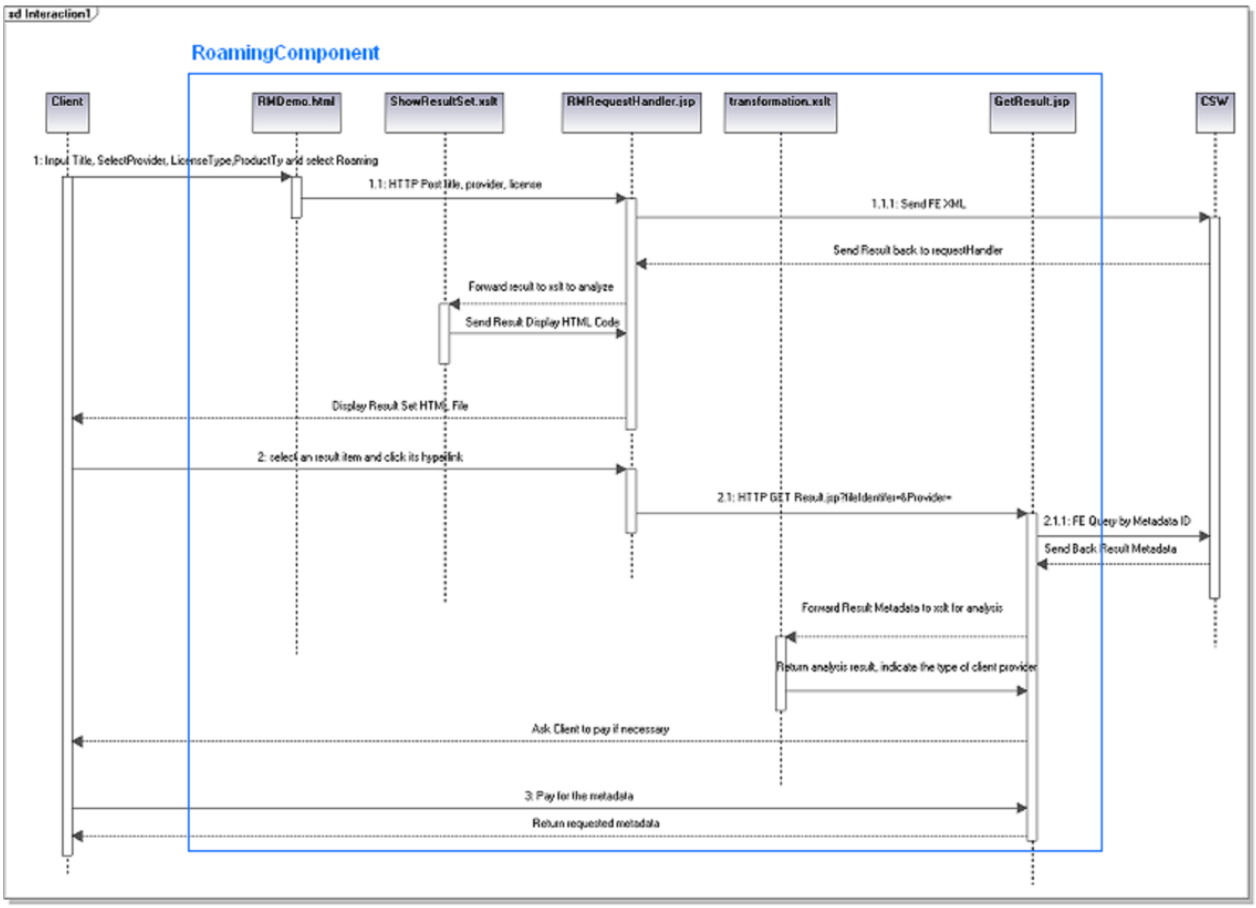


Figure 4-4 Sequences Diagram of Search by Roaming

In a roaming based query, RMRequestHandler set up query without considering the client's home provider. It organized encoding for a filter only by covering title and license types. Having sent the FE code to CSW, RMRequestHandler received the retuned metadata. Then RMRequestHandler initialize a XSLT processor by referencing ShowResultSet.xslt. As an output, the analyzed metadata groups are listed on a web page and the provider relationship is presented. Clients can check the result list and select an appropriate metadata. The selection is conducted by clicking the hyperlink of a metadata. The hyperlink will redirect the result page back to RMRequestHanlder.jsp. This time, RMRequestHandler will receive the identification of the requested metadata so that it can organize the second query-GetRecordByID. The returned message from CSW will

contain the complete metadata entity. The RMResultHanlder, however will not directly return it to client. It actually forwards the metadata to GetResult.jsp which analyzed the client's relationship. Moreover, based on the analysis, GetResult.jsp will generate three different "payment" pages to simulate the scenario of "Home Provider", "Partner Provider" and "Non-Contracted Provider". After reviewing the payment webpage, client can get the final metadata documents.

A non-roaming process is actually a simplified roaming, which has been mentioned above. The difference is, once RMRequestHandler receives the query condition from RMDemo.html. It will organize a filter encoding XML by considering the home provider. As a result, the query executed by CSW will only return the metadata which has the providers in its distributionInfo element. A shortcoming for this mechanism is: metadata from non-contracted providers will not be returned so that all the non-contracted resources are invisible to clients.

In short, our overall demo runs well under roaming and non roaming function with one roaming component which contains the files descried in table 4-2.

Table 4-2 Function Table of Roaming Component Elements

File Name	Function
RMDemo.html	Query Interface, Place some drop down menus to compose query conditions
RMRequstHandler.jsp	Generate Filter and Encoding Code for CSW
GetResult.jsp	Generate Filter encoding to conduct GetRecordByID
ShowResultSet.xslt	Parse the returned Metadata, generate a Web page to list the metadata by using title, license and provider type
Transformation.xslt	Handling a single Metadata, comparing the metadata distributor with the client's provider to determine which provider type the client belongs to
RoamingByServiceType.jsp	Generate Filter encoding Code for CSW, But only set the service type as query condition
AnalyzeServiceXML.xslt	Retrieve identifier of Dataset Metadata

	from a service metadata operateOn element
AnalyzeXML.xslt	Analyze Dataset Metadata, Retrieve its distributorInfo and compare all the distributors with client provider so that the provider type is identified

4.4.4 Roaming with service metadata

There are 3 resource type in INSPIRE metadata implementing rule, spatial dataset series, spatial dataset, spatial data services. Also in the OGC/ISO standards based deegree CSW database, we found 4 types of metadata, dataset metadata, service metadata, application metadata and datasets metadata. The metadata entity SV_ServiceIdentification for service metadata has the element of ServiceType, which is the generic name of the service type. In ISO19115/19119 the service type ID or codelist such as"WMS","WFS", relatively, in INSPIRE service type is newly defined as Discovery Service = INSPIRE:DiscoveryService, View Service = INSPIRE:ViewService,Dataset Download Service = INSPIRE:DatasetDownloadService..,etc. Currently most people think about the data as a product and not a combination of data and service. One thought that a product might be considered as a combination of DataType and ServiceType might be valuable. For instance, AnnexI 3_WMS can be changed to Product=AnnexI3 AND ServiceType=WMS.

We have implemented two approaches of querying by service types. The first approach, which is named "search only by service type", narrows down the querying scopes and retrieves only service metadata which matches the specific types of users' requests. While using this approach, all other query conditions, such as provider, product types, title are skipped because, according to the ISO 19115/19115, MD_distributionInfo, which is the basic representation of distributor, is an element of dataIdenfication, thus not an attribute of service metadata. Therefore, any queries related to provider with roaming function are meaningless for service metadata. Query only by service type returns the service metadata which is shown directly to the clients. The reason we come up with this kind of query is we have realized that there are some user requirements to directly

retrieve the service metadata inside CSW server. Additionally, the provider of a service can be described by the +MD_Identification

.pointOfContact

.CI_ResponsibleParty

The providers in the service metadata here actually are deliveries in the business model, for instance one SDI service provider can put his content to two web servers. Under the circumstance, it is the owner of these two organizations.

The second approach is named “Roaming by Service Type”. The essential difference of this approach with “search only by service type” lies in the returned metadata. Unlike “search only by service Type”, this approach (Roaming by Service Type) only concentrate on the dataset which is operated by the service type the client is querying. In detail, this approach wants to help those clients who aim at retrieving a bunch of dataset, which are particularly related to some service types they have known by using “operate on” relationships. While implementing this approach, we first execute a query only by “service type”. Doubtlessly, this query returned service metadata but dataset metadata. Then, the returned service metadata feeds an XLST parser, which serves retrieving any related dataset by looking for “operate on” tags from the service metadata. Captured dataset identifier (normally a UUID) is returned to roaming component and become a query condition for the following query. Therefore we designed AnalyzeServiceXML.xslt and RoamingByServiceType.jsp for implement this logic (table 4-1).

4.4.5 Result Interface design

Figure 4-5 represents how the demo lists the result metadata to a client. As is shown on the web interface, title, license and provider type of the metadata are displayed. Moreover, in order to help client reviewing the metadata by provider types, we set up four buttons to categorize the returned metadata list. The client can click the buttons to list the metadata separately by his home provider, partner provider, and non-contracted provider. Once the client finds out the requested metadata, he can click its title, which is actually a hyperlink

navigating to the complete part of the metadata. Having clicked the hyperlink, the interface will be redirected to roaming part (figure 4-5, 4-6, 4-7). The reason we design a metadata lists is: using this list, it is much better for clients to check the description of product (metadata), the license is assigned to the metadata and more important, the type of the provider to the client on this product. Therefore, before selecting a metadata, the client will fully understand what license he/she has to obey and whether they have to pay for the product (use the data)..

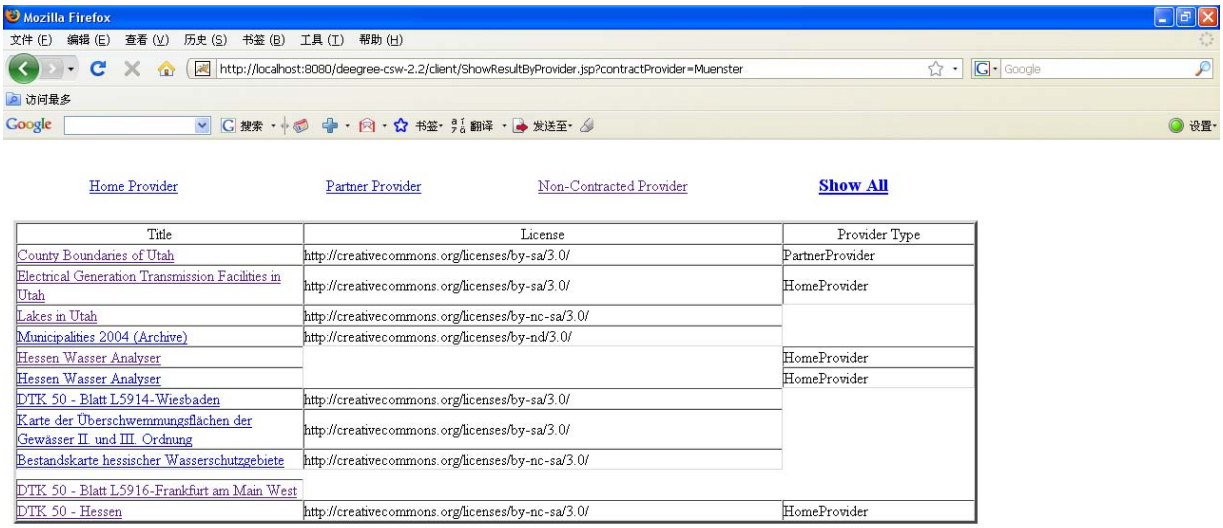


Figure 4-5 Results List

Roaming part is composed of three different pages. In this demo, every page represents a provider type scenario. Figure 4-6 shows the scenario of home provider. Under such circumstance, since the contracted provider of the client is just the owner (pointOfContact) of the data (service). The client does not have to pay any fee. It is free to use.

Figure 4-6 Roaming Page for Home Provider

Figure 4-7 shows the scenario of "partner provider". In this scenario, the contracted provider of this client is a "distributor / original provider's partner" of the data (service), therefore, some extra fees might be applied while retrieving the data.

Figure 4-7 Roaming Page for Partner Provider

Figure 4-8 represents the scenario of non-contracted provider. In this scenario, Contracted provider of the client is not shown in the metadata distributionInfo. That means, is the provider of this data is neither a home provider nor a partner provider of the client. So there should be a declaration to aware the client he want to use the data, he need to set up a new contract with this unknown provider.

Figure 4-8 Roaming Page for Partner Provider

Having gone through the roaming, payment process, the metadata is ready to be shown to the clients in figure 4-9.

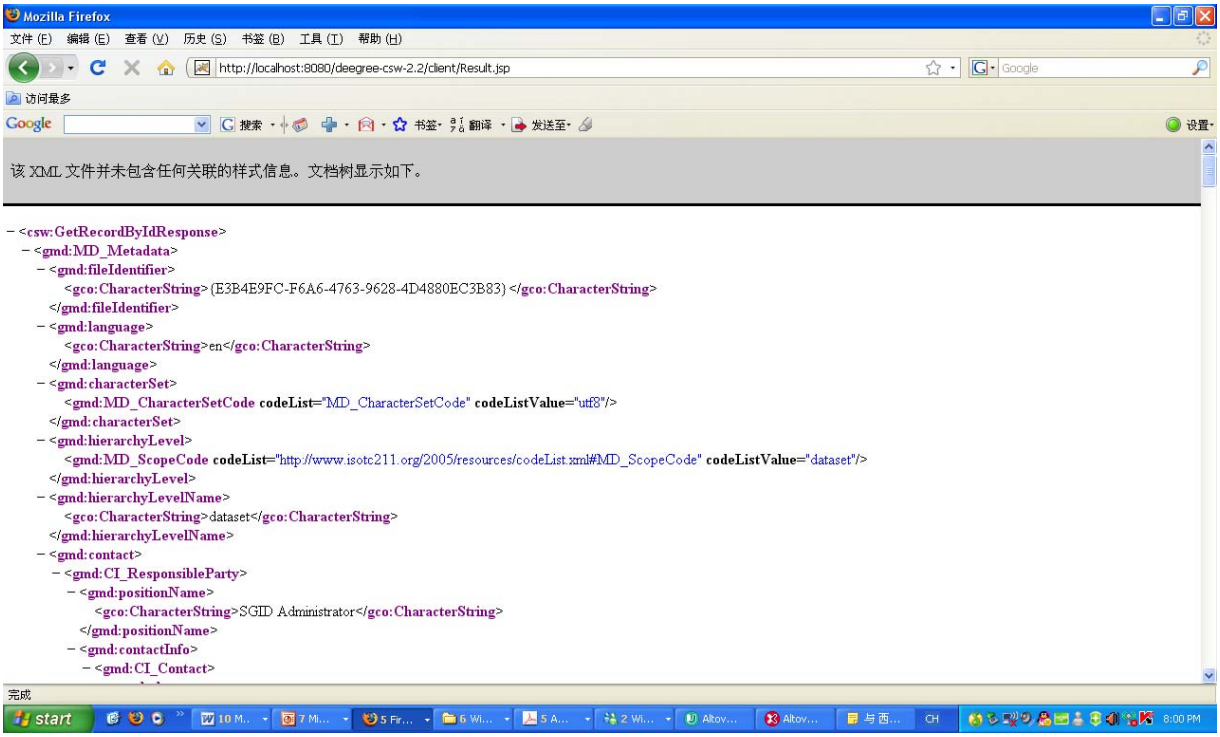


Figure 4-9 Metadata Document as the Final Results

There is a possible exception: if the CSW does not find any metadata requested by clients. Our demo will return an interface to notify the client. It is shown by figure 4-10.

Figure 4-10 Non Results, no provider

4.5 Summery of the results

1. The Creative Commons licensing approach was adapted to SDI catalog service under OGC standard based environment. During the this process, we compared the exited INSPIRE and OGC corresponding standards; we found some differences between the two core sets, for instance, a few terms , definitions and codelists are different. Based on the implementation, we found queryables different in INSPIRE and OGC (for example, useLimitaion is not the queryable in OGC). By expanding the OGC standards, we make the demonstration for the users to search metadata by license type.

2. We look back to GDI referencing model (figure 2-2),

In the adaption of the roaming enabled SDI, this thesis first defined the actor model with the roles, and then, enhanced the INSPIRE architecture model by rights management layer and roaming component. Scenarios were depicted with 5 use cases. The processing model is motioned, but not defined. Finally an implementation model was conducted.

3. The demonstration not only applies roaming and cc licensing concept, but also supplies advanced search for the users so that the user can make query by the product title, service type, license, and topic category. This demo implements the business cases in table 3-1 (inside the pink square). .

5 CONCLUSION

5.1 Conclusion and contribution

1. Gap licensing: The success of CC licensing adaption shows the possible direction to INSPIRE licensing.

2. Overall: This thesis shows that the roaming operation model can be a valuable solution for SDIs to balance different interests, demands and capabilities. It proves for the “find” phase that it is feasible and integratable with existing standards or components.

Using roaming in SDI increases the flexibility of getting data and enhances the collaborations of SDI service providers. Moreover, the business profits of providers are carefully protected and benefits are balanced by accurately deciding the relationships (home/partner/non) to their clients. The results of this thesis increase the confidence of the SDI operators to start first phase of a roaming SDI, and supports them to share the market, opportunities, interests while reduce the investments and risks. The capacity-enhanced SDI demonstration shows the roaming operation model can meet more users' need.

3. Gap Products**:** INSPIRE annex definitions solve the need for generic product descriptions. Major products can be roamed via INSPIRE annex product types.

5.2 Discussions and limitation

1. The naming of roles inside the business models is not perfectly accurate

A provider might not only provide service but also integrate data as one product shape. So the SDI service provider maybe need a more precise naming term.

2. When designing the roaming component (figure 4-1), in view of the number of the SDI providers may increase by time, how to update the provider information automatically becomes an important issue, and needs to be figured out. Our demonstration may consider inserting another jsp file linked with the user information database.

Service metadata and dataset metadata have some identical entities (such as MD_Constraints), so, for instance if they are both inserted "constrains" in database, and the response display list in our demo will mixed. Some form the result list are dataset metadata, some are service metadata. Under such circumstance, whether it is necessary for us to separate them.

3. As the standards can be combined and expanded for application, this might also be a potential research focus in the future.

4. Currently almost all geo severs are built under the OGC standard series, only a limited number of servers are based on other regional standards, among which none of INSPIRE

based server are observed. So it is still not convenient to use and apply the stands from other organizations.

6 FUTURE WORKS

1. According to our analysis, to start a roaming SDI age in geospatial industry, we suggest to take the most freedom to use filter encoding in next generation CSW 3.0, so that we will not need any roaming component.

2. OGC CSW 2.0 has some limitations. Use limitation is an important element for rights management and access control of geospatial data. Therefore it should be queryable. Moreover, since the role codelist is not well defined, the definition of rolecode is not clear which make it is not so helpful to use. Thus, we suggest CSW3.0 will update the queryable property so that the right management related concepts could be well defined.

3. Although many components are already matured, the overall operation model is still unclear; the rights management components are still missing. Therefore a process model with rights management mechanism should be developed in the future, for example, the SDI process phases “publish”, “agree” and “bind” need to be examined in detail (upcoming thesis, Ludwig for “agree” in March 2009).

4. All the experiments we have done are based on the lab environment. Thus, the feasibility of our new designs in a real world application still remains to be evaluated. A larger demonstrator (with more phases) will help to persuade and to prove.

5. The EU eContentplus Project ESDIN consortium decided to use the roaming approach. Therefore continuous work is expected. We have started to combine our new model with ESDIN Project, which is based on OGC and INSPIRE standards, therefore the results should also be feedback into OGC and INSPIRE.We hope the project will generate a lot of useful feedbacks to help us better refine our models in the future.

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8 APPENDICES

8.1 Appendix A: Xpaths of Queryables

Queryables	Xpath
LicenseType	./csw:UseLimitation=app:MD_Metadata/app:dataIdentification/app:MD_DataIdentification/app:identificationInfo/app:MD_Identification/app:legalConstraints/app:MD_LegalConstraints/app:useLimitations
ResponsibleParty	./csw:ProviderIdentification=app:distributionInfo/app:MD_Distribution/app:distributor/app:MD_Distributor/app:distributorContact/app:CI_RespParty/app:organisationname
ServicpeType	./csw:ServiceType=app:MD_Metadata/app:commonQueryablePropertiies/app:CQP_Main/app:serviceType
Title	./csw:title=app:MD_Metadata/app:commonQueryablePropertiies/app:CQP_Main/app:title

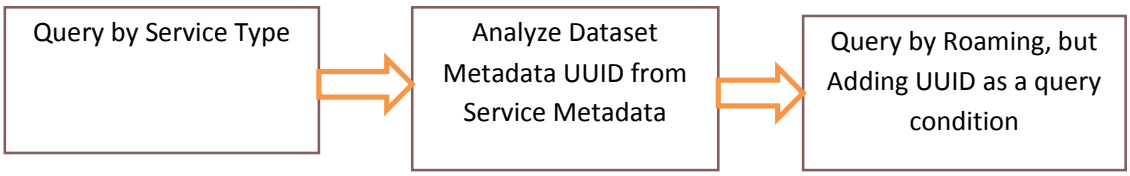
8.2 Appendix B: XML encoding for the filters in our deegree-based RMDemo

- **Query by non-roaming function:**

```
<?xml version="1.0" encoding="UTF-8"?>
<csw:GetRecords service="CSW" version="2.0.2"
 outputFormat="application/xml"
 outputSchema="http://www.isotc211.org/2005/gmd" resultType="RESULTS"
startPosition="1" maxRecords="50"
 xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
 xmlns:ogc="http://www.opengis.net/ogc"
 xmlns:apiso="http://www.opengis.net/cat/csw/apiso/1.0">
 <csw:Query typeNames="gmd:MD_Metadata">
  <csw:ElementSetName>full</csw:ElementSetName>
  <csw:Constraint version="1.1.0">
   <ogc:Filter>
    <ogc:And>
     <ogc:PropertyIsLike wildCard="%" singleChar="_" escape="\">
           <ogc:PropertyName>csw:title</ogc:PropertyName>
          <ogc:Literal>RequestedTitleName</ogc:Literal>
    </ogc:PropertyIsLike>
```

```
    <ogc:PropertyIsLike wildCard="%" singleChar="_" escape="\">
            <ogc:PropertyName>csw:UseLimitations</ogc:PropertyName>
           <ogc:Literal>LicenseType</ogc:Literal>
     </ogc:PropertyIsLike>
     <ogc:PropertyIsEqualTo>
            <ogc:PropertyName>csw:ProviderIdentification</ogc:PropertyName>
            <ogc:Literal>Client Provider</ogc:Literal>
      </ogc:PropertyIsEqualTo>
    <ogc:And>
  </ogc:Filter>
 </csw:Constraint>
</csw:Query>
</csw:GetRecords>
```

- **Query by roaming function:**



1. **Query only By Service Type**

```
<?xml version="1.0" encoding="UTF-8"?>
<csw:GetRecords service="CSW" version="2.0.2"
 outputFormat="application/xml"
 outputSchema="http://www.isotc211.org/2005/gmd" resultType="RESULTS"
startPosition="1" maxRecords="50"
 xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
 xmlns:ogc="http://www.opengis.net/ogc"
 xmlns:apiso="http://www.opengis.net/cat/csw/apiso/1.0">
 <csw:Query typeNames="gmd:MD_Metadata">
  <csw:ElementSetName>full</csw:ElementSetName>
  <csw:Constraint version="1.1.0">
   <ogc:Filter>
     <ogc:PropertyIsLike wildCard="%" singleChar="_" escape="\">
            <ogc:PropertyName>apiso:ServiceType</ogc:PropertyName>
           <ogc:Literal>ServiceType</ogc:Literal>
     </ogc:PropertyIsLike>
   </ogc:Filter>
  </csw:Constraint>
 </csw:Query>
</csw:GetRecords>
```

2. **Use AnalyzeServiceXML.xslt to analyze service metadata**

```
<?xml version="1.0" encoding="UTF-8"?>
<xsl:stylesheet version="2.0" xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
xmlns:gmd="http://www.isotc211.org/2005/gmd"
xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
xmlns:srv="http://www.isotc211.org/2005/srv"  exclude-result-prefixes="srv gmd csw">
        <xsl:output method="xml" version="1.0" encoding="UTF-8" indent="yes"/>
                <xsl:template match="/">
                <ResultSet>
          <xsl:for-each
select="//csw:SearchResults/gmd:MD_Metadata/gmd:identificationInfo/srv:SV_ServiceI
dentification">
              <xsl:for-each select="./srv:operatesOn ">
                <Dataset><xsl:value-of select="@uuidref"/> </Dataset>
              </xsl:for-each>
            </xsl:for-each>
                </ResultSet>
                </xsl:template>
</xsl:stylesheet>
```

3. **Query without considering provider, use Analyzed dataset metadata identifier as query condition**

```
<?xml version="1.0" encoding="UTF-8"?>
<csw:GetRecords service="CSW" version="2.0.2"
 outputFormat="application/xml"
 outputSchema="http://www.isotc211.org/2005/gmd" resultType="RESULTS"
startPosition="1" maxRecords="50"
 xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
 xmlns:ogc="http://www.opengis.net/ogc"
 xmlns:apiso="http://www.opengis.net/cat/csw/apiso/1.0">
 <csw:Query typeNames="gmd:MD_Metadata">
  <csw:ElementSetName>full</csw:ElementSetName>
  <csw:Constraint version="1.1.0">
   <ogc:Filter>
    <ogc:And>
     <ogc:PropertyIsLike wildCard="%" singleChar="_" escape="\">
            <ogc:PropertyName>csw:title</ogc:PropertyName>
           <ogc:Literal>RequestedTitleName</ogc:Literal>
    </ogc:PropertyIsLike>
    <ogc:PropertyIsLike wildCard="%" singleChar="_" escape="\">
            <ogc:PropertyName>csw:UseLimitations</ogc:PropertyName>
           <ogc:Literal>LicenseType</ogc:Literal>
    </ogc:PropertyIsLike>
    <ogc:Or>
```

```
            <ogc:PropertyName>apiso:identifier</ogc:PropertyName>
             <ogc:Literal>Dataset 1</ogc:Literal>
            <ogc:PropertyName>apiso:identifier</ogc:PropertyName>
             <ogc:Literal>Dataset 2</ogc:Literal>

     </ogc:Or>
      <ogc:And>
  </ogc:Filter>
 </csw:Constraint>
</csw:Query>
</csw:GetRecords>
```

Second Step: Use XSTL to filter the returned metadta by comparing provider

XSLT:

```
?xml version="1.0" encoding="UTF-8"?>
<xsl:stylesheet version="2.0" xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
xmlns:gco="http://www.isotc211.org/2005/gco"
xmlns:gmd="http://www.isotc211.org/2005/gmd"  xmlns:csw="http://www.opengis.net/cat/csw/2.0.2" exclude-result-prefixes="gco gmd csw">
 <xsl:output method="xml" version="1.0" encoding="UTF-8" indent="yes"/>

 <xsl:param name="contractProvider"/>
 <xsl:template match="/">
 <ResultSet>
      <xsl:for-each select="//csw:SearchResults/gmd:MD_Metadata">
       <Metadata>
           <FileIdentifier><xsl:value-of select="./gmd:fileIdentifier"/></FileIdentifier>
            <Title><xsl:value-of
select="./gmd:identificationInfo/gmd:MD_DataIdentification/gmd:citation/gmd:CI_Citation/gmd:title"/></Title>
           <License><xsl:value-of
select="./gmd:identificationInfo/gmd:MD_DataIdentification/gmd:resourceConstraints/gmd:MD_LegalConstraints/gmd:useLimitation/gco:CharacterString"/></License>
           <ProviderType>
           <xsl:for-each
select="./gmd:distributionInfo/gmd:MD_Distribution/gmd:distributor">
         <xsl:if
test="./gmd:MD_Distributor/gmd:distributorContact/gmd:CI_ResponsibleParty/gmd:organisationName/gco:CharacterString=$contractProvider">
         <xsl:choose>
         <xsl:when
test="./gmd:MD_Distributor/gmd:distributorContact/gmd:CI_ResponsibleParty/gmd:role/gmd:CI_RoleCode/@codeListValue='distributor'"> <xsl:text>PartnerProvider</xsl:text>
         </xsl:when>
         <xsl:otherwise>
         <xsl:text>HomeProvider</xsl:text>
```

```
        </xsl:otherwise>
        </xsl:choose>
                                </xsl:if>
       </xsl:for-each>
   </ProviderType>
      </Metadata>
      </xsl:for-each>
</ResultSet>

</xsl:template>
</xsl:stylesheet>
```

4. **Use XSLT to convey analyzed XML to HTML so that we can show it on website to allow users to choose their favorite dataset**

```
<?xml version="1.0" encoding="UTF-8"?>
<!--Designed and generated by Altova StyleVision Enterprise Edition 2008 rel. 2 sp2 - see http://www.altova.com/stylevision for more information.-->
<xsl:stylesheet version="2.0" xmlns:xsl="http://www.w3.org/1999/XSL/Transform" xmlns:iso19115="http://schemas.opengis.net/iso19115full" xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"  xmlns:smXML="http://metadata.dgiwg.org/smXML" exclude-result-prefixes="iso19115 csw smXML">
<xsl:output method="html" encoding="UTF-8" indent="yes"/>
 <xsl:param name="providerType"></xsl:param>
 <xsl:param name="contractProvider"></xsl:param>
 <xsl:template match="/">
 <table width="1020">
  <tbody>
   <tr>
    <th>
  <table width= "100%" border="0" style="word-break:break-all;"   >
   <tr>
   <td ></td>
    <td  align="center" width="25%"></td>
    <td></td>
    <td></td>
   </tr>
   <tr>
      <td align="center" width="25%"><a href="ShowResultByProvider.jsp?providerType=HomeProvider&amp;contractProvider={$contractProvider}"><xsl:choose>
       <xsl:when test="$providerType='HomeProvider'"><h3>Home Provider</h3></xsl:when><xsl:otherwise>Home Provider</xsl:otherwise>
      </xsl:choose></a></td>
```

```
    <td align="center" width="25%"><a
href="ShowResultByProvider.jsp?providerType=PartnerProvider&amp;contractProvider
={$contractProvider}"><xsl:choose>
     <xsl:when test="$providerType='PartnerProvider'"><h3>Partner
Provider</h3></xsl:when><xsl:otherwise>Partner Provider</xsl:otherwise>
    </xsl:choose></a></td>
    <td align="center" width="25%"><a
href="ShowResultByProvider.jsp?providerType=NonProvider&amp;contractProvider={
$contractProvider}"><xsl:choose>
     <xsl:when test="$providerType=""><h3>Non-Contracted
Provider</h3></xsl:when><xsl:otherwise>Non Provider</xsl:otherwise>
    </xsl:choose></a></td>
    <td align="center" width="25%"><a
href="ShowResultByProvider.jsp?providerType=showAll&amp;contractProvider={$cont
ractProvider}"><xsl:choose>
     <xsl:when test="$providerType='showAll'"><h3>Show
All</h3></xsl:when><xsl:otherwise>Show All</xsl:otherwise>
    </xsl:choose></a></td>
    <td/>
  </tr>
 </table></th>
 </tr>
  <tr>
   <th>
    <table  style="word-break:break-all;" width="100%" border="3" align="center"
cellspacing="0" cellpadding="0">
     <tr>
      <td align="center" width="30%">Title</td>
      <td align="center" width="50%">License</td>
      <xsl:if test="$providerType='showAll'">
      <td align="center" width="20%">Provider Type</td>
      </xsl:if>

     </tr>
     <xsl:choose>
      <xsl:when test="$providerType='showAll'">
     <xsl:for-each select="//Metadata">

      <tr>

       <td>

        <a
href="GetResult.jsp?fileIdentifier={./FileIdentifier}&amp;contractProvider={$contractPr
ovider}">
```

```
          <xsl:value-of select="./Title"/>
         </a>

        </td>
        <td>
         <xsl:value-of select="./License"/>
        </td>

        <td >
            <xsl:value-of select="./ProviderType"/>

        </td>

       </tr>
         </xsl:for-each>
       </xsl:when>
       <xsl:otherwise>


      <xsl:for-each select="//Metadata">
      <xsl:if test="$providerType=./ProviderType">
       <tr>

        <td>

         <a
href="GetResult.jsp?fileIdentifier={./FileIdentifier}&amp;contractProvider={$contractPr
ovider}">
          <xsl:value-of select="./Title"/>
         </a>

        </td>
        <td>
        <xsl:value-of select="./License"/>

        </td>
        </tr>
       </xsl:if>
       </xsl:for-each>
       </xsl:otherwise>
      </xsl:choose>

     </table>
            </th>
  </tr>
```

```
 </tbody>
 </table>
 </xsl:template>
</xsl:stylesheet>
```
Fourth Step:

5. **Users choose the dataset, and get Record by the ID of the metadata**

```
 <?xml version="1.0" encoding="UTF-8"?>
<csw:GetRecordById service="CSW" version="2.0.2" outputFormat="application/xml"
outputSchema=http://www.opengis.net/cat/csw/2.0.2"
xmlns:csw=http://www.opengis.net/cat/csw/2.0.2" >
 <csw:Id>fileIdentifier</csw:Id>
<csw:ElementSetName>full</csw:ElementSetName>
</csw:GetRecordById>
```

Declaration of originality

This is to certify that the work is entirely my own and not of any other person, unless explicitly acknowledged (including citation of published and unpublished sources). The work has not previously been submitted in any form to the University of Münster or to any other institution for assessment for any other purpose.

Signed _____

Date ____02/03/2009_____