Department for Environment Food & Rural Affairs

UK INSPIRE
UK Location Infrastructure
Data Publisher – How To Guide

Implementing an INSPIRE Web Feature Service with GeoServer

DOCUMENT CONTROL

Change Summary

Version	Date	Author/Editor	Change Summary
1.0	13 March 2014	Marcus Sen	Initial version
1.1	12 September 2014	Marcus Sen	Fix hyperlinks in PDF
1.2	26 August 2015	Marcus Sen	Updated GeoServer version Updated changed links Various rewrites, including mention of INSPIRE geology theme schema

Contents

Introduction

This guidance describes how to set up a web service using free and open source Geoserver software to provide an INSPIRE compliant ISO/OGC Web Feature Service (WFS) version 2.0 for any of the recently published INSPIRE ANNEX I, II or III Data specifications. It describes how you can implement the WFS functionality described in chapters 6 and 7 of the latest Technical Guidance for the implementation of INSPIRE Download Services.

The guidance includes example data and configuration files that can be used to create running Open GeoSpatial Consortium (OGC) Web Feature Services (WFS) that deliver data following the INSPIRE Annex II Geology domain data specification recommendation to use the GeoScIML 3.2 encoding schema. This example illustrates aspects of service and data configuration that should help the reader to set up services using their own data that implement any of the INSPIRE ANNEX I, II and III encoding schemas.

This Geoserver open sourced based guidance is the third in a series of 'Data Publisher - How To Guides' series from UK Location for INSPIRE work the first two being:

- Setting up GeoServer on a Windows Machine
- Establish a Reference Implementation for an INSPIRE View Service using GeoServer

both are available from http://www.data.gov.uk.

Pre-requisites / System Requirements

The cookbook is technical and some assumptions are made about the reader's background knowledge:

- The reader is a, or is working closely with an expert in the data model and schema for the particular INSPIRE theme for which they are planning to supply data.
- The reader has some familiarity with setting up web servers and preferably Java servlet containers.
- The reader is able to install software on their machine and can follow the appropriate installation instructions for PostgreSQL, PostGIS and GeoServer documented on the websites for that software.

To set up a production WFS you will need server equipment to run your database and GeoServer. Estimating the level of hardware resources required to support a responsive service is a complex task depending on the amount of your data, its complexity and the demand that will be placed on your service by users. It is out of the scope of this document to give advice on these issues but you can find some assistance from the GeoServer web site and mailing list. To test setting up a service using the example in this guide a modern PC with Intel Core or equivalent processor and 4Gb RAM should certainly be adequate and you can probably get away with less.

The software required includes the PostgreSQL database with PostGIS spatial extensions, Java, a Java servlet container such as Apache Tomcat, and GeoServer itself. If you use one of the GeoServer packages that include Jetty then you won't need to install a servlet container separately. There are a lot of different versions and all these software packages are continuously updated. You may have conditions specific to your site which make particular versions preferable. For example, you may already have your data in a different database system such as Oracle Spatial rather than PostGIS. It isn't possible to cover all possible set ups here. Below are the specific software versions we have used to test the contents of this cookbook.

Operating system	PostgreSQL	PostGIS	Java	GeoServer
Windows 7	9.1	1.5	7	2.6.2
Windows 7	9.1	1.5	7	2.7

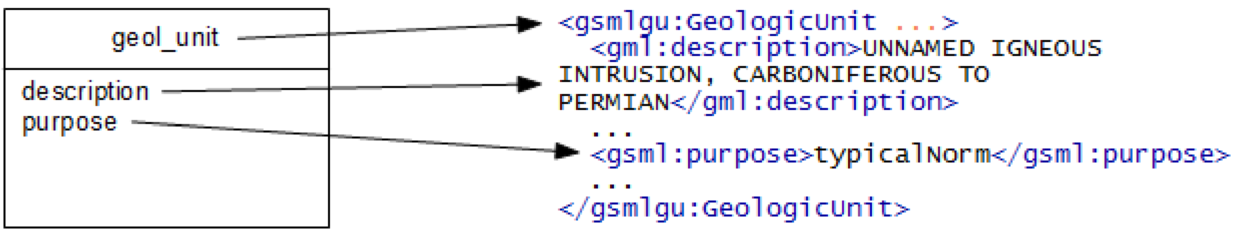
The guidance in this cookbook should also work with other versions of the software possibly with minor modifications. You should use GeoServer v2.7 or later to get support for WFS 2.0 features such as paging. v2.4.5 was the earliest version we have successfully used without significant bugs in the complex feature support. Specific GeoServer versions have specific requirements of the version of Java that they will work with. You should check http://docs.geoserver.org/stable/en/user/production/java.html#production-java for the current recommendations. For GeoServer 2.6 and 2.7, Java 7 (a.k.a. 1.7) is required. At the time of writing (March 2015) Java 8 has not been fully checked although it should work.

Overview

The text in this cookbook will assume you have your source data in tables in a relational database system. This is the most likely situation for data of any complexity but you should be able to adapt the details for other sources such as files etc.

You will need to study the data model for the INSPIRE theme for which you are supplying data. Having done this you will need to work out a mapping from your source data to appropriate parts of the INSPIRE theme model. There may be specific guidance for your INSPIRE theme on how to populate parts of the model (for example, there is a mapping cookbook for the Geology theme). You will then have the task of configuring your software to generate XML conformant to your INSPIRE theme schema from your source data. The structure of your source data may be similar to or quite different from the INSPIRE model and we can’t cover all possible situations but you will be able to make configuration changes in two places (i) in your underlying database and (ii) in the WFS software configuration mapping database contents to generated output. A number of constraints; administrative, performance, flexibility of the WFS software configuration and complexity will govern exactly how you do this but, as a general principle, it will usually be preferable to do as much in the database as possible to create source data matching INSPIRE output as closely as possible. GeoServer can do some quite powerful processing of the underlying data but this is often at the expense of performance and ability to query the data.

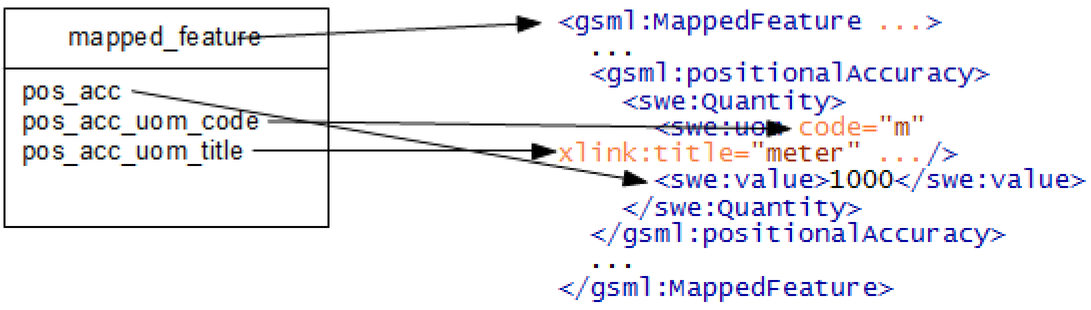
Normally you will have one main table for each feature type you are intending to serve. In a simple feature WFS each row will generate one feature and the values of the table columns will be the values contained in simple property values of the generated features (or spatial data columns generating GML geometry property values). The diagram below shows a table `geol_unit` which is mapped to the feature type `gsmlgu:GeologicUnit`. Two example text columns `description` and `purpose` are mapped directly to simple feature properties `gml:description` and `gsml:purpose` with their text content being put directly inside the property elements.



```
<gsmlgu:GeologicUnit ...>
  <gml:description>UNNAMED IGNEOUS
INTRUSION, CARBONIFEROUS TO
PERMIAN</gml:description>
  ...
  <gsml:purpose>typicalNorm</gsml:purpose>
  ...
</gsmlgu:GeologicUnit>
```

With complex features such as in the INSPIRE data specifications there are a number of ways in which the configuration can be more complex.

A feature property could be 1-1 but its value a complex type with attributes or nested element content whose values come from the table columns. In the below diagram the columns of the `mapped_feature` table are directly placed inside property elements or attribute values within a complex nested property structure.

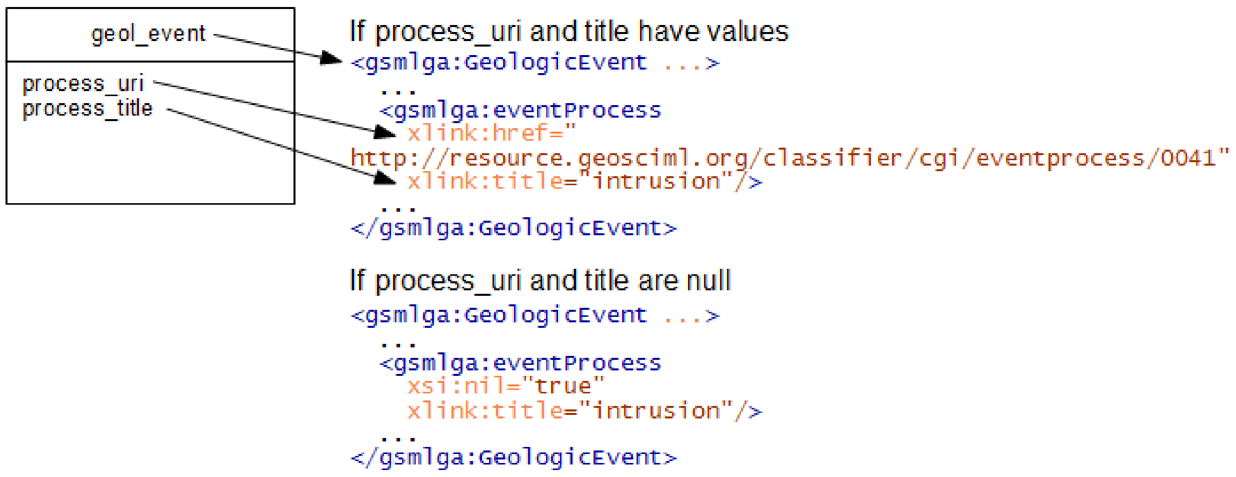


```
<gsml:MappedFeature ...>
  ...
  <gsml:positionalAccuracy>
    <swe:Quantity>
      <swe:uom code="m"
xlink:title="meter" .../>
      <swe:value>1000</swe:value>
    </swe:Quantity>
  </gsml:positionalAccuracy>
  ...
</gsml:MappedFeature>
```

Note

often attributes like the units of measure may be the same for all rows in your table and you may want to hard code a value such as “meter” in the service configuration rather than repeat the same values in every row of your database table.

The property values may be polymorphic having different content structure depending on the particular data under consideration. A simple example would be nillable properties where the output structure changes when the property has nil values.



If process_uri and title have values

```
<gsmlga:GeologicEvent ...>
  ...
  <gsmlga:eventProcess
    xlink:href="
http://resource.geosciml.org/classifier/cgi/eventprocess/0041"
    xlink:title="intrusion"/>
  ...
</gsmlga:GeologicEvent>
```

If process_uri and title are null

```
<gsmlga:GeologicEvent ...>
  ...
  <gsmlga:eventProcess
    xsi:nil="true"
    xlink:title="intrusion"/>
  ...
</gsmlga:GeologicEvent>
```

Other complexities include one to many, many to one or many to many relationships between features and their properties. In these cases you will normally have separate database tables for the features and their property values (which may be features in their own right).

Installation of Software

The software used here all has extensive documentation and support forums and mailing lists. Here we will just point you to the appropriate places to download the software and get installation instructions.

We assume:

- You have a basic familiarity with relational databases
- You are able to install applications such as PostGIS, Apache Tomcat, GeoServer etc. on a server with your chosen operating system using their project documentation.

Database

If you already have your data in a relational database system you will want to check the Working with Databases section of the GeoServer manual to see if your database is supported by GeoServer and follow the instructions for installation of any extensions that may be needed for this support. PostGIS support is built into the core GeoServer download.

If you want to try the example data or don't have a supported database system you should install PostGIS. The PostGIS Installation page contains instructions on how to do this for different operating systems. For the purposes of testing this cookbook setup we used the Enterprise DB Windows Installer which installs the base PostgreSQL database, has an option to install the PostGIS extension into this and also includes the pgAdmin graphical database administration tool.

You may use a database on the same machine as GeoServer or you can have it on a separate machine which is accessible over a network from your GeoServer machine.

GeoServer

GeoServer has extensive documentation which you should refer to in addition to this cookbook. References will be made to relevant parts rather than repeating too much of what is already there. There is also the geoserver-users mailing list.

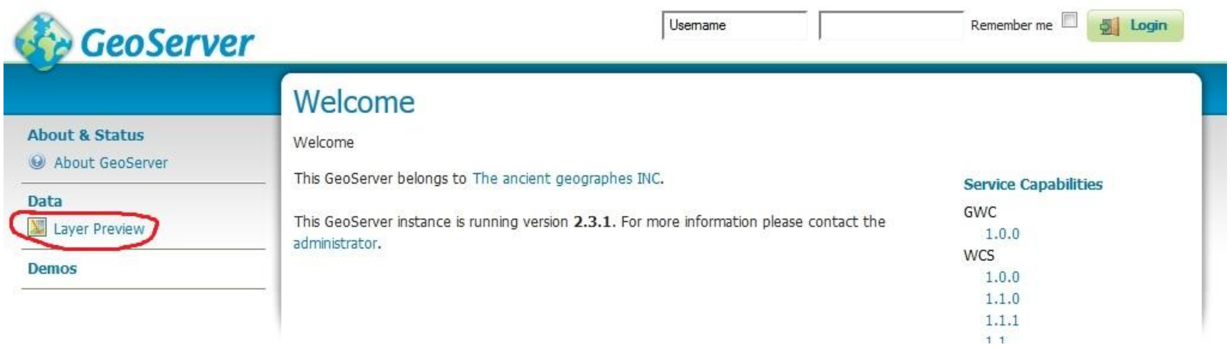
Assumptions

You will need to have Java installed on the machine on which you are going to install GeoServer. The GeoServer manual recommends Oracle JRE 7 for GeoServer 2.6 and 2.7 at the time of writing (March 2015). See http://docs.geoserver.org/stable/en/user/production/java.html#production-java for the current recommendations. If you want to try other versions of Java you may need to do extra work and be prepared to enter into technical discussions on the geoserver-users email list in order to get it working with these.

Ideally you will be familiar with deploying applications in a servlet container application such as Apache Tomcat. If not, you can use one of the all-in-one installers that packages GeoServer already deployed in the Jetty servlet container. Note that Tomcat and Jetty are the two most tested servlet containers used with GeoServer so, although you should be able to use others, there may be extra work involved and you may need to get advice from the geoserver-users email list.

Basic Installation

- Download and install GeoServer following whichever one of the installation paths in the GeoServer manual suits your situation best. If you already have a servlet container application such as Apache Tomcat set up or you are familiar with how to set one up then you will probably wish to download the web archive (WAR) and deploy that in your servlet container. If you are not comfortable with configuring a servlet container then you will probably wish to use one of the installer programs.
- Run GeoServer at least once to check the installation has worked. If, for example, you are testing in a local instance of Tomcat on your own machine with default settings you should be able to visit http://localhost:8080/geoserver and click on the *Layer Preview* link to check that the example services shipped with GeoServer work properly. You will have to modify the preceding URL appropriately if you have deployed GeoServer on a different machine or port.



Welcome

This GeoServer belongs to The ancient geographes INC.

This GeoServer instance is running version 2.3.1. For more information please contact the administrator.

App-schema Plugin Installation

- Download and install the app-schema plugin `geoserver-*-app-schema-plugin.zip` following the application schema installation instructions. Note the WFS service settings.
- Check you can restart GeoServer without any errors being thrown.

INSPIRE Plugin Installation

For an INSPIRE download service you will need to provide the extra INSPIRE mandated metadata in the WFS GetCapabilities response.

- Download and install the INSPIRE plugin `geoserver-*-inspire-plugin.zip` following the INSPIRE plugin installation instructions.
- Check that the WFS 1.1.0 and 2.0.0 GetCapabilities responses contain the `inspire_dls:ExtendedCapabilities` section.

Example Data and Configuration

This tutorial chapter will show you how to set up an INSPIRE Annex II Geology theme compliant GeoSciML v3.2 WFS using the Open Source GeoServer WFS and PostGIS spatial database with an example source dataset. It enables you to get some initial experience setting up a service. Your own services may be set up by customising it or you may use it to get some understanding of what is involved when setting up your own service.

The tutorial assumes you are familiar with representing complex features in GML applications.

Loading example PostGIS data

It is assumed that you have installed the PostGIS software and that you have a spatially enabled database (the default installation will create one called postgis). The following will all be working within this spatially enabled database.

Download the latest version of the database dump file wfscookbook.YYYY-MM-DD.backup from ftp://ftp.bgs.ac.uk/pubload/OneGeology/wfscookbook/. (Each version will have its release date in place of YYYY-MM-DD.)

Create a separate schema for the example data. The schema name is used in the commands below so, if you change it from `wfscookbook` you will need to change these accordingly

```
CREATE SCHEMA wfscookbook AUTHORIZATION postgres;
```

Import the data from the database dump file downloaded above. If you have installed the pgAdmin graphical administration tool you can use the menu option *Tools ‣ Restore...*. If you are using the command line you can use the command **pg_restore --host localhost --port 5432 --username "postgres" --dbname "postgis" --no-password --no-owner --no-privileges --no-tablespaces --schema wfscookbook --verbose wfscookbook.backup** (assuming you are using the default ‘postgis’ named database. You should create a database user with read-only access to these tables for the WFS software to use when accessing them. With more recent versions of PostgreSQL you can use the shorter syntax to grant access to all tables in the wfscookbook schema, with older versions you will have to grant access to each table individually

```
CREATE ROLE ows_reader LOGIN PASSWORD 'your_password'
 VALID UNTIL 'infinity';
COMMENT ON ROLE ows_reader
IS 'A role with read only access to data used in web services.';
```

```
grant usage on schema wfscookbook to ows_reader;
grant select on table geometry_columns to ows_reader;
grant select on table spatial_ref_sys to ows_reader;
```

Short syntax for versions of PostgreSQL (works at least as far back as v9.1)

```
grant select on all tables in schema wfscookbook to ows_reader;
```

Separate grants for each table for older versions of PostgreSQL (known to be required for v8.4)

```
grant select on table wfscookbook.mapped_feature to ows_reader;
grant select on table wfscookbook.geol_unit to ows_reader;
grant select on table wfscookbook.geol_unit_comp_part to ows_reader;
```

If you have problems with the above steps which are difficult to resolve you may find that setting `log_statement=all` in `postgresql.conf`, reloading the server and then monitoring the log file is helpful for debugging them.

Configuring GeoServer WFS

Download the latest version of the example configuration files in data_625k.YYYY-MM-DD.zip from ftp://ftp.bgs.ac.uk/pubload/OneGeology/wfscookbook/ and expand it to a spare location on your server. Copy the files from this expanded directory to the matching locations in your GeoServer data directory. The main configuration files are inside the `workspaces` directory. The contents of the `demo` directory are some example requests which are documented below. Overwrite any files that already exist, although there shouldn't be any in a fresh installation (apart from the containing directories). Note that the web interface does not yet support app-schema store for layer administration so you will have to edit these files directly when configuring your service.

Copy the latest version of the file app-schema.inspire.YYYY-MM-DD.properties from ftp://ftp.bgs.ac.uk/pubload/OneGeology/wfscookbook/ to `WEB-INF/classes/app-schema.properties`. (Don't forget to rename the file, removing the *.inspire* and datestamp parts.)

Edit the database connection parameters appropriately for your installation of PostgreSQL. If you want to use a JNDI data connection configured in your servlet container then you will also need to edit the appropriate places in the `datastore.xml` files described in a subsequent section. So it will be easier for initial testing just to enter the host, database, user and password parameters.

Perform any configuration required by your servlet container, and then start the servlet.

One configuration item you may need to change is to increase the memory available for Java. The method depends on how you have installed GeoServer but if you get `java.lang.OutOfMemoryError: Java heap space` errors with the request below you will need to increase the memory with a directive such as `-Xmx256M`. The details of tuning memory and other options of the Java Virtual Machine are complex and not dealt with in this cookbook. Some information is in the GeoServer User Manual under the Running in a Production Environment section.

If you have used the Windows Installer you can apply this by editing the file `C:\Program Files (x86)\GeoServer 2.4.5\wrapper\wrapper.conf` (The exact file location will depend on where you installed GeoServer and which version you are using.) Find the line `wrapper.java.maxmemory=128` and increase the value 128 (or whatever it happens to be) to something like 256.

If you are running in Apache Tomcat on Windows you can use the “Configure Tomcat” program that the Tomcat Windows installer provides. In the “Java” tab you can put a maximum memory value such as 256 (MB) in the Maximum Memory pool field.

- The first time GeoServer starts with the tutorial configuration, it will download all the schema (XSD) files it needs and store them in the `app-schema-cache` folder in the data directory. **You must be connected to the internet for this to work.**

Complex Feature Test requests

When GeoServer is running, test app-schema WFS in a web browser. You can query the feature types using these links. (Change `localhost:8080` in the examples below if you have deployed it at a different location.):

- http://localhost:8080/geoserver/wfs?service=WFS&version=2.0.0&request=GetFeature&typeNames=gsml:MappedFeature&count=25
- http://localhost:8080/geoserver/wfs?service=WFS&version=2.0.0&request=GetFeature&typeNames=gsmlgu:GeologicUnit&count=25

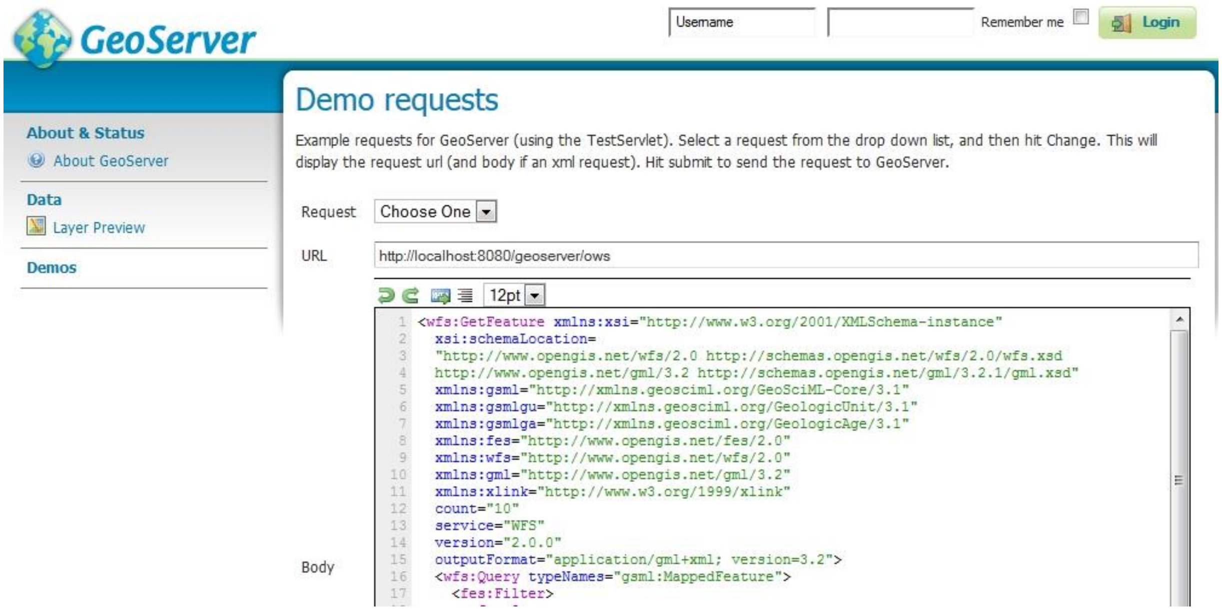
From GeoServer 2.7 there is also support for WFS 2.0 paged queries such as below. The performance has been tuned so that you should be able to retrieve a small subset range of features anywhere within a large set of features matching a particular query.

- http://localhost:8080/geoserver/wfs?service=WFS&version=2.0.0&request=GetFeature&typeNames=gsml:MappedFeature&count=10&startindex=9 - Get features 10 to 20 (startindex is 0 for first feature)

- http://localhost:8080/geoserver/wfs?service=WFS&version=2.0.0&i request=GetFeature&typeNames=gsml:MappedFeature&count=10&startindex=9999 - Get features 10000 to 10010

(At the time of writing the response is not fully WFS 2.0 compliant as the returned collection only returns a link to retrieve the previous set of results, not to the next set of results. However, a client that can formulate the paged queries should be able to work these out itself.)

You can also obtain WFS responses by using the Demo requests page in the GeoServer web interface. You can select some of the example age and lithology queries that are supplied with the example data directory from the request drop-down list or put `http://localhost:8080/geoserver/ows` into the service URL section and try pasting in your own queries. Some of the examples are reproduced below with their names as listed on the demo queries page.



Demo requests

Example requests for GeoServer (using the TestServlet). Select a request from the drop down list, and then hit Change. This will display the request url (and body if an xml request). Hit submit to send the request to GeoServer.

Request: Choose One

URL: http://localhost:8080/geoserver/ows

Body:

```
<wfs:GetFeature xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation=
  "http://www.opengis.net/wfs/2.0 http://schemas.opengis.net/wfs/2.0/wfs.xsd
  http://www.opengis.net/gml/3.2 http://schemas.opengis.net/gml/3.2.1/gml.xsd"
  xmlns:gsml="http://xmlns.geosciml.org/GeoSciML-Core/3.1"
  xmlns:gsmlgu="http://xmlns.geosciml.org/GeologicUnit/3.1"
  xmlns:gsmlga="http://xmlns.geosciml.org/GeologicAge/3.1"
  xmlns:fes="http://www.opengis.net/fes/2.0"
  xmlns:wfs="http://www.opengis.net/wfs/2.0"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  count="10"
  service="WFS"
  version="2.0.0"
  outputFormat="application/gml+xml; version=3.2">
  <wfs:Query typeNames="gsml:MappedFeature">
    <fes:Filter>
```

A query for mapped features showing outcrops of geologic units of a particular age

`WFS_getFeature1GInspireAge.xml`

```
<?xml version="1.0" encoding="UTF-8"?>
<wfs:GetFeature xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="http://www.opengis.net/wfs/2.0
http://schemas.opengis.net/wfs/2.0/wfs.xsd
  http://www.opengis.net/gml/3.2
http://schemas.opengis.net/gml/3.2.1/gml.xsd"
 xmlns:gsml="http://xmlns.geosciml.org/GeoSciML-Core/3.2"
 xmlns:gsmlgu="http://xmlns.geosciml.org/GeologicUnit/3.2"
 xmlns:gsmlga="http://xmlns.geosciml.org/GeologicAge/3.2"
 xmlns:fes="http://www.opengis.net/fes/2.0"
 xmlns:wfs="http://www.opengis.net/wfs/2.0"
 xmlns:gml="http://www.opengis.net/gml/3.2"
 xmlns:xlink="http://www.w3.org/1999/xlink" count="10" service="WFS"
 version="2.0.0" outputFormat="application/gml+xml; version=3.2">
 <wfs:Query typeNames="gsml:MappedFeature">
  <fes:Filter>
   <fes:Or>
    <fes:PropertyIsEqualTo>

<fes:ValueReference>gsml:specification/gsmlgu:GeologicUnit/gsml:relatedFeat
ure/gsmlga:GeologicHistory/gsml:relatedFeature/gsmlga:GeologicEvent/gsmlga:
youngerNamedAge/@xlink:href</fes:ValueReference>

<fes:Literal>http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/lo
werDevonian</fes:Literal>
    </fes:PropertyIsEqualTo>
    <fes:PropertyIsEqualTo>

<fes:ValueReference>gsml:specification/gsmlgu:GeologicUnit/gsml:relatedFeat
ure/gsmlga:GeologicHistory/gsml:relatedFeature/gsmlga:GeologicEvent/gsmlga:
youngerNamedAge/@xlink:href</fes:ValueReference>

<fes:Literal>http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/em
sian</fes:Literal>
    </fes:PropertyIsEqualTo>
    <fes:PropertyIsEqualTo>

<fes:ValueReference>gsml:specification/gsmlgu:GeologicUnit/gsml:relatedFeat
ure/gsmlga:GeologicHistory/gsml:relatedFeature/gsmlga:GeologicEvent/gsmlga:
youngerNamedAge/@xlink:href</fes:ValueReference>

<fes:Literal>http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/lo
chkovian</fes:Literal>
    </fes:PropertyIsEqualTo>
    <fes:PropertyIsEqualTo>

<fes:ValueReference>gsml:specification/gsmlgu:GeologicUnit/gsml:relatedFeat
ure/gsmlga:GeologicHistory/gsml:relatedFeature/gsmlga:GeologicEvent/gsmlga:
youngerNamedAge/@xlink:href</fes:ValueReference>

<fes:Literal>http://inspire.ec.europa.eu/codelist/GeochronologicEraValue/pr
agian</fes:Literal>
    </fes:PropertyIsEqualTo>
   </fes:Or>
  </fes:Filter>
 </wfs:Query>
</wfs:GetFeature>
```

A OneGeology query for mapped features showing outcrops of geological units with particular lithologies

`WFS_getFeature1GInspireLith.xml`

```xml
<?xml version="1.0" encoding="UTF-8"?>
<wfs:GetFeature xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation=
  "http://www.opengis.net/wfs/2.0
   http://schemas.opengis.net/wfs/2.0/wfs.xsd
  http://www.opengis.net/gml/3.2
   http://schemas.opengis.net/gml/3.2.1/gml.xsd"
 xmlns:gsml="http://xmlns.geosciml.org/GeoSciML-Core/3.2"
 xmlns:gsmlgu="http://xmlns.geosciml.org/GeologicUnit/3.2"
 xmlns:gsmlga="http://xmlns.geosciml.org/GeologicAge/3.2"
 xmlns:fes="http://www.opengis.net/fes/2.0"
 xmlns:wfs="http://www.opengis.net/wfs/2.0"
 xmlns:gml="http://www.opengis.net/gml/3.2"
 xmlns:xlink="http://www.w3.org/1999/xlink" count="10" service="WFS"
 version="2.0.0" outputFormat="application/gml+xml; version=3.2">
 <wfs:Query typeNames="gsml:MappedFeature">
  <fes:Filter>
   <fes:Or>
    <fes:PropertyIsEqualTo>

<fes:ValueReference>gsml:specification/gsmlgu:GeologicUnit/gsmlgu:compositi
on/gsmlgu:CompositionPart/gsmlgu:material/gsmlem:RockMaterial/gsmlem:lithol
ogy/@xlink:href</fes:ValueReference>

<fes:Literal>http://inspire.ec.europa.eu/codelist/LithologyValue/limestone<
/fes:Literal>
    </fes:PropertyIsEqualTo>
    <fes:PropertyIsEqualTo>

<fes:ValueReference>gsml:specification/gsmlgu:GeologicUnit/gsmlgu:compositi
on/gsmlgu:CompositionPart/gsmlgu:material/gsmlem:RockMaterial/gsmlem:lithol
ogy/@xlink:href</fes:ValueReference>

<fes:Literal>http://inspire.ec.europa.eu/codelist/LithologyValue/chalk</fes
:Literal>
    </fes:PropertyIsEqualTo>
    <fes:PropertyIsEqualTo>

<fes:ValueReference>gsml:specification/gsmlgu:GeologicUnit/gsmlgu:compositi
on/gsmlgu:CompositionPart/gsmlgu:material/gsmlem:RockMaterial/gsmlem:lithol
ogy/@xlink:href</fes:ValueReference>

<fes:Literal>http://inspire.ec.europa.eu/codelist/LithologyValue/travertine
</fes:Literal>
    </fes:PropertyIsEqualTo>
   </fes:Or>
  </fes:Filter>
 </wfs:Query>
</wfs:GetFeature>
```

A bounding box query to retrieve mapped features with shapes that overlap the specified bounding box

`WFS_getFeature1GBBOX.xml`

```
<?xml version="1.0" encoding="UTF-8"?>
<GetFeature xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="http://www.opengis.net/wfs/2.0
   http://schemas.opengis.net/wfs/2.0/wfs.xsd
  http://www.opengis.net/gml/3.2
   http://schemas.opengis.net/gml/3.2.1/gml.xsd"
 xmlns="http://www.opengis.net/wfs/2.0"
 xmlns:gsml="http://xmlns.geosciml.org/GeoSciML-Core/3.2"
 xmlns:fes="http://www.opengis.net/fes/2.0"
 xmlns:xlink="http://www.w3.org/1999/xlink"
 xmlns:gml="http://www.opengis.net/gml/3.2" version="2.0.0" service="WFS"
 count="100">
 <Query typeNames="gsml:MappedFeature"
srsName="urn:ogc:def:crs:EPSG::4326">
  <fes:Filter>
   <fes:BBOX>
    <fes:ValueReference>gsml:shape</fes:ValueReference>
    <gml:Envelope srsName="urn:ogc:def:crs:EPSG::4326">
     <gml:lowerCorner>56.08643859340388 -
4.0004826736994445</gml:lowerCorner>
     <gml:upperCorner>56.165510496146474 -
3.8381055732299343</gml:upperCorner>
    </gml:Envelope>
   </fes:BBOX>
  </fes:Filter>
 </Query>
</GetFeature>
```

Note

App-schema cannot be configured using the web interface, you will need to edit the configuration files directly. You will see the configured workspaces and stores appear in the web interface but not the layers (features). The properties that can be edited in the web interface are very limited.

INSPIRE Extended Capabilities

For an INSPIRE download service you will need to provide the extra INSPIRE mandated metadata in the WFS GetCapabilities response.

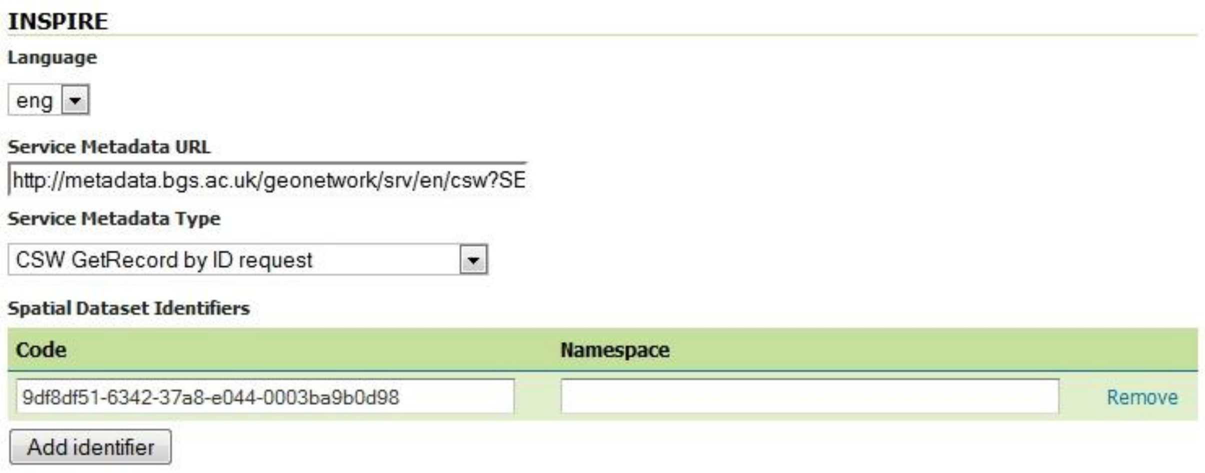
As described in the plugin documentation you should find a section in the WFS service settings of the administration interface where you can choose a language, enter a service metadata URL and type and add one or more spatial dataset identifiers. For guidance on what to enter in these settings see the Technical Guidance for the implementation of INSPIRE Download Services.

Check that the GetCapabilities responses contain your edited values.

Note

The plugin GUI only allows you to select one of two values for the Service Metadata Type: “Online ISO 19139 ServiceMetadata document” sets the MIME type to `application/vnd.iso.19139+xml`, “CSW GetRecord by ID request” sets the MIME type to `application/vnd.ogc.csw.GetRecordByIdResponse_xml`. If neither of these correspond to the actual MIME type of your metadata resource you will need to work around this by manually editing the wfs.xml file inside the GeoServer data directory as documented in issue GEOS-5157 . On the other hand it isn’t clear whether any client would actually use this information.

For example, entering the values shown in the screenshot below would result in a GetCapabilities response with the ExtendedCapabilities section shown below it.


INSPIRE

Language: eng

Service Metadata URL: http://metadata.bgs.ac.uk/geonetwork/srv/en/csw?SE

Service Metadata Type: CSW GetRecord by ID request

Spatial Dataset Identifiers

Code	Namespace	
9df8df51-6342-37a8-e044-0003ba9b0d98		Remove

```
<ows:ExtendedCapabilities>
 <inspire_dls:ExtendedCapabilities>
  <inspire_common:MetadataUrl
   xsi:type="inspire_common:resourceLocatorType">
   <inspire_common:URL>
```

```
http://metadata.bgs.ac.uk/geonetwork/srv/en/csw?SERVICE=CSW&amp;REQUEST=Get
RecordById&amp;elementSetName=full&amp;OutputSchema=http://www.isotc211.org
/2005/gmd&amp;ID=7822e848-822d-45a5-8584-56d352fd2170&amp;
   </inspire_common:URL>
   <inspire_common:MediaType>
    application/vnd.ogc.csw.GetRecordByIdResponse_xml
   </inspire_common:MediaType>
  </inspire_common:MetadataUrl>
  <inspire_common:SupportedLanguages
   xsi:type="inspire_common:supportedLanguagesType">
   <inspire_common:DefaultLanguage>
    <inspire_common:Language>eng</inspire_common:Language>
   </inspire_common:DefaultLanguage>
  </inspire_common:SupportedLanguages>
  <inspire_common:ResponseLanguage>
   <inspire_common:Language>eng</inspire_common:Language>
  </inspire_common:ResponseLanguage>
  <inspire_dls:SpatialDataSetIdentifier>
   <inspire_common:Code>
    9df8df51-6342-37a8-e044-0003ba9b0d98
   </inspire_common:Code>
  </inspire_dls:SpatialDataSetIdentifier>
 </inspire_dls:ExtendedCapabilities>
</ows:ExtendedCapabilities>
```

INSPIRE Pre-defined Dataset Download

If you decide that you are going to provide your INSPIRE pre-defined dataset download service direct from your WFS rather than pre-generating the full datasets and just providing links to the download through ATOM then you can do this by creating a Stored Query such as the one below. The example data directory includes the CreateStoredQuery command in the Demos examples.

```
<?xml version="1.0" encoding="UTF-8"?>
<wfs:CreateStoredQuery
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation=
  "http://www.opengis.net/wfs/2.0
   http://schemas.opengis.net/wfs/2.0/wfs.xsd"
 xmlns:gsml="http://xmlns.geosciml.org/GeoSciML-Core/3.2"
 xmlns:fes="http://www.opengis.org/fes/2.0"
 xmlns:wfs="http://www.opengis.net/wfs/2.0"
 xmlns:gml="http://www.opengis.net/gml/3.2"
 xmlns:xsd="http://www.w3.org/2001/XMLSchema"
 service="WFS"
 version="2.0.0">
 <wfs:StoredQueryDefinition
```

```
  id='http://inspire.ec.europa.eu/operation/download/GetSpatialDataSet'>
  <wfs:Parameter name='CRS' type='xsd:string'/>
  <wfs:Parameter name='DataSetIdCode' type='xsd:string'/>
  <wfs:Parameter name='DataSetIdNamespace' type='xsd:string'/>
  <wfs:Parameter name='Language' type='xsd:string'/>
  <wfs:Parameter name="count" type="xsd:integer"></wfs:Parameter>
  <wfs:QueryExpressionText
   returnFeatureTypes='gsml:MappedFeature'
   language='urn:ogc:def:queryLanguage:OGC-WFS::WFS_QueryExpression'
   isPrivate='false'>
   <wfs:Query typeNames='gsml:MappedFeature' srsName="${CRS}">
   </wfs:Query>
  </wfs:QueryExpressionText>
 </wfs:StoredQueryDefinition>
</wfs:CreateStoredQuery>
```

This can then be invoked with a request like:

http://localhost:8080/geoserver/ows?service=WFS&version=2.0.0&request=GetFeature&
storedquery_id=http://inspire.ec.europa.eu/operation/download/GetSpatialDataSet&
DataSetIdCode=13603180&DataSetIdNamespace=http://data.bgs.ac.uk/id/dataHolding/&
CRS=urn:ogc:def:crs:EPSG::4326&Language=eng&count=20&

Complex Feature Configuration

This part of the cookbook describes selected parts of the configuration files from the example set. This should give you a good overview of the configuration files needed and what the different parts do. They produce valid GeoSciML v3.2 and INSPIRE Annex II Geology theme features and so, hopefully will provide a good starting point to adapt for your own services. However, the mapping for your service from your source data may require some features not used in the example. For these cases you should refer to the Working with Application Schemas section of the GeoServer manual which contains comprehensive documentation on the different kinds of mapping from source to output XML that are possible. (It uses GeoSciML v2 based examples.)

Because a single `gsmlgu:GeologicUnit` can be observed at several distinct locations on the Earth's surface, several `gsml:MappedFeature` features may point via their gsml:specification property to the same gsmlgu:GeologicUnit.

```
<?xml version="1.0" encoding="UTF-8"?>
<wfs:FeatureCollection>
 <!-- ... -->
 <wfs:member>
  <gsml:MappedFeature gml:id="bgsn_digmap20111213000014089_625k">
   <gml:boundedBy>
    <gml:Envelope srsDimension="2" srsName="urn:ogc:def:crs:EPSG::27700">
     <gml:lowerCorner>276992.0639999996 693085.1679999997</gml:lowerCorner>
     <gml:upperCorner>277851.8129999998 694098.9850000012</gml:upperCorner>
    </gml:Envelope>
   </gml:boundedBy>
   <!-- ... -->
   <gsml:shape>
    <gml:MultiSurface gml:id="gsml.shape.bgsn_digmap20111213000014089_625k"
     srsDimension="2" srsName="urn:ogc:def:crs:EPSG::27700">
     <gml:surfaceMember>
      <gml:Polygon gml:id="gsml.shape.bgsn_digmap20111213000014089_625k.1"
       srsDimension="2">
       <gml:exterior>
        <gml:LinearRing>
         <gml:posList>277851.8129999998 693998.524000001 277823.5400000005
          693969.0079999991 277654.64600000007 693696.0569999999
          277576.6949999996 693449.1019999995 277550.7119999993
          693280.1319999992 277537.7199999998 693085.1679999997
          276992.0639999996 693202.1460000003 277018.0469999999
          693566.081000001 277134.9740000011 693839.0320000002
          277251.8999999991 694098.9850000012 277851.8129999998
          693998.524000001</gml:posList>
        </gml:LinearRing>
       </gml:exterior>
      </gml:Polygon>
     </gml:surfaceMember>
    </gml:MultiSurface>
   </gsml:shape>
   <gsml:specification>
    <gsmlgu:GeologicUnit gml:id="SYG-CYCS">
     <gml:description>STRATHCLYDE GROUP - SEDIMENTARY ROCK CYCLES,
      STRATHCLYDE GROUP TYPE</gml:description>
     <!-- ... -->
    </gsmlgu:GeologicUnit>
   </gsml:specification>
   <gsml:metadata xsi:nil="true" gco:nilReason="unpopulated"/>
  </gsml:MappedFeature>
 </wfs:member>
 <wfs:member>
  <gsml:MappedFeature gml:id="bgsn_digmap20111213000015084_625k">
   <gml:boundedBy>
    <gml:Envelope srsDimension="2" srsName="urn:ogc:def:crs:EPSG::27700">
     <gml:lowerCorner>280207.97299999953
694960.4289999997</gml:lowerCorner>
     <gml:upperCorner>281182.8969999998 696298.8440000011</gml:upperCorner>
    </gml:Envelope>
   </gml:boundedBy>
   <!-- ... -->
   <gsml:shape>
    <!-- ... -->
   </gsml:shape>
   <gsml:specification>
    <gsmlgu:GeologicUnit gml:id="CKN-CYCC">
```

```
     <gml:description>CLACKMANNAN GROUP - SEDIMENTARY ROCK CYCLES,
      CLACKMANNAN GROUP TYPE</gml:description>
     <!-- ... -->
    </gsmlgu:GeologicUnit>
   </gsml:specification>
   <gsml:metadata xsi:nil="true" gco:nilReason="unpopulated"/>
  </gsml:MappedFeature>
 </wfs:member>
 <wfs:member>
  <gsml:MappedFeature gml:id="bgsn_digmap20111213000016262_625k">
   <gml:boundedBy>
    <gml:Envelope srsDimension="2" srsName="urn:ogc:def:crs:EPSG::27700">
     <gml:lowerCorner>273924.59599999984
687632.7340000008</gml:lowerCorner>
     <gml:upperCorner>276292.57699999935
690639.8490000011</gml:upperCorner>
    </gml:Envelope>
   </gml:boundedBy>
   <!-- ... -->
   <gsml:shape>
    <!-- ... -->
   </gsml:shape>
   <gsml:specification xlink:href="#SYG-CYCS"/>
   <gsml:metadata xsi:nil="true" gco:nilReason="unpopulated"/>
  </gsml:MappedFeature>
 </wfs:member>
 <wfs:member>
  <gsml:MappedFeature gml:id="bgsn_digmap20111213000016481_625k">
   <gml:boundedBy>
    <gml:Envelope srsDimension="2" srsName="urn:ogc:def:crs:EPSG::27700">
     <gml:lowerCorner>275822.8000000001 690776.9270000004</gml:lowerCorner>
     <gml:upperCorner>277358.40499999985
693332.1230000001</gml:upperCorner>
    </gml:Envelope>
   </gml:boundedBy>
    <!-- ... -->
   <gsml:shape>
    <!-- ... -->
   </gsml:shape>
   <gsml:specification xlink:href="#SYG-CYCS"/>
   <gsml:metadata xsi:nil="true" gco:nilReason="unpopulated"/>
  </gsml:MappedFeature>
 </wfs:member>
 <wfs:member>
  <gsml:MappedFeature gml:id="bgsn_digmap20111213000023007_625k">
   <gml:boundedBy>
    <gml:Envelope srsDimension="2" srsName="urn:ogc:def:crs:EPSG::27700">
     <gml:lowerCorner>247904.646999999 664467.5469999999</gml:lowerCorner>
     <gml:upperCorner>289537.88300000026
697616.4020000009</gml:upperCorner>
    </gml:Envelope>
   </gml:boundedBy>
    <!-- ... -->
   <gsml:shape>
    <!-- ... -->
   </gsml:shape>
   <gsml:specification xlink:href="#CKN-CYCC"/>
   <gsml:metadata xsi:nil="true" gco:nilReason="unpopulated"/>
  </gsml:MappedFeature>
 </wfs:member>
</wfs:FeatureCollection>
```

app-schema.properties

This file (in the `WEB-INF/classes` directory) is not strictly required but is very useful for storing certain configuration parameters that will be re-used in different parts of the other configuration files and for storing configuration parameters like database usernames and passwords outside of the GeoServer data directory so that the latter can be copied freely. The Property Interpolation section of the GeoServer manual contains more information on how properties can be set and used in other parts of the configuration files. In the reference configuration files this contains database connection parameters, some commonly used URI values and the setting to turn on joining. In fact with current versions of GeoServer (certainly pre-dating v2.4.5) joining is turned on by default and is the recommended setting. There may be some limited situations as described in the joining documentation, however, when you need to switch this off.

Data directory

The example configuration files can be copied into an existing GeoServer data directory so that you can get a working service to try out up and running as quickly as possible. The parts relevant for configuration of a complex feature WFS are contained in the `workspaces` directory described in the next section. Other parts of your service configuration like service metadata, security etc. can be set up using the web interface. Thus, when you come to set up your own service, you will probably start with the default GeoServer data directory, configure service metadata etc. in the web interface, and copy the complex feature configuration files from the reference `data/workspaces` directory to your own data directory for editing there.

Workspace layout

The files for configuring complex feature output are contained in the `data/workspaces` directory. Inside this directory there is a sub-directory for each namespace of features you will be serving and other namespaces that these features may use somewhere in their content. In the example this includes:

```
workspaces
├── base
├── gco
├── ge
├── gmd
├── gml
├── gsml
├── gsmlem
├── gsmlga
├── gsmlgs
├── gsmlgu
├── gsmlu
├── swe
└── xlink
```

These cover all the namespaces used by features in the example data set so, if you are producing a Geology theme service, it is likely that you will use the same ones. However, for other themes you will need to create similar directories for the namespaces used in those themes and, even for the geology theme, you may need to add others if you use additional GeoSciML packages such as boreholes.

GeoSciML is being used as the main example in this cookbook as it is a complex schema that should illustrate most of the kinds of mapping that may be needed for all the INSPIRE schemas. However, there are also mapping files for the simpler INSPIRE Geology theme schema in the `ge` and `base` directories which have, for example, mappings for the common inspireId property.

The example configuration defines 2 feature types to be served by the WFS. Their configurations are stored in data store sub-directories of the appropriate namespace directory and are named according to the pattern `prefix_Feature` for a feature `prefix::Feature`:

```
workspaces
├── gco
├── gmd
├── gml
├── gsml
│   └── gsml_MappedFeature
├── gsmlem
├── gsmlga
├── gsmlgs
├── gsmlgu
│   └── gsmlgu_GeologicUnit
├── gsmlu
├── swe
└── xlink
```

Each of the data store directories contains files similar to the following example for `gsml::MappedFeature`:

```
gsml_MappedFeature
├── AppSchemaDataAccess.xsd
├── datastore.xml
├── gsml_MappedFeature
│   └── featuretype.xml
└── gsml_MappedFeature.xml
```

The `AppSchemaDataAccess.xsd` file isn't used for the configuration, it is just provided as a convenience when you are editing a mapping file such as `gsml_MappedFeature.xml` to allow a validating XML editor to give you hints that you have the structure of the file correct. The following sections will describe the `datastore.xml` file which creates an application schema data store and specifies the mapping file described in the section after which contains the substantive portion of the configuration mapping source data fields to output in the complex feature types.

datastore.xml

Each data store configuration file `datastore.xml` specifies the location of a mapping file and triggers its loading as an app-schema data source. This file should not be confused with the source data store, which is specified inside the mapping file.

For `gsml:MappedFeature` the file is `workspaces/gsml/gsml_MappedFeature/datastore.xml`

```
<dataStore>
 <id>gsml_MappedFeature_datastore</id>
 <name>gsml_MappedFeature</name>
 <enabled>true</enabled>
 <workspace>
  <id>gsml_workspace</id>
 </workspace>
 <connectionParameters>
  <entry key="namespace">http://xmlns.geosciml.org/GeoSciML-
Core/3.2</entry>
  <entry
key="url">file:workspaces/gsml/gsml_MappedFeature/gsml_MappedFeature.xml</e
ntry>
  <entry key="dbtype">app-schema</entry>
 </connectionParameters>
</dataStore>
```

Note

Ensure that there is no whitespace inside an `entry` element.

For other feature types the pattern is the same where you replace the names and ids appropriately and change the namespace if necessary. The url entry is a file: URI pointing to the location of the mapping file relative to the GeoServer data directory. The dbtype entry will always be app-schema to define complex feature types.

Mapping files

Configuration of app-schema feature types is performed in mapping files e.g.

- `workspaces/gsmlgu/gsmlgu_GeologicUnit/gsmlgu_GeologicUnit.xml`
- `workspaces/gsml/gsml_MappedFeature/gsml_MappedFeature.xml`

Namespaces

Each mapping file contains namespace prefix definitions. The below extract is from `gsml_MappedFeature.xml`

```
<namespaces>
 <Namespace>
  <prefix>gml</prefix>
  <uri>http://www.opengis.net/gml/3.2</uri>
 </Namespace>
 <Namespace>
  <prefix>gsml</prefix>
  <uri>http://xmlns.geosciml.org/GeoSciML-Core/3.2</uri>
 </Namespace>
 <Namespace>
  <prefix>gsmlgu</prefix>
  <uri>http://xmlns.geosciml.org/GeologicUnit/3.2</uri>
 </Namespace>
 <Namespace>
  <prefix>gsmlgs</prefix>
  <uri>http://xmlns.geosciml.org/GeologicStructure/3.2</uri>
 </Namespace>
 <Namespace>
  <prefix>swe</prefix>
  <uri>http://www.opengis.net/swe/2.0</uri>
 </Namespace>
 <Namespace>
  <prefix>gmd</prefix>
  <uri>http://www.isotc211.org/2005/gmd</uri>
 </Namespace>
 <Namespace>
  <prefix>gco</prefix>
  <uri>http://www.isotc211.org/2005/gco</uri>
 </Namespace>
 <Namespace>
  <prefix>xlink</prefix>
  <uri>http://www.w3.org/1999/xlink</uri>
 </Namespace>
 <Namespace>
  <prefix>xsi</prefix>
  <uri>http://www.w3.org/2001/XMLSchema-instance</uri>
 </Namespace>
</namespaces>
```

Only those namespace prefixes used in the mapping file need to be declared although you may find it easier just to put all the namespaces used by your target schema in all of them.

Source data store

The data for this tutorial is contained in the PostGIS database set up in the previous section.

For this example, each feature type uses an identical source data store configuration. The `Parameter` elements contain values for various database connection parameters. Here we are using property interpolation so that these don't have to get changed in each mapping file if they change and so that the configuration files can be shared without exposing password information. The values of the interpolated variables (which have the form `${name}`) should be defined in the `WEB-INF/classes/app-schema.properties` file. An example which you can use as a template to fill in with your own values is at ftp://ftp.bgs.ac.uk/pubload/OneGeology/wfscookbook/app-schema.inspire.properties. (The example service can be configured to use INSPIRE vocabulary values or IUGS-CGI vocabulary values by setting appropriate variables in this file.)

```
<sourceDataStores>
 <DataStore>
  <id>datastore</id>
  <parameters>
   <Parameter>
    <name>dbtype</name><value>${cgi.dbtype}</value>
   </Parameter>
   <!--
   <Parameter>
    <name>jndiReferenceName</name><value>${cgi.jndi}</value>
   </Parameter>
   -->
   <Parameter>
    <name>host</name><value>${cgi.host}</value>
   </Parameter>
   <Parameter>
```

```
    <name>port</name><value>${cgi.port}</value>
   </Parameter>
   <Parameter>
    <name>database</name><value>${cgi.database}</value>
   </Parameter>
   <Parameter>
    <name>user</name><value>${cgi.user}</value>
   </Parameter>
   <Parameter>
    <name>passwd</name><value>${cgi.passwd}</value>
   </Parameter>
   <Parameter>
    <name>schema</name><value>${cgi.schema}</value>
   </Parameter>
   <Parameter>
    <name>Expose primary keys</name><value>true</value>
   </Parameter>
  </parameters>
 </DataStore>
</sourceDataStores>
```

See http://docs.geoserver.org/stable/en/user/data/app-schema/data-stores.html for a description of how to use other types of data store.

Target types

The XML Schemas which are required to define a feature type and its properties are specified in the `targetTypes` section. The type of the output feature is defined in `targetElement` in the `typeMapping` section. The below example is from `gsml_MappedFeature.xml`

```
<targetTypes>
 <FeatureType>
  <schemaUri>
   http://schemas.geosciml.org/geologicunit/3.2/geologicUnit.xsd
  </schemaUri>
 </FeatureType>
 <FeatureType>
  <schemaUri>
   http://schemas.geosciml.org/geologicstructure/3.2/geologicStructure.xsd
  </schemaUri>
 </FeatureType>
</targetTypes>
```

In this case the schema is published, but because the OASIS XML Catalog is used for schema resolution, a private or modified schema in the catalog can be used if desired.

Mappings

The `typeMappings` element begins with configuration elements. From `gsml_MappedFeature.xml`

```
<typeMappings>
 <FeatureTypeMapping>
  <sourceDataStore>datastore</sourceDataStore>
  <sourceType>mapped_feature</sourceType>
  <targetElement>gsml:MappedFeature</targetElement>
```

- The mapping starts with `sourceDataStore`, which gives the arbitrary identifier used above to name the source of the input data in the `sourceDataStores` section.
- `sourceType` gives the name of the source simple feature type. In this case it is the simple feature type `gsml_mappedfeature`, sourced from the table of the same name in the PostGIS database set up in the previous chapter.
- When working with databases `sourceType` is the name of a table or view. Database identifiers must be lowercase for PostGIS or uppercase for Oracle Spatial.
- `targetElement` is the name of the output complex feature type.

gml:id mapping

The first mapping sets the `gml:id` to be the feature id specified in the source property file

```
<AttributeMapping>
 <targetAttribute>gsml:MappedFeature</targetAttribute>
 <idExpression><OCQL>uuid</OCQL></idExpression>
</AttributeMapping>
```

- `targetAttribute` is the XPath to the element for which the mapping applies, in this case, the top-level feature type.
- `idExpression` is a special form that can only be used to set the `gml:id` on a feature. In the tutorial database we have a column `uuid` suitable for use as a `gml:id` attribute value. If your database doesn't have such a column you may be able to use the special function `getId()` here instead. This will synthesise an id from the table or view name, a dot ".", and the primary key of the table. If this is not desirable, any other field or CQL expression can be used, if it evaluates to an NCName.

The above would generate output like

```
<gsml:MappedFeature gml:id="bgsn_digmap20111213000014089_625k">
...
```

inspireId mapping

A common property that many INSPIRE themes will have is an inspireId. An example mapping for this property is contained in the `workspaces/ge/ge_GeologicUnit/ge_GeologicUnit.xml` file. The relevant section is reproduced below

```
<AttributeMapping>

<targetAttribute>ge:inspireId/base:Identifier/base:localId</targetAttribute
>
 <sourceExpression><OCQL>bgs_namedrockunit_uri</OCQL></sourceExpression>
</AttributeMapping>
<AttributeMapping>

<targetAttribute>ge:inspireId/base:Identifier/base:namespace</targetAttribu
te>
 <sourceExpression><OCQL>'http://data.bgs.ac.uk/'</OCQL></sourceExpression>
</AttributeMapping>
```

Ordinary mapping

Most mappings consist of a target and source. Here is a simple property with a text value from `gsmlgu_GeologicUnit.xml`

```
<AttributeMapping>
 <targetAttribute>gml:description</targetAttribute>
 <sourceExpression>
  <OCQL>description</OCQL>
 </sourceExpression>
</AttributeMapping>
```

- In this case, the value of `gml:description` is just the value of the `description` column in the `geol_unit` table.
- For a database, the field name is the name of the column (the table/view is set in `sourceType` above). Database identifiers must be lowercase for PostGIS or uppercase for Oracle Spatial.
- CQL expressions can be used to calculate content. Use caution because queries on CQL-calculated values prevent the construction of efficient SQL queries.
- Source expressions can be CQL literals, which are single-quoted.

The above would generate output like

```
<gml:description>STRATHCLYDE GROUP - SEDIMENTARY ROCK CYCLES,
 STRATHCLYDE GROUP TYPE</gml:description>
```

Client properties

In addition to the element content, a mapping can set values of XML attributes on property elements. These are called “client properties” in GeoServer terminology. Here is one from `gsmlgu_CompositionPart.xml`

```
<AttributeMapping>

<targetAttribute>gsmlgu:material/gsmlem:RockMaterial/gsmlem:lithology</targ
etAttribute>

<ClientProperty><name>xlink:href</name><value>${dic.col.prefix}lithology_ur
i</value></ClientProperty>

<ClientProperty><name>xlink:title</name><value>${dic.col.prefix}lithology_l
abel</value></ClientProperty>
</AttributeMapping>
```

- This mapping leaves the content of the `gsmlem:lithology` element empty but sets an `xlink:href` attribute to the value of the `${dic.col.prefix}lithology_uri` column and an `xlink:title` attribute to the value of the `${dic.col.prefix}lithology_label` column. Note that in this case the property attributes being set are nested two levels below the parent `gsmlgu:CompositionPart`. Note also that we are using property interpolation here to select the exact name of the database column to be used based on a variable set in the app-schema.properties file. This was useful so the example dataset can be configured to use vocabularies from different authorities but is less likely to be useful for your services.
- As can be seen from this example, multiple `ClientProperty` mappings can be set.

This would generate output like

```
<gsmlem:lithology
 xlink:href=
  "http://inspire.ec.europa.eu/codelist/LithologyValue/clasticMudstone"
 xlink:title="Mudstone"/>
```

Feature chaining

In feature chaining, one feature type is used as a property of an enclosing feature type, by value or by reference. The following examples show the parts of the `gsml_MappedFeature.xml` and `gsmlgu_GeologicUnit.xml` mapping files that put the gsmlgu:GeologicFeature elements inside the gsml:specification properties of gsml:MappedFeature elements.

In `gsml_MappedFeature.xml`

```
<AttributeMapping>
 <targetAttribute>gsml:specification</targetAttribute>
 <sourceExpression>
  <OCQL>lex_rcs</OCQL>
  <linkElement>gsmlgu:GeologicUnit</linkElement>
  <linkField>FEATURE_LINK</linkField>
 </sourceExpression>
</AttributeMapping>
```

In `gsmlgu_GeologicUnit.xml`

```
<AttributeMapping>
 <targetAttribute>FEATURE_LINK</targetAttribute>
 <sourceExpression><OCQL>lex_rcs</OCQL></sourceExpression>
</AttributeMapping>
```

- In this case from the mapping for `gsml:MappedFeature`, we specify a mapping for its `gsml:specification` property.
- The `linkElement` specifies which feature (or other complex type) should be used as the value of the property.
- The `link_specification` field of the source `gsml_MappedFeature` simple feature is use as the “foreign key”, which maps to the special `FEATURE_LINK` field in each `gsml:GeologicFeature`.
- The mapping of the special `FEATURE_LINK` attribute in `gsmlgu_GeologicFeature.xml` to the foreign key field of the underlying table means that every `gsmlgu:GeologicFeature` with `lex_rcs` equal to the `lex_rcs` of the `gsml:MappedFeature` under construction is included as a `gsml:specification` property of the `gsml:MappedFeature` (by value).

Feature chaining has been used to construct the property `gsml:specification` of `gsml:MappedFeature`. This property is a `gsmlgu:GeologicUnit`. The WFS response for `gsml:MappedFeature` combines the output of both feature types into a single response. The first `gsml:MappedFeature` has a `gsml:specification` property value of the `gsmlgu:GeologicUnit` with the same `lex_rcs` code. The next time a mapped feature with the same `lex_rcs` code appears, rather than including the whole geologic unit inline again the property has an xlink:href attribute pointing to the first occurrence. The relationships between the feature instances are data driven.

INSPIRE Conformance

In the previous section we have set up, in INSPIRE terminology, both a ‘Web Feature Service and Filter Encoding Implementation of Pre-defined Dataset Download Service’ and a ‘Web Feature Service and Filter Encoding implementation of Direct Access Download Service’. The former needs to conform to the requirements set out in chapter 6 and the latter to the requirements set out in chapter 7 of the Technical Guidance for the implementation of INSPIRE Download Services. We briefly illustrate how the example service conforms to each requirement below.

Pre-defined Dataset Download

TG Requirement 46

Implementations shall conform to ISO 19142 Conformance Class ‘Simple WFS’

The GetCapabilities response from the service includes the declaration

```
<ows:Constraint name="ImplementsBasicWFS">
 <ows:NoValues/>
 <ows:DefaultValue>TRUE</ows:DefaultValue>
</ows:Constraint>
```

and the WFS 2.0.0 standard states that conforming to the Basic WFS class means also implementing the Simple WFS conformance class. It is difficult to guarantee that an implementation is compliant under all circumstances and configurations. Running the OGC CITE tests that check for conformance to the standards is part of the GeoServer build process but the versions of tests run are not always the latest and sometimes test failures can be errors in the tests themselves. Of particular importance for the complex feature services covered here is that many tests may only be run against simple feature examples and the app-schema extension used for complex features has the potential to introduce errors not present in the core. Some known conformance errors are noted below, an up-to-date list of known problems can be founded by searching the project issue tracker.

Apart from the queries getting information about what the service holds like GetCapabilities, DescribeFeatureType, ListStoredQueries and DescribeStoredQueries, this conformance class requires that the server at least implements a GetFeature request with the WFS 2.0.0 standard query to get a feature using its id as shown by the example request below:

http://localhost:8080/geoserver/ows?service=WFS&version=2.0.0&request=GetFeature&storedquery_id=urn:ogc:def:query:OGC-WFS::GetFeatureById&id=mf.1&
Note

At the time of writing (March 2013) there seems to be a bug so that the above query doesn't actually work. See bug report GEOS-6233

TG Requirement 47

Implementations shall conform to ISO 19143 Conformance Class 'Query'

We can send a query using the wfs:Query element such as the below

```
<?xml version="1.0" encoding="UTF-8"?>
<wfs:GetFeature xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation=
  "http://www.opengis.net/wfs/2.0
   http://schemas.opengis.net/wfs/2.0/wfs.xsd
 http://www.opengis.net/gml/3.2
  http://schemas.opengis.net/gml/3.2.1/gml.xsd"
 xmlns:gsml="http://xmlns.geosciml.org/GeoSciML-Core/3.2"
 xmlns:fes="http://www.opengis.net/fes/2.0"
 xmlns:wfs="http://www.opengis.net/wfs/2.0"
 xmlns:gml="http://www.opengis.net/gml/3.2"
 service="WFS"
 version="2.0.0"
 outputFormat="application/gml+xml; version=3.2"
 count="10">
 <wfs:Query typeNames="gsml:MappedFeature">
 </wfs:Query>
</wfs:GetFeature>
```

TG Requirement 48

Implementations shall conform to ISO 19142 Conformance Class 'HTTP Get'

This is illustrated by an example KVP encoded request like the following:

http://localhost:8080/geoserver/ows?service=WFS&version=2.0.0&request=GetFeature&typenames=gsml:MappedFeature&count=20&
Note

At the time of writing (March 2013) there seems to be a bug so that, if you explicitly define the namespaces you are using in a GetFeature query like the above in the way required by the WFS 2.0.0 standard, you will get an error. See bug report GEOS-6885

TG Requirement 49

Pre-defined Stored Queries shall be provided to make pre-defined datasets available.

The stored query with the name specified in the technical guidance can be invoked with the following query. (Note you must have used the CreateStoredQuery request in the previous chapter to create the stored query first.)

http://localhost:8080/geoserver/ows?service=WFS&version=2.0.0&request=GetFeature&
storedquery_id=http://inspire.ec.europa.eu/operation/download/GetSpatialDataSet&
DataSetIdCode=13603180&DataSetIdNamespace=http://data.bgs.ac.uk/id/dataHolding/&
CRS=urn:ogc:def:crs:EPSG::4326&Language=eng&count=20&

TG Requirement 50

Any possible (i.e. available) combinations of CRS/DataSetIdCode/DataSetIdNamespace/language shall be made available through pre-defined stored queries.

In the example service there is only one combination of CRS/DataSetIDCode/DataSetIdNamespace/language available and that is illustrated under requirement 49 above.

TG Recommendation 13

The following identifier should be used to identify the Stored Query for serving pre-defined Spatial Data Sets: http://inspire.ec.europa.eu/operation/download/GetSpatialDataSet

This has been implemented as illustrated by the query under requirement 49 above.

TG Requirement 51

Pre-defined Stored Queries shall use the parameter names “CRS”, “DataSetIdCode”, “DataSetIdNamespace” and “Language” to identify the CRS, dataset ID code, dataset ID namespace and language components of a query.

The query shown under requirement 49 above shows the use of these parameters.

TG Requirement 52

A separate WFS endpoint shall be provided for each INSPIRE dataset thus providing one dataset per GetCapabilities response.

Currently there is only one dataset in the example service so this is satisfied trivially.

TG Requirement 53

INSPIRE Metadata for the Download Service shall EITHER be linked to via an <inspire_common:MetadataURL> in an extended capabilities section, OR the extended capabilities section shall contain all the INSPIRE Metadata for the Download Service in accordance with Table 4 and the inspire_dls:ExtendedCapabilities schema.

The example service uses the inspire_common:MetadataURL element as shown below. This has a dummy URL as the example isn't a real service and so it isn't registered in a metadata catalogue. The INSPIRE plugin GUI described in the previous chapter only allows setting a MetadataURL.

```
<inspire_common:MetadataUrl xsi:type="inspire_common:resourceLocatorType">
 <inspire_common:URL>
  http://metadata.bgs.ac.uk/geonetwork/srv/en/csw?SERVICE=CSW&
   REQUEST=GetRecordById&ID=_id_of_service_to_be_entered_here_&
   elementSetName=full&OutputSchema=http://www.isotc211.org/2005/gmd&
 </inspire_common:URL>
 <inspire_common:MediaType>
  application/vnd.ogc.csw.GetRecordByIdResponse_xml
 </inspire_common:MediaType>
</inspire_common:MetadataUrl>
```

TG Requirement 54

A network service [Download Service] metadata response shall contain a list of the natural languages supported by the service. This list shall contain one or more languages that are supported.

This is included in the extended capabilities section of the GetCapabilities response as shown below

```
<inspire_common:SupportedLanguages
 xsi:type="inspire_common:supportedLanguagesType">
 <inspire_common:DefaultLanguage>
  <inspire_common:Language>eng</inspire_common:Language>
 </inspire_common:DefaultLanguage>
</inspire_common:SupportedLanguages>
<inspire_common:ResponseLanguage>
 <inspire_common:Language>eng</inspire_common:Language>
</inspire_common:ResponseLanguage>
```

TG Requirement 55

A client may specify a specific language in a request. If the requested language is contained in the list of supported languages, the natural language fields of the service response shall be in the requested language. It the requested language is not supported by the service, then this parameter shall be ignored.

This is trivially supported by the example service as there is only one language supported and all responses are in that language.

TG Requirement 56

The GetCapabilities operation is extended by an additional parameter that indicates the client's preferred language.

The name of this parameter shall be "LANGUAGE". The parameter values are based on ISO 639-2/B alpha 3 codes as used in [INS MDTG].

For the example service the parameter value is 'eng' which is the ISO 639-2/B alpha 3 code for English.

TG Requirement 57

If a client request specifies an unsupported language, or the parameter is absent in the request, the above fields [Title, Abstract] shall be provided in the service default language.

The response to the following request specifying the unsupported Finnish language is in English:

http://localhost:8080/geoserver/ows?service=WFS&version=2.0.0&
request=GetCapabilities&language=fin&

TG Requirement 58

The Extended Capabilities shall indicate the response language used for the GetCapabilities-Response: Depending on the requested language the value of the <inspire_common:ResponseLanguage> corresponds to the current used language. If a supported language was requested, <inspire_common:ResponseLanguage> shall correspond to that requested language. If an unsupported language was requested or if no specific language was requested <inspire_common:ResponseLanguage> shall correspond to the service default language <inspire_common:DefaultLanguage>

This is illustrated by the fragment shown under requirement 54.

TG Requirement 59

The Extended Capabilities shall contain the list of supported languages indicated in <inspire_common:SupportedLanguages>. This list of supported languages shall consist of 1. exactly one element <inspire_common:DefaultLanguage> indicating the service default language, and 2. zero or more elements <inspire_common:SupportedLanguage> to indicate all additional supported languages. Regardless of the response language, the list of supported languages is invariant for each GetCapabilities-Response.

This is illustrated by the fragment shown under requirement 54.

TG Requirement 60

The Extended Capabilities shall use the XML Schema as defined in the INSPIRE online schema repository.

The example service declares the above schema in the schemaLocation attribute of the GetCapabilities response as shown below and the response document validates according to the Schema.

```
xsi:schemaLocation=
"http://www.opengis.net/wfs/2.0 http://schemas.opengis.net/wfs/2.0/wfs.xsd
 http://inspire.ec.europa.eu/schemas/common/1.0
 http://inspire.ec.europa.eu/schemas/common/1.0/common.xsd
 http://inspire.ec.europa.eu/schemas/inspire_dls/1.0
 http://inspire.ec.europa.eu/schemas/inspire_dls/1.0/inspire_dls.xsd"
```

TG Recommendation 14

For further language support for other operations it is recommended to replace the operation-online-resources in each language specific GetCapabilities-Response by a specific operation-online-resource for that language. To support the additional operation-online-resources the service shall listen at the language specific operation end-points to distinguish for the requested languages.

The example service does not implement this recommendation as it doesn’t support more than one language anyway.

TG Recommendation 15

The support of IETF RFC 4646 is recommended wherever the support of ISO/639 B alpha3 for languages infringes the conformity with the standard used for implementing the [INS NS].

I think this doesn’t apply to any INSPIRE service as yet as there is no language support defined in current OGC standards applying to WFS.

Direct Access Download

TG Requirement 61

Implementations shall meet TG Requirement 48 (conformance to [ISO 19142] ‘HTTP GET’ conformance class) and TG Requirement 52 (one endpoint for each INSPIRE dataset).

This is covered under requirements 48 and 52 above.

TG Requirement 62

Implementations shall conform to ISO 19142 Conformance Class ‘Basic WFS’.

The comments under requirement 46 in fact also apply to this requirement. A illustration of a query showing GetFeature with a Query element which is part of the Basic WFS conformance class but not the Simple WFS conformance class would be the BBOX query below

```xml
<?xml version="1.0" encoding="UTF-8"?>
<wfs:GetFeature xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation=
  "http://www.opengis.net/wfs/2.0
   http://schemas.opengis.net/wfs/2.0/wfs.xsd
  http://www.opengis.net/gml/3.2
   http://schemas.opengis.net/gml/3.2.1/gml.xsd"
 xmlns:gsml="http://xmlns.geosciml.org/GeoSciML-Core/3.2"
 xmlns:fes="http://www.opengis.net/fes/2.0"
 xmlns:wfs="http://www.opengis.net/wfs/2.0"
 xmlns:gml="http://www.opengis.net/gml/3.2"
 service="WFS"
 version="2.0.0"
 outputFormat="application/gml+xml; version=3.2"
 count="10">
 <wfs:Query typeNames="gsml:MappedFeature">
  <fes:Filter>
   <fes:BBOX>
    <fes:ValueReference>gsml:shape</fes:ValueReference>
    <gml:Envelope>
     <gml:lowerCorner>-1.0 51.0</gml:lowerCorner>
     <gml:upperCorner>0.0 52.0</gml:upperCorner>
    </gml:Envelope>
   </fes:BBOX>
  </fes:Filter>
 </wfs:Query>
</wfs:GetFeature>
```

TG Requirement 63

A Direct Access Download Service shall conform to ISO 19143 ‘Ad hoc Query’ Conformance Class.

The age, lithology and BBOX queries described in the previous chapter show various examples of different queries in this class.

TG Requirement 64

A Direct Access Download Service shall conform to ISO 19143 ‘Resource Identification’ Conformance Class.

This is illustrated by the query below

```
<?xml version="1.0" encoding="UTF-8"?>
<wfs:GetFeature xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation=
  "http://www.opengis.net/wfs/2.0
   http://schemas.opengis.net/wfs/2.0/wfs.xsd
  http://www.opengis.net/gml/3.2
   http://schemas.opengis.net/gml/3.2.1/gml.xsd"
 xmlns:gsml="http://xmlns.geosciml.org/GeoSciML-Core/3.2"
 xmlns:fes="http://www.opengis.net/fes/2.0"
 xmlns:wfs="http://www.opengis.net/wfs/2.0"
 xmlns:gml="http://www.opengis.net/gml/3.2"
 service="WFS"
 version="2.0.0"
 outputFormat="application/gml+xml; version=3.2"
 count="10">
 <wfs:Query typeNames="gsml:MappedFeature">
  <fes:Filter>
   <fes:ResourceId rid="mf.1"/>
  </fes:Filter>
 </wfs:Query>
</wfs:GetFeature>
```

TG Requirement 65

A Direct Access Download Service shall conform to ISO 19143 ‘Minimum Standard Filter’ Conformance Class.

This is illustrated by the age and lithology queries in the previous chapter.

TG Requirement 66

A Direct Access Download Service shall conform to ISO 19143 ‘Minimum Spatial Filter’ Conformance Class.

This is illustrated by the BBOX query in the previous chapter.

TG Requirement 67

A Direct Access Download Service shall conform to ISO 19143 ‘Minimum Temporal Filter’ Conformance Class.

The GetCapabilities response states that this is supported as is the ‘During’ filter operation but the example data does not contain any temporal properties.

TG Requirement 68

A Direct Access Download Service shall conform to ISO 19143 ‘Minimum XPath’ Conformance Class.

The age and lithology queries in the previous chapter show the use of XPath to refer to some nested property values.