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NETMAR

Open service network for marine environmental data

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Executive Summary

NETMAR aims to develop a pilot European Marine Information System (EUMIS) for searching, downloading and integrating satellite, in situ and model data from ocean and coastal areas. EUMIS will use a semantic framework coupled with ontologies for identifying and accessing distributed data, such as near-real time, forecast and historical data.

The NETMAR semantic framework aims to provide the tools (APIs and services) required to handle semantics in various EUMIS components, and external applications. It will be responsible for reasoning over the NETMAR semantic knowledge and for providing high-level and easy-to-use semantic operations through a standardised interface, called the semantic web service (SWS).

The SWS was specified and implemented according to the user requirements for the NETMAR pilots identified as part of the system architecture (WP2). The first version of the SWS was implemented in Java using the Jena ontology framework. The service is available at http://netmar.ucc.ie/srv/SWS. It was tested using a sample ontology developed as part of the Geoscientific Data Integration (GeoDI) project. The next step is to test the SWS using larger semantic resources from the NERC Vocabulary Server (NVS). The current SWS supports KVP (keyword-value pair) requests over HTTP. However it does not yet support XML requests and SOAP, these are to be included in the second version. The semantic aspects of uncertainty and uncertainty propagation are currently being developed by the UncertWeb project. The XML schemas and vocabularies developed by UncertWeb will be used to encode uncertainty in NETMAR as soon as they are available.

Nine operations are currently supported, which are:

- GetCapabilities – Retrieves the SWS capabilities document (Mandatory)
- GetConceptSchemes – Retrieves information about the concept schemes delivered by the SWS (Mandatory)
- GetConceptScheme – Retrieves information about a specified concept scheme (Mandatory)
- GetConcepts – Retrieves the concepts of 0 or many concept schemes (Mandatory)
- GetExplicitTopConcepts – Retrieves the concepts explicitly asserted as top concepts of a specified concept scheme (Optional)
- GetImplicitTopConcepts – Retrieves the top concepts of a specified concept scheme, i.e., those that do not have any broader concept within the same specified concept scheme (Mandatory)
- GetConceptHierarchy – Builds the concept Hierarchy of a specified concept scheme according to the SKOS narrower and broader relationships (Optional)
- GetConcept – Retrieves information about a specified concept (Mandatory)
- GetRelatedConcepts – Returns the concepts that are related to one or more specified concepts by one or more specified SKOS semantic relationships (Mandatory)
- SearchConcept – Searches a concept by a free text keyword (Mandatory)

These operations were tested using the NETMAR ontology browser and catalogue service mediator. The specified exception handling was improved during the implementation by including and supporting an exhaustive list of exception types.

The performance of the implemented SWS was tested using a “small” ontology that counts around 300 resources. Tests show that the SWS has good response times (1.5 second for the most complex operation, *GetConceptHierarchy*). This will be further tested and improved in the second version of the SWS.

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1 Introduction

1.1 Background

NETMAR[1] aims to develop a pilot European Marine Information System (EUMIS) for searching, downloading and integrating satellite, in situ and model data from ocean and coastal areas. It will be a user-configurable system offering flexible service discovery, access and chaining facilities using OGC, OPeNDAP and W3C standards. It will use a semantic framework (SF) coupled with ontologies for identifying and accessing distributed data, such as near-real time, forecast and historical data. EUMIS will also enable further processing of such data to generate composite products and statistics suitable for decision-making in diverse marine application domains. Figure 1.1 illustrates how observations, derived parameters and predictions are retrieved from a distributed service network through standard protocols, and delivered through the EUMIS portal using ontologies and semantic frameworks to select suitable products and where new products can be generated dynamically using chained processing services.

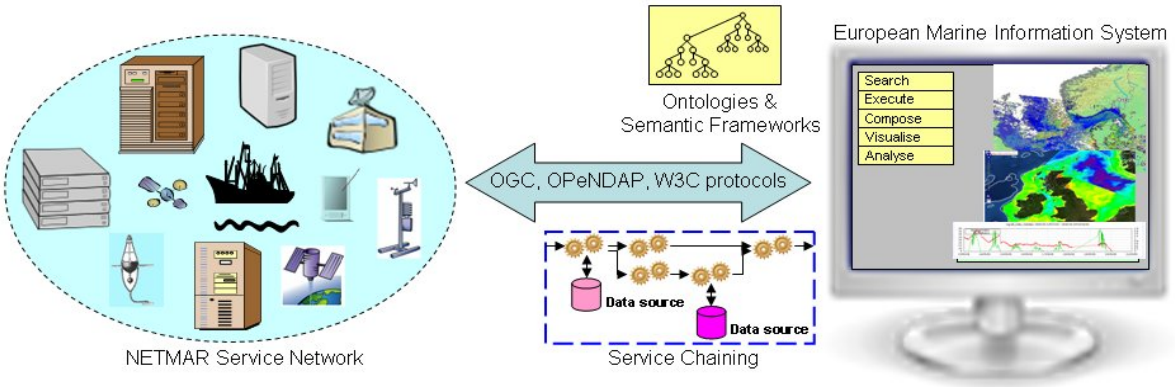

Figure 1.1. The NETMAR Service Network

1.2 Objective of this Report

This report describes the implementation of **version 1.0** of the NETMAR semantic framework for discovering, accessing and chaining marine environmental web services. It summarises the features supported by this version, and provides examples of how to use it. The NETMAR semantic framework and its features were specified and implemented according to the user requirements identified as part of WP 1 (report D1.1, "Use case specification and schedule for testing" [PTS+11]) and WP 2 (report D2.2.1, " NETMAR system architecture design – First version " [PHD+11]).

The semantic aspects of uncertainty and uncertainty propagation are currently being developed by the UncertWeb[2] project, and therefore will not be discussed in this document. The XML schemas and vocabularies developed by UncertWeb will be used to encode uncertainty in NETMAR as soon as they are available. The NETMAR partners are working closely with the UncertWeb community to:

1. Make sure that the NETMAR requirements will be taken into consideration in the developed vocabularies and schemas.
2. Advise the UncertWeb community as to the appropriate semantic models and services to use for the uncertainty vocabularies (e.g., the use of SKOS as a model,

[1] http://www.netmar-project.eu/

[2] http://www.uncertweb.org/

RDF/XML as an encoding, and the NERC Vocabulary Server (NVS) as a delivery service).

1.3 Organisation of this Report

This report is organised as follows. Chapter 2 describes the status of implementation of the semantic web service. Next Chapter 3 provides examples of SWS requests and responses to illustrate how the current version of the SWS works and how to use it.

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2 Implementation

The semantic web service was implemented in Java, using the Jena ontology framework. It is deployed one the CMRC server and can be accessed at http://netmar.ucc.ie/srv/SWS. For this first version, rather than accessing semantic resources from the NERC Vocabulary Server (NVS), the semantic framework uses a triple store containing a sample ontology developed by CMRC as part of the GeoDI[3] project. The reason behind this choice is the lack of support for inferencing in the current version of the NVS.

2.1 Request Protocols

Conforming to the semantic web service specification [LLC+11], the SWS supports keyword-value pair (KVP) requests over HTTP. However, as the current version of the SWS is only experimental, it does not yet support XML requests and SOAP. XML and SOAP will be supported and tested in the second version of the SWS as a way to optimise implementation efforts.

2.2 Implemented Operations

The development of the first version of the semantic web service, the ontology browser and the catalogue service mediator allowed us to better understand the requirements of the various components in terms of the semantic operations needed. Therefore, the implemented operations are sometimes different than the specified ones both in name and in the required parameters. This is part of the specification and development cycle wherein implementation and testing are used to detect potential problems in the specification and to improve it. All the differences between the SWS specification and its implementation in this first version will be fed back into the second version of the specification to make sure that the second versions of the specification and implementation are compliant. The table below defines the implemented operations and specifies whether they are mandatory (M) or optional (O). More details on these operations are to be found in Chapter 3.

Table 5.2. Implemented SWS Operations

Exception code	Description	Use
GetCapabilities	Retrieves the SWS capabilities document	M
GetConceptSchemes	Retrieves information about the concept schemes delivered by the SWS	M
GetConceptScheme	Retrieves information about a specified concept scheme	M
GetConcepts	Retrieves the concepts of 0 or many concept schemes	M
GetExplicitTopConcepts	Retrieves the concepts explicitly asserted as top concepts of a specified concept scheme	O
GetImplicitTopConcepts	Retrieves the top concepts of a specified concept scheme, i.e., those that do not have any broader concept within the same specified concept scheme	M
GetConceptHierarchy	Builds the concept Hierarchy of a specified concept scheme according to the SKOS narrower and broader relationships	O
GetConcept	Retrieves information about a specified concept	M
GetRelatedConcepts	Returns the concepts that are related to one or more specified concepts by one or more specified SKOS semantic relationships	M
SearchConcept	Searches a concept by a free text keyword	M

[3] http://geodi.ucc.ie

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2.3 Exception Management

During the implementation of the first version of the NETMAR semantic framework, we discovered more exception types that may occur than originally specified in [LLC+11]. Therefore new exception types were added and implemented. For an easier and more efficient documentation of exceptions, we replaced the numeric exception codes specified in [LLC+11] with character strings as specified in Table 2.1.

Table 5.1. SWS Exception Codes

Exception code	Description
InternalError	Internal error to the SWS
InvalidParameterValue	The parameter value is not valid
InvalidRequest	The request message is either invalid or is not well-formed
MissingParameter	A parameter is missing
NoApplicableCode	There is no applicable code to this exception
NotImplemented	The (abstract) operation has not been implemented
NotSupported	A service option or capability is not supported
NullResourceValue	A requested resource has a null value
NullValue	Null value exception: a required parameter or variable is null
ResourceNotFound	The requested resource does not exist or could not be found
ResourceTypeMismatch	The requested resource does not have the required type
UnknownError	The error type is unknown

Particular attention was paid to providing human-readable messages as well as machine processable codes and locators in exceptions for identifying the types of exceptions and their causes.

The XML fragment below illustrates an exception report generated by the SWS due to an unknown concept scheme specified in a *GetConceptScheme* operation.

```
<sws:ExceptionReport xmlns:sws="http://cmrc.ucc.ie/sws/1.0"
 xmlns:xml=http://www.w3.org/XML/1998/namespace xml:lang="en" version="1.0">
  <sws:Exception exceptionCode="ResourceNotFound"
   locator="http://geodi.ucc.ie/ont/20110429/geoscience.owl#BadCS">
    <sws:ExceptionText>
      Resource "http://geodi.ucc.ie/ont/20110429/geoscience.owl#BadCS": No such
      concept scheme or resource.
    </sws:ExceptionText>
  </sws:Exception>
</sws:ExceptionReport>
```

2.3.1 *Performance*

In general all the SWS operations were optimised for performance and memory through the use of optimised algorithms and data structure to avoid unneeded instructions and data. The Jena framework itself uses an indexer to optimise semantic resource querying.

The NETMAR SWS was tested with a small ontology that counts around 300 resources (concepts, concept schemes, properties, etc.). The slowest operation is the *GetConceptHierarchy*, which takes up to 1.5 second to build the hierarchy for all the concepts including all their definitions and labels. The *SearchConcept* operation takes in average 0.8 second to search concepts matching a keyword and to return their full information (all definitions and labels). In the current implementation the s*earchConcept* operation runs through all the available concepts, ranks them according to their similarities with the specified keyword and only returns those with the highest scores above a fixed threshold. This will be improved in the second version of the SWS using an indexer.

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The performance results presented above are only initial figures. It is difficult to conclude as to the performance of the implemented SWS using larger ontologies and as to its scalability. This will be further investigated and optimised as part of the development of the second version of the SWS.

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3 Using the SWS

This chapter provides examples of SWS requests and responses to illustrate how the current version of the SWS works and how to use it.

All the SWS requests below shall specify the service type, the accepted service versions and the request type. In addition, they may specify the level of resource information to be returned by the SWS. Therefore, they all use the parameters defined in Table 3.1.

Table 3.1. Common SWS Request Parameters

Parameter	Cardinality	Definition	Example
service	1	Type of service requested ***Possible values:*** "SWS"	service=SWS
version	1	Service version accepted by the client ***Possible values:*** "1.0"	version=1.0
request	1	Operation requested by the client ***Possible values:*** see Table 5.2	request=GetConcept
elementSet	0..1	Level of resource details returned by the SWS ***Possible values and meanings:*** • "abstract": *only URI SHALL be returned* • "brief": *abstract information and preferred label SHALL be returned* • "summary": *brief information, associated concept schemes (if applicable), and definitions SHALL be returned* • "full": *summary information and alternate labels SHALL be returned* • "extended": *full information and hidden labels SHALL be returned*	elementSet=full

3.1 GetConceptSchemes Operation

The GetConceptSchemes operation is used to retrieve information about the available concept schemes. The GetConceptSchemes operation does not require more parameters than the ones defined in Table 3.1.

An example of a GetConceptSchemes request is given below.

```
http://netmar.ucc.ie/srv/SWS?
service=SWS
&version=1.0
&request=GetConceptSchemes
&elementSet=full
```

Encoded URL:
http://netmar.ucc.ie/srv/SWS?service=SWS&version=1.0&request=GetConceptSchemes&elementSet=full

The core of the GetConceptSchemes response consists of an RDF document containing the list of concepts schemes delivered by the SWS. The RDF document is embedded in a GetConceptSchemesResponse wrapper.

The XML below shows a fragment of the GetConceptSchemes response associated with the request example above. For sake of readability, namespace declarations have been omitted.

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```
<sws:GetConceptSchemesResponse>
  <sws:Results numberOfResourcesReturned="25" elementSet="full">
    <rdf:RDF>
      <skos:ConceptScheme rdf:about="Themes">
        <skos:prefLabel xml:lang="en">Themes</skos:prefLabel>
        <skos:definition xml:lang="en">
          A concept scheme for defining theme keywords
        </skos:definition>
      </skos:ConceptScheme>
      <skos:ConceptScheme rdf:about="Parameters">
        <skos:prefLabel xml:lang="en">Parameters</skos:prefLabel>
        <skos:definition xml:lang="en">
          A concept scheme for defining parameter keywords
        </skos:definition>
      </skos:ConceptScheme>
      <!--Other concept schemes-->
    </rdf:RDF>
  </sws:Results>
</sws:GetConceptSchemesResponse>
```

3.2 GetConceptScheme Operation

The GetConceptScheme operation allows a client to retrieve information about a specified concept scheme identified by its URI.

In addition to the common SWS request parameters (defined in Table 3.1), the *GetConceptScheme* request uses the *conceptScheme* parameter that specifies the URI of the concept scheme requested by the client (c.f., Table 3.2).

Table 3.2 GetConceptScheme Request Parameters

Parameter	Cardinality	Definition	Example
conceptScheme	1	URI of the concept scheme requested ***Type:*** URI	conceptScheme=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Themes

An example of a GetConceptScheme request is provided below.

http://netmar.ucc.ie/srv/SWS?
service=SWS
&version=1.0
&request=GetConceptScheme
&elementSet=full
&conceptScheme=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Themes

Encoded URL:
http://netmar.ucc.ie/srv/SWS?service=SWS&version=1.0&request=GetConceptScheme&elementSet=full&conceptScheme=http%3A%2F%2Fgeodi.ucc.ie%2Font%2F20110429%2Fgeoscience.owl%23Themes

The core of the GetConceptScheme response consists of an RDF document describing the requested concept scheme, and embedded in a GetConceptSchemeResponse wrapper.

The XML below shows a fragment of the GetConceptScheme response associated with the request example above.

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```
<sws:GetConceptSchemeResponse>
  <sws:Results numberOfResourcesReturned="1" elementSet="full">
    <rdf:RDF>
      <skos:ConceptScheme rdf:about="Themes">
        <skos:prefLabel xml:lang="en">Themes</skos:prefLabel>
        <skos:definition xml:lang="en">
          A concept scheme for defining theme keywords
        </skos:definition>
      </skos:ConceptScheme>
    </rdf:RDF>
  </sws:Results>
</sws:GetConceptSchemeResponse>
```

3.3 GetConcepts Operation

The GetConcepts operation retrieves all the concepts of one or more concept schemes, identified by their URIs.

In addition to the common SWS request parameters (defined in Table 3.1), the *GetConcepts* request uses the *conceptScheme* parameter that specifies the URI of a concept scheme requested by the client (c.f., Table 3.3).

Table 3.3 GetConcepts Request Parameters

Parameter	Cardinality	Definition	Example
conceptScheme	1..*	URI of a requested concept scheme ***Type:*** URI	conceptScheme=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Themes

An example of a GetConcepts request is provided below.

http://netmar.ucc.ie/srv/SWS?
service=SWS
&version=1.0
&request=GetConcepts
&elementSet=full
&conceptScheme=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Themes

Encoded URL:
http://netmar.ucc.ie/srv/SWS?service=SWS&version=1.0&request=GetConcepts&elementSet=full&conceptScheme=http%3A%2F%2Fgeodi.ucc.ie%2Font%2F20110429%2Fgeoscience.owl%23Themes

The core of the *GetConcepts* response consists of an RDF document listing the concepts belonging to the requested concept scheme, and embedded in a *GetConceptsResponse* wrapper. The XML below shows a fragment of the *GetConcepts* response associated with the request example above.

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```
<sws:GetConceptsResponse>
  <sws:Results numberOfResourcesReturned="29" elementSet="full">
    <rdf:RDF>
      <skos:Concept rdf:about="SubBottomProfiling">
        <skos:prefLabel xml:lang="en">Sub Bottom Profiling</skos:prefLabel>
        <skos:inScheme
         rdf:about="Themes"/>
        <skos:definition xml:lang="en">
          The identification and measure of thes various sediment layers that
          exist below the seabed
        </skos:definition>
        <skos:altLabel xml:lang="en">
          Sub-Surface Seabed Classification
        </skos:altLabel>
      </skos:Concept>
      <skos:Concept rdf:about="Geology">
        <skos:prefLabel xml:lang="en">Geology</skos:prefLabel>
        <skos:inScheme rdf:about="INSPIREThemes_Annex2"/>
        <skos:inScheme rdf:about="Disciplines"/>
        <skos:inScheme rdf:about="Themes"/>
        <skos:definition xml:lang="en">
          Geology characterised according to composition and structure.
          Includes bedrock, aquifers and geomorphology.
        </skos:definition>
      </skos:Concept>
      <!--Other concepts-->
    </rdf:RDF>
  </sws:Results>
</sws:GetConceptsResponse>
```

3.4 GetExplicitTopConcepts Operation

The *GetExplicitTopConcepts* operation retrieves all the concepts asserted as being the top concepts of a specified concept scheme identified by its URI.

In addition to the common SWS request parameters (defined in Table 3.1), the *GetExplicitTopConcepts* request uses the *conceptScheme* parameter that specifies the URI of the concept scheme requested by the client (c.f., Table 3.4).

Table 3.4 *GetExplicitTopConcepts* Request Parameters

Parameter	Cardinality	Definition	Example
conceptScheme	1	URI of the requested concept scheme ***Type:*** URI	conceptScheme=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Themes

An example of a *GetExplicitTopConcepts* request is provided below.

```
http://netmar.ucc.ie/srv/SWS?
service=SWS
&version=1.0
&request=GetExplicitTopConcepts
&elementSet=full
&conceptScheme=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Themes
```

Encoded URL:
http://netmar.ucc.ie/srv/SWS?service=SWS&version=1.0&request=GetExplicitTopConcepts&elementSet=full&conceptScheme=http%3A%2F%2Fgeodi.ucc.ie%2Font%2F20110429%2Fgeoscience.owl%23Themes

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The core of the *GetExplicitTopConcepts* response consists of an RDF document listing the top concepts of the requested concept scheme, and embedded in a *GetExplicitTopConceptsResponse* wrapper. The response is similar to that of a *GetConcepts* response (see example in section 3.3).

3.5 GetImplicitTopConcepts Operation

The GetExplicitTopConcepts operation retrieves all the concepts belonging to a concept scheme and having no broader concepts within that same concept scheme. This includes the explicit top concepts.

Like the GetExplicitTopConcepts operation, the *GetImplicitTopConcepts* request uses the *conceptScheme* parameter that specifies the URI of the concept scheme requested by the client (c.f., Table 3.5).

Table 3.5 GetImplicitTopConcepts Request Parameters

Parameter	Cardinality	Definition	Example
conceptScheme	1	URI of the requested concept scheme ***Type:*** URI	conceptScheme=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Themes

An example of a *GetImplicitTopConcepts* request is provided below.

http://netmar.ucc.ie/srv/SWS?
service=SWS
&version=1.0
&request=GetImplicitTopConcepts
&elementSet=full
&conceptScheme=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Themes

Encoded URL:
http://netmar.ucc.ie/srv/SWS?service=SWS&version=1.0&request=GetImplicitTopConcepts&elementSet=full&conceptScheme=http%3A%2F%2Fgeodi.ucc.ie%2Font%2F20110429%2Fgeoscience.owl%23Themes

The core of the *GetImplicitTopConcepts* response consists of an RDF document listing the top concepts of the requested concept scheme, and embedded in a *GetImplicitTopConceptsResponse* wrapper. The response is similar to that of a *GetConcepts* response (see example in section 3.3).

3.6 GetConceptHierarchy Operation

The GetConceptHierarchy operation retrieves all the concepts of one or more concept schemes, identified by their URIs, and organised in a hierarchy (nested structure) according to the SKOS broader and narrower relationships.

In addition to the common SWS request parameters (defined in Table 3.1), the *GetConceptHierarchy* request uses the *conceptScheme* parameter that specifies the URI of a concept scheme requested by the client (c.f., Table 3.6).

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Table 3.6 GetConceptHierarchy Request Parameters

Parameter	Cardinality	Definition	Example
conceptScheme	1	URI of a requested concept scheme ***Type:*** URI	conceptScheme=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Themes

An example of a *GetConceptHierarchy* request is provided below.

http://netmar.ucc.ie/srv/SWS?
service=SWS
&version=1.0
&request=GetConceptHierarchy
&elementSet=brief
&conceptScheme=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Themes

Encoded URL:
http://netmar.ucc.ie/srv/SWS?service=SWS&version=1.0&request=GetConceptHierarchy&elementSet=brief&conceptScheme=http%3A%2F%2Fgeodi.ucc.ie%2Font%2F20110429%2Fgeoscience.owl%23Themes

The core of the GetConceptHierarchy response consists of an RDF document containing the hierarchy of the concepts belonging to the requested concept scheme, and embedded in a GetConceptHierarchyResponse wrapper. The XML below shows a fragment of the GetConceptHierarchy response associated with the request example above.

```
<sws:GetConceptHierarchyResponse>
  <sws:Results numberOfResourcesReturned="10" elementSet="full">
    <rdf:RDF>
      <skos:Concept rdf:about="NaturalRiskZones">
        <skos:prefLabel xml:lang="en">Natural risk zones</skos:prefLabel>
      </skos:Concept>
      <skos:Concept rdf:about="Geology">
        <skos:prefLabel xml:lang="en">Geology</skos:prefLabel>
        <skos:narrower>
          <skos:Concept rdf:about="MarineGeology">
            <skos:prefLabel xml:lang="en">Marine geology</skos:prefLabel>
            <skos:narrower>
              <skos:Concept rdf:about="MarineGeophysics">
                <skos:prefLabel xml:lang="en">Marine Geophysics</skos:prefLabel>
                <skos:narrower>
                  <skos:Concept rdf:about="MarineGravityField">
                    <skos:prefLabel xml:lang="en">
                      Marine Gravity Field
                    </skos:prefLabel>
                  </skos:Concept>
                </skos:narrower>
                <!--Other concepts narrower than "MarineGeophysics"-->
              </skos:Concept>
            </skos:narrower>
            <!--Other concepts narrower than "MarineGeology"-->
          </skos:Concept>
        </skos:narrower>
        <!--Other concepts narrower than "Geology"-->
      </skos:Concept>
      <!--Other top concepts-->
    </rdf:RDF>
  </sws:Results>
</sws:GetConceptHierarchyResponse>
```

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3.7 GetConcept Operation

The *GetConcept* operation allows a client to retrieve information about a specified concept identified by its URI.

In addition to the common SWS request parameters, *GetConcept* requires the *concept* parameter that specifies the URI of the concept requested by the client (c.f., Table 3.7).

Table 3.7 GetConcept Request Parameters

Parameter	Cardinality	Definition	Example
concept	1	URI of the requested concept ***Type:*** URI	concept=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Geology

An example of a *GetConceptScheme* request is provided below.

http://netmar.ucc.ie/srv/SWS?
service=SWS
&version=1.0
&request=GetConcept
&elementSet=full
&concept=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Geology

Encoded URL:
http://netmar.ucc.ie/srv/SWS?service=SWS&version=1.0&request=GetConcept&elementSet=full&concept=http%3A%2F%2Fgeodi.ucc.ie%2Font%2F20110429%2Fgeoscience.owl%23Geology

The core of the *GetConcept* response consists of an RDF document describing the requested concept, and embedded in a *GetConceptResponse* wrapper. The XML below shows a fragment of the *GetConcept* response associated with the request example above.

```
<sws:GetConceptResponse>
  <sws:Results numberOfResourcesReturned="1" elementSet="full">
    <rdf:RDF>
      <skos:Concept rdf:about="Geology">
        <skos:prefLabel xml:lang="en">Geology</skos:prefLabel>
        <skos:inScheme rdf:about="Themes"/>
        <skos:inScheme rdf:about="Disciplines"/>
        <skos:inScheme rdf:about="INSPIREThemes_Annex2"/>
        <skos:definition xml:lang="en">
          Geology characterised according to composition and structure.
          Includes bedrock, aquifers and geomorphology.
        </skos:definition>
      </skos:Concept>
    </rdf:RDF>
  </sws:Results>
</sws:GetConceptResponse>
```

3.8 GetRelatedConcepts Operation

The *GetRelatedConcepts* operation retrieves all the concepts related to one or more specified concepts, identified by their URIs, by one or more SKOS relationships. Concepts may be filtered by concept schemes.

In addition to the common SWS request parameters (defined in Table 3.1), the *GetRelatedConcepts* request uses the parameters defined in Table 3.8.

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Table 3.8 GetRelatedConcepts Request Parameters

Parameter	Cardinality	Definition	Example
concept	1..*	URI of the concept of interest	concept=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Geology
relation	*	URI of a SKOS relationship	relation=http://www.w3.org/2004/02/skos/core#narrowerTransitive
conceptScheme	*	URI of a concept scheme ***Type:*** URI	conceptScheme=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Disciplines

An example of a GetRelatedConcepts request is provided below.

http://netmar.ucc.ie/srv/SWS?
service=SWS
&version=1.0
&request=GetRelatedConcepts
&elementSet=full
&concept=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Geology
&relation=http://www.w3.org/2004/02/skos/core#narrowerTransitive
&conceptScheme=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Disciplines

Encoded URL:
http://netmar.ucc.ie/srv/SWS?service=SWS&version=1.0&request=GetRelatedConcepts&elementSet=summary&concept=http%3A%2F%2Fgeodi.ucc.ie%2Font%2F20110429%2Fgeoscience.owl%23Geology&relation=http%3A%2F%2Fwww.w3.org%2F2004%2F02%2Fskos%2Fcore%23narrowerTransitive&conceptScheme=http%3A%2F%2Fgeodi.ucc.ie%2Font%2F20110429%2Fgeoscience.owl%23Themes

The core of the GetRelatedConcepts response consists of an RDF document listing the concepts related to the requested concept using the specified relationships and belonging to the specified concept scheme. The RDF document is embedded in a GetRelatedConceptsResponse wrapper. The XML below shows a fragment of the GetRelatedConcepts response associated with the request example above.

```
<sws:GetRelatedConceptsResponse>
  <sws:Results numberOfResourcesReturned="16" elementSet="full">
    <rdf:RDF>
      <skos:Concept rdf:about="AcousticSeabedClassification">
        <skos:prefLabel xml:lang="en">
          Acoustic Seabed Classification
        </skos:prefLabel>
        <skos:inScheme rdf:about="Themes"/>
        <skos:definition xml:lang="en">
          The classification of seabed based on acoustic properties. This can
          be divided into two main categories: seabed surface classification and
          seabed sub-surface classification (sub bottom profiling).
        </skos:definition>
      </skos:Concept>
      <skos:Concept rdf:about="FaciesInterpretation">
        <skos:prefLabel xml:lang="en">Facies interpretation</skos:prefLabel>
        <skos:inScheme rdf:about="Themes"/>
        <skos:definition xml:lang="en">
          The characterisation of a rock or series of rocks reflecting their
          appearance, composition, and conditions of formation
        </skos:definition>
      </skos:Concept>
      <!--Other related concepts-->
    </rdf:RDF>
  </sws:Results>
</sws:GetRelatedConceptsResponse>
```

3.9 SearchConcept Operation

The *SearchConcept* operation retrieves the concepts that most match a free text keyword.

In addition to the common SWS request parameters (defined in Table 3.1), the *SearchConcept* request uses the parameters defined in Table 3.9.

Table 3.9 GetRelatedConcepts Request Parameters

Parameter	Cardinality	Definition	Example
keyword	1	free text keyword to be matched	keyword=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Geology
conceptScheme	*	URI of a concept scheme ***Type:*** URI	conceptScheme=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Disciplines

An example of a *SearchConcept* request is provided below.

http://netmar.ucc.ie/srv/SWS?
service=SWS
&version=1.0
&request=SearchConcept
&elementSet=full
&keyword=geo
&conceptScheme=http://geodi.ucc.ie/ont/20110429/geoscience.owl#Parameters

Encoded URL:
http://netmar.ucc.ie/srv/SWS?service=SWS&version=1.0&request=SearchConcept&elementSet=full&keyword=geo&conceptScheme=http%3A%2F%2Fgeodi.ucc.ie%2Font%2F20110429%2Fgeoscience.owl%23Parameters

The core of the *SearchConcept* response consists of an RDF document listing the concepts matching the specified keyword and belonging to the specified concept scheme. Concepts are ranked according to their relevance to the user's keyword. The RDF document is embedded in a *SearchConceptResponse* wrapper. The XML below shows a fragment of the *SearchConcept* response associated with the request example above.

```
<sws:SearchConceptResponse>
  <sws:Results numberOfResourcesReturned="1" elementSet="full">
    <rdf:RDF>
      <skos:Concept rdf:about="GeotechnicalPropertyOfSeabedSamples">
        <skos:prefLabel xml:lang="en">
          Geotechnical Property of Seabed Samples
        </skos:prefLabel>
        <skos:inScheme rdf:about="Parameters"/>
        <skos:definition xml:lang="en">
          Parameter pertaining to the geotechnical analysis of seabed samples
        </skos:definition>
      </skos:Concept>
    </rdf:RDF>
  </sws:Results>
</sws:SearchConceptResponse>
```

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4 Discussion and Future Work

Version 1 of the SWS implements all the operations required by the EUMIS semantically enabled components (discovery service, ontology browser, and service chaining component). The request format is KVP. Version 2 will implement the XML request format and SOAP. More useful operations may be identified and implemented in version 2.

Currently the SWS responses are SKOS documents encoded in RDF/XML and embedded in SWS response wrappers (e.g., GetConceptSchemesResponse, GetConceptResponse, etc.). This requires an extra parsing effort by the SWS clients. Therefore, in the next version, these wrappers will be omitted, and pure SKOS documents will be returned by the SWS. As SKOS documents may be structured in different ways, it would be useful to define, as part of the SWS specification (version 2), an XML schema for the SKOS documents returned by the SWS.

Version 1 of the SWS was implemented based on a CMRC triple store containing a small ontology. Version 2 should build on the NVS. For this purpose, a tool will be developed to load the relevant NVS vocabularies into the CMRC triple store and perform the required inferencing on them.

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5 References

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6 Acronyms

CMRC	Coastal and Marine Resources Centre
EUMIS	European Marine Information System
GeoDI	Geoscientific Data Integration
KVP	Keyword-Value Pair
NERC	Natural Environmental Research Council
NETMAR	Open service Network for Marine Environmental Data
NVS	NERC Vocabulary Server
OGC	Open Geospatial Consortium
OpenDAP	Open-source Project for a Network Data Access Protocol
OWL	Web Ontology Language
RDBMS	Relational Database Management System
RDF	Resource Description Framework
RDFS	(Also RDF-S) RDF Schema
SKOS	Simple Knowledge Organisation System
SOAP	Simple Object Access Protocol
SWS	Semantic Web Service
URI	Uniform Resource Identifier
W3C	World Wide Web Consortium
XML	eXtensible Markup Language

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