WEB Map Service (WMS)

How can we publish a map over the web?

If we use HTTP requests all of these might be valid:

- http://myURL/myMap.png
- http://myURL/mapService?id=myMap
- http://myURL/mapService/dubai/map/large

Let's agree on the URL format

If we agree about how to encode the URL the following HTTP GET request will get a map from a province of the Basque Country in Spain

`Link <
http://b5m.gipuzkoa.net/ogc/wms/gipuzkoa_wms?service=wms&version=1.3.0&requ

```
 http://b5m.gipuzkoa.net/ogc/wms/gipuzkoa_wms?
service=wms&
version=1.3.0&
request=getmap&
layers=udal_barrutiak_limites_municipales&
styles=&
crs=epsg:23030&
bbox=530000,4740000,610000,4820000&
width=600&
```

```
height=600&
format=image/png
```

```
http://b5m.gipuzkoa.net/ogc/wms/gipuzkoa_wms?
service=wms&
version=1.3.0&
request=getmap&
layers=udal_barrutiak_limites_municipales&
styles=&
crs=epsg:23030&
bbox=530000,4740000,610000,4820000&
width=600&
height=600&
format=image/png
```

WMS

- The OGC Web Map Service Interface Standard (WMS) defines a set of interfaces (e.g. the rule of how to encode the URL) for requesting map images over the Internet.
- WMS makes it easy for a client to request images on demand changing parameters such as size and coordinate reference systems.

WMS Server

- Provides information about what maps a service can produce
- Produces a Map
- Answers queries about content of a Map

Benefit

- WMS clients can request images from multiple WMS servers, and then combine them into a single view for the user.
- The standard guarantees that these images can all be overlaid on one another using a common geospatial coordinate reference system.
- Hundreds of servers and clients support WMS.

Relation to other OGC Standards

- OGC Web Map Tile Service Interface Standard (WMTS): The WMTS standard is a better fit For highly scalable systems (many simultaneous requests) that only need static maps. It complements the WMS standard with cachable static map tiles. WMS servers can be used as data sources or rendering engines for WMTS services.
- OGC Web Feature Service (WFS): The WFS standard is a better fit for extended query functionality of spatial data. It provides programmatic access to the geographic feature data. WMS and WFS often go together. An organization publishing both WMS and WFS often use the same data source.

Overview of WMS Operations

WMS Operations

- **GetCapabilities**
- **GetMap**
- **GetFeatureInfo** (Optional)
- **DescribeLayer** (Optional)
- **GetLegendGraphic** (Optional)

GetCapabilities

- Returns metadata about a WMS server, including how to generate WMS requests and what parameters can be used.
- The metadata includes supported image formats and the availability of layers.
- Metadata for each layer include: bounding box, coordinate reference system, URI of the data and whether the layer is mostly opaque or not.

GetCapabilities Demonstration

This is a link to a GetCapabilities request.

```
http://metaspatial.net/cgi-bin/ogc-wms.xml?
SERVICE=WMS&
VERSION=1.3
REQUEST=GetCapabilities&
```

GetCapabilities Parameters

There are three parameters (and values) being passed to the WMS server, `SERVICE=WMS`, `VERSION=1.3`, and `REQUEST=GetCapabilities`.

- The `SERVICE` parameter tells the server that a WMS request is forthcoming.
- The `VERSION` parameter tells the server what version of the WMS is being requested.
- The `REQUEST` parameter tells the server that the operation requested is the *GetCapabilities* operation.

GetCapabilities Parameters and Accepted Values

Parameter	Required	Description
`SERVICE`	Yes	Service name. Value is `WMS`.
`VERSION`	Yes	Service version. Value is one of `1.0.0`, `1.1.0`, `1.1.1`, `1.3`.
`REQUEST`	Yes	Operation name. Value is `GetCapabilities`.

GetCapabilities Response

The response is a Capabilities XML document with a detailed description of the WMS service. It contains three main sections:

Service	Contains service metadata such as the service name, keywords, and contact information for the organization operating the server.
Request	Describes the operations the WMS service provides and the parameters and output formats for each operation.
Layer	Lists the available coordinate systems and layers. In some servers (e.g. Geoserver) layers are named in the form "namespace:layer". Each layer provides service metadata such as title, abstract and keywords.

GetCapabilities Layer Style Section

The GetCapabilites response contains a *Layer* section, which details about the style available to that layer. In the example bellow the available style is *default*.

GetCapabilities - Layer

```
<Layer queryable="0" opaque="0" cascaded="0">
  <Name>nationalparks</Name>
  <Title>National Parks</Title>
  <EX_GeographicBoundingBox>
    <westBoundLongitude>-4.43064</westBoundLongitude>
    <eastBoundLongitude>1.99728</eastBoundLongitude>
    <southBoundLatitude>50.3532</southBoundLatitude>
    <northBoundLatitude>55.5917</northBoundLatitude>
  </EX_GeographicBoundingBox>
  <BoundingBox CRS="EPSG:27700"
         minx="246828" miny="56378.4" maxx="652374" maxy="633117"/>
  <Style>
   ...
  </Style>
</Layer>
```

GetCapabilities Layer Style Section

```xml
<Layer queryable="0" opaque="0" cascaded="0">
  ...
  <Style>
    <Name>default</Name>
    <Title>default</Title>
    <LegendURL width="110" height="22">
      <Format>image/png</Format>
      <OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
         xlink:type="simple"
         xlink:href="..."/>
    </LegendURL>
  </Style>
</Layer>
```

GetMap

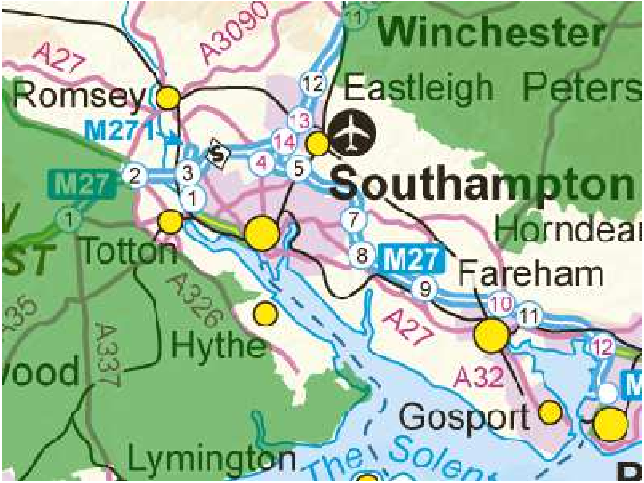
- Returns a map image.
- Parameters specified in the GetMap request include: width and height of the map, coordinate reference system, rendering style and image format.
- The information needed to specify values for parameters such as `layers`, `styles` and `Spatial Reference Systems (SRS)` can be obtained from the Capabilities document.

GetMap - Request Example

Link to a GetMap request.

```
http://metaspatial.net/cgi-bin/ogc-wms.xml?
VERSION=1.3.0&
REQUEST=GetMap&
SERVICE=WMS&
LAYERS=DTM,Overview,Raster_250K,Topography,nationalparks,Infrastructure,Places&
STYLES=,,,,,,&
CRS=EPSG:27700&
BBOX=424735.97883597884,96026.98412698413,467064.02116402116,127773.01587301587&
WIDTH=400&
HEIGHT=300&
FORMAT=image/png&
BGCOLOR=0xffffff&
TRANSPARENT=TRUE&
EXCEPTIONS=XML
```

Example Image from a GetMap request



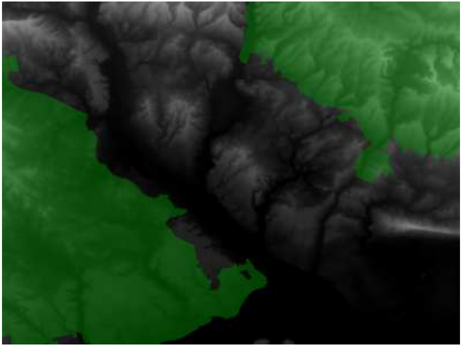
GetMap - Request

```
...
LAYERS=DTM,Overview,Raster_250K,Topography,nationalparks,Infrastructure,Places
...
CRS=EPSG:27700&
BBOX=424735.97883597884,96026.984126984...
WIDTH=400&
HEIGHT=300&
FORMAT=image/png&
BGCOLOR=0xffffff&
TRANSPARENT=TRUE&
EXCEPTIONS=XML
```

- The service provides seven map layers: DTM, Overview etc.
- The coordinate reference system EPSG:27700 is the Ordnance Survey National Grid reference system.
- The image returned is a PNG transparent format with width 400 and height 300 pixels, and background color is white (Hex code=0xffffff).

GetMap - Request - Example 2

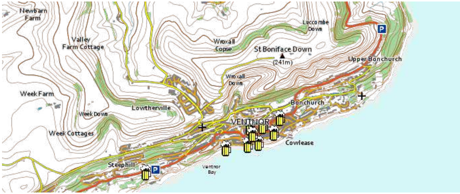
GetMap without the Overview Layer.



```
LAYERS=DTM,Raster_250K,Topography,nationalparks,Infrastructure,Places
```

GetMap Transparency / Translucency

The map image can be overlayed with maps from other servers. In those cases it may be helpful to request the top level image in a format which supports a transparency such as the alpha channel. Then we can see what is below this map image.



GetMap Scale Limits

It is important to understand that every layer can have scale limits when it is not displayed. For example it would not make sense to display the "Overview" and "Raster_250K" at the same time because they contain the same data but with different levels of generalization. So instead they have mutually exclusive scale limits so that they will never be returned in one image. The scale limits are set by the server and do not have to be configured by the client.

```
<Name>Raster_250K</Name>
<MaxScaleDenominator>60000</MaxScaleDenominator>
<MinScaleDenominator>250000</MinScaleDenominator>

<Name>Overview</Name>
<MinScaleDenominator>250000</MinScaleDenominator>
```

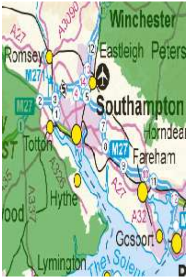
GetMap - Zooming

- The client can "zoom in" and "zoom out" of the map by calculating new values for the BBOX (bounding box) parameter. The same applies to all map navigation functions like panning or selecting a completely new area.
- It is important to note that the server only returns an image to the client, but no additional information about the size, coordinate system, scale, etc

Squashed Map

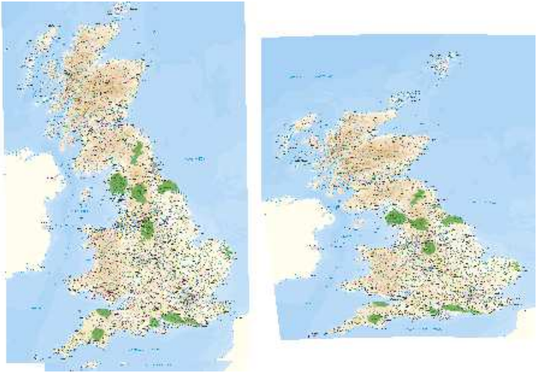
Happens when a with a width to height ratio is other than 1:1 For example when saying **WIDTH=200&HEIGHT=300**?

you get squashed Map



Reprojecting Maps

Change the parameter: **CRS** Left is the original CRS=EPSG:22770 and on the right hand side CRS=EPSG:4326.



GetMap - Parameters

Parameter	Required	Description
`service`	Yes	Service name. Value is `WMS`.
`version`	Yes	Service version. Value is one of `1.0.0`, `1.1.0`, `1.1.1`, `1.3`.
`request`	Yes	Operation name. Value is `GetMap`.
`layers`	Yes	Layers to display on map. Value is a comma-separated list of layer names.
`styles`	Yes	Styles in which layers are to be rendered. Value is a comma-separated list of style names, or empty if default styling is required. Style names may be empty in the list, to use default layer styling.

`srs` *or* `crs`	Yes	Spatial Reference System for map output. Value is in form `EPSG:nnn`. `crs` is the parameter key used in WMS 1.3.0.
`bbox`	Yes	Bounding box for map extent. Value is `minx,miny,maxx,maxy` in units of the SRS.
`width`	Yes	Width of map output, in pixels.
`height`	Yes	Height of map output, in pixels.
`format`	Yes	Format for the map output.
`transparent`	No	Whether the map background should be transparent. Values are `true` or `false`. Default is `false`
`bgcolor`	No	Background color for the map image. Value is in the form `RRGGBB`. Default is `FFFFFF` (white).

`exceptions`	No	Format in which to report exceptions. Default value is `application/vnd.ogc.se_xml`.
`time`	No	Time value or range for map data.
`sld`	No	A URL referencing a StyledLayerDescriptor XML file which controls or enhances map layers and styling
`sld_body`	No	A URL-encoded StyledLayerDescriptor XML document which controls or enhances map layers and styling

GetFeatureInfo

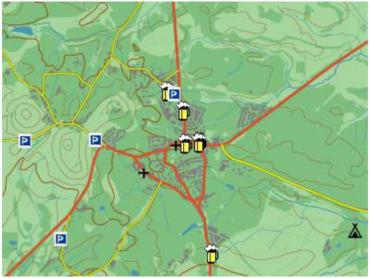
- Returns information (e.g. data) associated to a coordinate of the map image. The layer supporting this operation is marked as 'queryable'.
- It is similar to the WFS GetFeature operation, but less flexible in both input and output.
- The one advantage of `GetFeatureInfo` is that the request uses an (x,y) pixel value from a returned WMS image.
- This is easier to use for a naive client that is not able to perform true geographic referencing.

GetFeatureInfo

Before querying for objects we need to see a map. We use the GetMap request to get a map image:

```
http://metaspatial.net/cgi-bin/ogc-wms.xml?
VERSION=1.3.0&
REQUEST=GetMap&
SERVICE=WMS&
LAYERS=Overview,Raster_250K,nationalparks,Topography,Infrastructure,osm_points&
WIDTH=400&
HEIGHT=300&
CRS=EPSG:27700&
BBOX=427966.6666666667,106800,431833.3333333333,109700&
FORMAT=image/png&
EXCEPTIONS=XML
```

The result will look like this:



In the next step the user has to click into the map. Let's assume the user has clicked the position:

```
X=231
Y=280
```

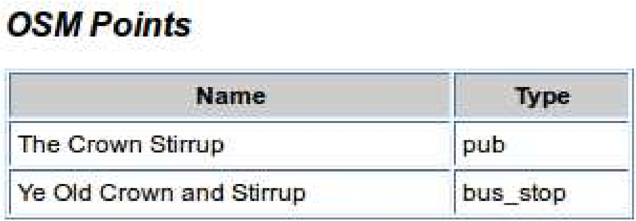
Then the client do this request

```
http://metaspatial.net/cgi-bin/ogc-wms.xml?
VERSION=1.3.0&
REQUEST=GetFeatureInfo&
SERVICE=WMS&
LAYERS=osm_points&
QUERY_LAYERS=osm_points&
WIDTH=400&
HEIGHT=300&
CRS=EPSG:27700&
BBOX=427966.6666666667,106800,431833.3333333333,109700&
INFO_FORMAT=text/html&
EXCEPTIONS=XML&
X=231& Y=280
```

Link to the GetFeatureInfo request.

GetFeatureInfo - Response in HTML

If the server has found features it will return them in the requested format. In this example the server finds a pub called "The Crown Stirrup" and a bus stop named "Ye Old Crown and Stirrup" and returns them in an HTML file.



OSM Points

Name	Type
The Crown Stirrup	pub
Ye Old Crown and Stirrup	bus_stop

GetFeatureInfo - Response in GML

```
<osm_points_feature>
      <gml:boundedBy>
        <gml:Box srsName="EPSG:27700">
          <gml:coordinates>
          430172.215950,107071.994504 430172.215950,107071.994504
          </gml:coordinates>
        </gml:Box>
      </gml:boundedBy>
      <osm_id>503420358</osm_id>
      <timestamp>2009-09-20T16:44:15Z</timestamp>
      <name>Ye Old Crown and Stirrup</name>
      <type>bus_stop</type>
    </osm_points_feature>
  </osm_points_layer>
```

Marking layers telling clients that GetFeatureInfo is available

In the GetCapabilities document the layer should have **queryable="1"**

```
<Layer queryable="1" opaque="0" cascaded="0">
  <Name>osm_points</Name>
  <Title>OpenStreetMap point objects</Title>
  <CRS>EPSG:4326</CRS>
```

GetFeatureInfo - Parameters

Parameter	Required	Description
`SERVICE`	Yes	Service name. Value is `WMS`.
`VERSION`	Yes	Service version. Value is one of `1.0.0`, `1.1.0`, `1.1.1`, `1.3`.
`REQUEST`	Yes	Operation name. Value is `GetFeatureInfo`.
`QUERY_LAYERS`	Yes	Comma separated list of layers to be queried\`
`INFO_FORMAT`	No	Format for the feature information response (MIME type).

FEATURE_COUNT	No	Maximum number of features to return. Default is 1.
i	Yes	Pixel column point on the map. 0 is left side. x is the parameter key used in WMS 1.1.0.
j	Yes	Pixel row on the map. 0 is the top. y is the parameter key used in WMS 1.1.0.
EXCEPTIONS	No	Format in which to report exceptions. The default value is application/vnd.ogc.se_xml.

GetFeatureInfo - `INFO_FORMAT` parameter

Format	Syntax	Notes
TEXT	info_format= text/plain	Simple text output. (The default format)
GML 2	info_format= application/vnd.ogc.gm	Works only for Simple Features
GML 3	info_format= application/vnd.ogc.gml/3.1.1	Works for both Simple and Complex Features
HTML	info_format= text/html	Uses HTML templates that are defined on the server.
JSON	info_format= application/json	Simple JSON representation.

GetLegendGraphic

Returns a legend, as an image, for the map image, providing a visual guide to the map elements.

Getting a legend via GetLegendGraphic

Link to GetLegend request.

```
http://metaspatial.net/cgi-bin/ogc-wms.xml?
version=1.3.0&
service=WMS&
request=GetLegendGraphic&
sld_version=1.1.0&
layer=nationalparks&
format=image/png&
STYLE=default
```

nationalparks

DescribeLayer

Returns additional information about the requested layer.

Wrong requests

- If the request is wrong the server will return an error message.
- The request specifies how the client would like to receive the request. For example:

```
EXCEPTIONS=XML
```

Error Messages

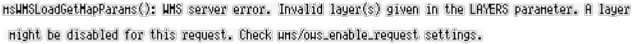
In case the client causes an error by formulating a wrong request the server will return an error message. For example if requesting a non existing layer, the server will return the following:

```
<?xml version='1.0' encoding="ISO-8859-1" standalone="no" ?>
  <ServiceExceptionReport version="1.3.0" xmlns="http://www.opengis.net/ogc"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/ogc
  http://schemas.opengis.net//wms/1.3.0/exceptions_1_3_0.xsd">
  <ServiceException code="LayerNotDefined">
    msWMSLoadGetMapParams(): WMS server error.
    Invalid layer(s) given in the LAYERS parameter.
    A layer might be disabled for this request.
    Check wms/ows_enable_request settings.
  </ServiceException>
</ServiceExceptionReport>
```

INIMAGE Error Messages

One problem with the previous message is that the client cannot display the message in the image display window. To prevent this from happening we can change the format of the error message (the EXCEPTIONS parameter) to INIMAGE. In that case we can see the error message printed into an image:

INIMAGE Error Message



```
msWMSLoadGetMapParams(): WMS server error. Invalid layer(s) given in the LAYERS parameter. A layer
 might be disabled for this request. Check wms/ows_enable_request settings.
```

Exceptions

A WMS Server reports an exception when a request from a client is not correct.

Format	Syntax	Notes
XML	`application/vnd.ogc.se_xml`	The error is described in XML.
PNG	`application/vnd.ogc.se_inimage`	The error is return as an image.
Blank	`application/vnd.ogc.se_blank`	A blank image is returned.
JSON	`application/json`	The error is reported as a simple JSON representation.