

# SERVING MAP WITH OGC STANDARDS VIA NETWORK

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### ABSTRACT:

Using geographic information economically is important as much as getting geographic information. In our country geographic information is reproduced when not sharing it between each organizations (General Command of Mapping, TKGM, Bank of Province, Municipalities etc). Reproducing data is effect country economy negatively. With sharing geographic information independent from hardware and software via computer network, reproduce same information is being prevented and costs are reduces. This independence is obtained with developing and implementing international standard. The Open Geospatial Consortium (OGC) is established for this aim and improves standards about sharing geographic information via network. The aim of research is to expose what kind of benefits gain from sharing, using and presenting geographic information at international standards; to offer suggestions with comparing some software which make map service at international standards. In this document Web Map Service (WMS)'s structure and which OGC standards will be applied when serving map via network are described. Besides, Geoserver, MapServer and ArcGIS Server software are tested which will serve map. These software use Hypertext Transfer Protocol (HTTP) to communicate between service and client. Response time of service is compared between each other with using raster data.

## 1. INTRODUCTION

In our country, many institutions and organizations, which produce maps, can not share their produced geographic data; because of that reproduction data is caused. Reproduction of previously generated data leads to inefficient use of our country's resources. When data sharing between institutions occurs, country economy will gain benefit and also institutions will be able to use their time and resources in other aspects.

A need of creating national geographic databases, which is expressed on many platforms, is still ongoing. In ensuring national cooperation, take into consideration international standards is useful when making regulation.

National Spatial Data Infrastructure must adapt it self to not only International Organization for Standardization (ISO) standards but also OGC standards and other international standards like HTTP, Geography Markup Language (GML) etc. for sharing geographic data and technology and for being in harmony with World Spatial Data Infrastructure which will established in the future (Bakırtaş et al, 2005).

Institution must use one type of data model and communication language when sharing geographical data. International standards of geographic data are determined by ISO / Technical Committee (TC) 211 and OGC. To serve online geo-data and geo-processing capabilities, the OGC has introduced specifications for geospatial web services, such as Web Feature Service (WFS) and Web Map Service (WMS) (Aktas et al, 2006). Institutions, which are produce and use geographic information, must comply these standards in order to be in international arena.

WMS prepares geographic information for client and then services this information. WMS makes three base processes to service map. WMS announces its capabilities to clients with

GetCapabilities process. WMS provides the map which is needed by client with GetMap process. It makes attribute interrogation of feature on map with GetFeatureInfo process. Server's GIS performance on web is indicates the quality level of service. The response time of the service for the client is defines the overall service performance. WMS performance is composed of these three process provided by service and initiated by client (Yang et al, 2007). Low response time, indicates a good level of service performance.

Open source Geoserver and Mapserver software which are produce WMS have been tested (Aime et al., 2008). In this test response times of services were found by using 164 Mbytes raster Joint Photographic Experts Group (JPEG) images. Services were gradually tested for 1, 10, 20, and 40 users. For 40 users Mapserver responded in 659 ms and Geoserver responded in 486 ms to requests. Test results are indicated that Geoserver software's response times were better.

Today map services become widespread in the international arena. Companies which are producing and holding geographic information, offer own data to the world through. In the United States of America (USA) each map producer institutions share map information with the world as much as possible and provides new investments in the country. For example TerraServer is instantaneous data base of U.S. which is provides free aerial photographs and many maps belonging to the United States to the public (<http://terraserver-usa.com/ogcwms.aspx>).

Performance tests of six WMS servers which have widespread use were made by Yang et al. (2007). GetCapabilities and GetMap requests are made to services and response times were measured. For a single request, responses of services were varied between 2 and 30 seconds. When concurrent five

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requests are made, server response times are become longer (Yang et al, 2007).

In this study advices will be presented about how to share products at international standards and how to meet geographic information needs effortlessly to map-producing agencies and map-using organization. ArcGIS Server, Geoserver and Mapserver software which are supports OGC standards will be made comparison and suggestions will be offered to network service users.

Software, which will be used in the study, will be installed as described in the setup document by using default value on the same computer. Software will be tested on equal terms by introducing same geographic data to web services and using same mapping request. In tests, effects of uncertain densities which are caused by internet network will be resolved by making server and client processes on the same computer.

## 2. METHODS

Although software which are serving geospatial data via internet at international standards designed for the same purpose, data processing and sending to client time may be different. When these software are preferred, how to comply with international standards, for which level of software user, which data formats are supported and data processing speed are important. In this study, ArcGIS Server, Geoserver and Mapserver software were set up on the same computer and same geographic data are introduced to software. Performance tests of software have been made with Internet Explorer software.

Geospatial data, held in vector or raster data format, may be in the database structure or file structure. WMS would have to know where the geographic data which will be used to produce map. Service prepares metadata based on geographic data which can be used. In the metadata mainly service name, its capabilities, layers, layer styles, supported coordinate systems and areas covered by geographical data are take part in.

A client, who wants to see metadata of the service, demands from service by using client applications (Browser or GIS programs) over network. This process is called "GetCapabilities". To be able to do GetCapabilities process, client must transmit at least service type (Example: WMS) and request name (Example: GetCapabilities) to the service. This information is sent to the service by creating Uniform Resource Locators (URL). For example,

*"http://localhost:8080/geoserver/wms?service=WMS&request=GetCapabilities"*

request gets service metadata.

If GetCapabilities process is done properly, service offers its own metadata at HTML/XML (Extensible Markup Language) format. A client who got service's metadata sees which requests can be done. For example, a portion of the service's response to request at above is shown below

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE WMT_MS_Capabilities SYSTEM
"http://localhost:8080/geoserver/schemas/wms/1.1.1/WMT_MS_Capabilities.dtd">
<WMT_MS_Capabilities version="1.1.1"
updateSequence="114">
<Service>
<Name>OGC:WMS</Name>
```

```
<Title>Turkiye WMS</Title>
<KeywordList>
<Keyword>WMS</Keyword>
<Keyword>TURKEY</Keyword>
</KeywordList>
</Service>
<Capability>
<Request>
<GetCapabilities>
<Format>application/vnd.ogc.wms_xml</Format>
</GetCapabilities>
<GetMap>
<Format>openlayers</Format>
</GetMap>
</Request>
<Layer queryable="1">
<Name>tr:karayolu</Name>
<Title>karayolu</Title>
<SRS>EPSG:4326</SRS>
<Style>
<Name>karayolu</Name>
<Title>Default Style</Title>
<LegendURL width="20" height="20">
<Format>image/png</Format>
</LegendURL>
</Style>
</Layer>
```

A client, who gets service metadata and who will make service prepare map, requests map from service by using client applications over network. This process is called "GetMap". In order to make GetMap process, client must sent at least request version (Example: 1.3.0), request name (Example: GetMap), layer names, style names, coordinate reference systems, boundaries of geographical region, result map sizes and image format over network. This information is sent to the service by creating URL. For example,

*"http://localhost:8080/geoserver/wms?version=1.1.1&request=GetMap&layers=tr:il\_alan&styles=&crs=EPSG:4326&bbox=26,36,45,42&width=800&height=375&format=image/png"*

request, requires tr:il\_alan layer's map which includes region that between 360-420 North and 260-450 East in WGS:84 coordinate reference system, 800x375 pixels in size and in Portable Network Graphics (PNG) format from WMS generated by Geoserver software.

If client sends its requests to service properly, service offers digital image to client via network by creating map according to request. A response, given by service to map request written above, shown on Figure 1.



Figure 1. A prepared map which is result of GetMap request

Service uses styles belong to layer when preparing map. A part of default style of tr:il\_alan layer is shown on below.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<StyledLayerDescriptor version="1.0.0"
xmlns="http://www.opengis.net/sld"
xmlns:ogc="http://www.opengis.net/ogc"xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:gml="http://www.opengis.net/gml"
xsi:schemaLocation="http://www.opengis.net/sld
http://schemas.opengis.net/sld/1.0.0/StyledLayerDescriptor.xsd"
">
  <NamedLayer>
    <Name>Populations of Provinces</Name>
    <UserStyle>
      <Name>population</Name>
      <Title>Population Numbers of Turkey's Provinces</Title>
      <Abstract> Turkey's provinces that was classified into five
class according to population number</Abstract>
      <FeatureTypeStyle>
        <Rule>
          <Title> Provinces that have population few than
250.000</Title>
          <ogc:Filter>
            <ogc:PropertyIsLessThan>
              <ogc:PropertyName>NUFUS_97
              </ogc:PropertyName>
              <ogc:Literal>250000</ogc:Literal>
            </ogc:PropertyIsLessThan>
          </ogc:Filter>
          <PolygonSymbolizer>
            <Fill>
              <CssParameter name="fill">#4DFF4D
              </CssParameter>
              <CssParameter name="fill-opacity">0.7
              </CssParameter>
            </Fill>
          </PolygonSymbolizer>
        </Rule>
      </FeatureTypeStyle>
    </UserStyle>
  </NamedLayer>
</StyledLayerDescriptor>
```

According to this style definition, service separates features into five class by using layer's NUFUS 97 attribute values and service defines filling color for each class.

A client who wants to get information about feature that presented from service, requests feature info from service by using client application via network. This process is called "GetFeatureInfo". But before making this request, does service support GetFeatureInfo process or not must be examined by looking service metadata. If the service support this process, a client who wants to get feature info from WMS, must send at least request version (Example: 1.3.0), layer names, style names, coordinate reference system, geographical region boundaries, result map size, image format, request name (Example: GetFeatureInfo), to be queried layer names and result format to service via network by using service metadata. This information is sent to the service by creating URL. For example,

```
"http://localhost:8080/geoserver/wms?
request=GetFeatureInfo&BBOX=26,36,45,42&X=275&Y=17
0&info_format=text/plain&query_layers=tr:il_alan&layers=tr:
il_alan&styles=&crs=EPSG:4326&version=1.1.1&WIDTH=
800&HEIGHT=375&format=image/png"
```

request, requires feature info at the x=275 and y=170 pixel coordinate of tr:il\_alan layer's map which includes region that between 360-420 North and 260-450 East in WGS:84

coordinate reference system, 800x375 pixels in size and in PNG format from WMS generated by Geoserver software.

If GetFeatureInfo process has been made correctly, service offers location and attribute information of requested features to client in requested format. For example, a response is below which is given by service to request written above.

Results for FeatureType 'il\_alan':

```
-----
the_geom = [GEOMETRY (MultiPolygon) with 587 points]
ALAN_KM2 = 25436.8
CEVRE_KM = 25436.8
IL_ADI = ANKARA
IL_KODU = 06
NUFUS_97 = 3693390
-----
```

### 3. APPLICATION

Geoserver, Mapserver and ArcGIS Server software are set up on the same computer as described in the setup document. Because of ArcGIS Server software didn't allowed to service vector data that is in "shp" format, only raster data is used in software tests. Raster data of Turkey was introduced to services on each software. Raster data consists of six picture format in JPEG format and geographic coordinate system on computer's hard disk (akdeniz.jpg 1.93 MB, batikaradeniz.jpg 1.25 MB, doguanadolu.jpg 2.25 MB, dogukaradeniz.jpg 1.12 MB, ege.jpg 1.58 MB, marmara.jpg 1.63 MB).

In Geoserver and Mapserver software, image files were introduced to services by using their directory names. In ArcGIS Server software, image files opened in "mxd" file and this file introduced to service because service uses a single picture file. Second WMS of ArcGIS Server software has been created by using single picture file in JPEG format (batikaradeniz.jpg 1.25 MB), that considering response time of service will be effected by this situation. Thus test number has been doubled. The second service (jpg) created with ArcGIS Server software, was used in second test.

Services were subjected to two tests. In the first test, three services (Geoserver, Mapserver, ArcGIS Server (mxd)) that use six image file were tested by using Internet Explorer program. In the second test, four services (Geoserver, Mapserver, ArcGIS Server (mxd), ArcGIS Server (jpg)) that use single image file (batikaradeniz.jpg 1.25 MB) were tested by using Internet Explorer program.

Seven GetMap requests, which consist of same parameter values and belong to service, were prepared to compare the performance of services with each other. First three requests were used in first tests, rest of four requests were used in second test.

In the first three GetMap requests prepared for services, 1.1.1 version number; six layer names introduced to services; the code that identifies WGS 84 coordinate reference system; minX = 25.5 minY = 35.5, maxX = 45, maxY = 42.5 values that define geographic area; width = 2000, height = 700 values that define image size of map and code of PNG image format.

A request prepared for Geoserver software is,

```
"http://localhost:8080/geoserver/wms?
version=1.1.1&request=GetMap&layers=tr:marmara,tr:ege,tr:
akdeniz,tr:batikaradeniz,tr:doguanadolu,tr:dogukaradeniz&st
```

yles=&srs=EPSG:4326&bbox=25.5,35.5,45,42.5&width=2000&height=700&format=image/png&transparent=TRUE”

A request prepared for Mapserver software is,

“http://localhost:90/cgi-bin/mapserv.exe?version=1.1.1&request=GetMap&layers=marmara,ege,akdeniz,batikaradeniz,doguanadolu,dogukaradeniz&styles=&srs=EPSG:4326&bbox=25.5,35.5,45,42.5&width=2000&height=700&format=image/png&transparent=TRUE&map=\ms4w\apps\ms\_ogc\_workshop\service\config2.map”

A request prepared for ArcGIS Server software is,

“http://localhost:8399/arcgis/services/Turkiye\_Fiziki/MapServer/WMServer?version=1.1.1&request=GetMap&layers=0,1,2,3,4,5&styles=&srs=EPSG:4326&bbox=25.5,35.5,45,42.5&width=2000&height=700&format=image/png&transparent=TRUE”

In the last four GetMap requests prepared for services, 1.1.1 version number; one layer name introduced to services; the code that identifies WGS 84 coordinate reference system; minX = 29.9 minY = 39.9, maxX = 36.1, maxY = 44 values that define geographic area; width = 1200, height = 800 values that define image size of map and code of PNG image format.

A request prepared for Geoserver software is,

“http://localhost:8080/geoserver/wms?version=1.1.1&request=GetMap&layers=tr:batikaradeniz&styles=&srs=EPSG:4326&bbox=29.9,39.9,36.1,44&width=1200&height=800&format=image/png&transparent=TRUE”

A request prepared for Mapserver software is,

“http://localhost:90/cgi-bin/mapserv.exe?version=1.1.1&request=GetMap&layers=batikaradeniz&styles=&srs=EPSG:4326&bbox=29.9,39.9,36.1,44&width=1200&height=800&format=image/png&transparent=TRUE&map=\ms4w\apps\ms\_ogc\_workshop\service\config2.map”

A request prepared for ArcGIS Server software, which uses raster image file name (jpeg), is,

“http://localhost:8399/arcgis/services/batikaradeniz/ImageServer/WMServer?version=1.1.1&request=GetMap&layers=0&styles=&srs=EPSG:4326&bbox=29.9,39.9,36.1,44&width=1200&height=800&format=image/png&transparent=TRUE”

A request prepared for ArcGIS Server software which uses “mxd” file, is,

“http://localhost:8399/arcgis/services/Batikaradeniz/MapServer/WMServer?version=1.1.1&request=GetMap&layers=0&styles=&srs=EPSG:4326&bbox=29.9,39.9,36.1,44&width=1200&height=800&format=image/png&transparent=TRUE”

### 3.1 Test Environment

Tests were made in computer that has Intel Core 2 Duo 2.0 GHz processor, 3 GB memory, an external graphics card with 512 MB and Microsoft Windows XP Professional SP2 operating system. WMSs were installed on this computer and requests were sent from this computer. Thus effects of irregular and uncertain delays, which could be caused by network, are prevented. Only one service was tested at the same time and other programs were not worked. Two separate tests were made

for WMSs. Internet Explorer (version 6.0) software was used in first and second tests. Before starting to tests, "Temporary Internet Files" folder has been emptied. So that preparing map image again by service for each incoming GetMap request is provided.

The requests, prepared for WMS in the first and second tests, were sent by typing in the address section of Internet Explorer software. The timer was started at the moment of sending request to the service and was stopped by arising map image on screen. So that response time (second) of service were measured. File size (byte) of sent response were founded by saving image on computer. This process was repeated 12 times for each service. At the comparison of services with each other, shortest 10 durations were subjected to evaluation from among response times for every service.

### 3.2 Test Results

In the first test, obtained response times and file sizes of responses for the services are shown in Table 1.

WMS	Data Size (kbyte)	Request No.										Avg
		1	2	3	4	5	6	7	8	9	10	
		Response Times (sec)										
Geoserver	2915	7.05	6.45	7.26	7.24	6.56	6.52	6.70	6.40	6.75	7.10	6.80
Mapserver	3122	6.73	7.06	7.14	6.89	6.63	6.62	7.18	7.20	6.80	6.54	6.88
ArcGIS Server	3039	11.9	12.5	11.6	12.4	12.0	12.0	11.7	12.0	11.6	12.1	12.02

Table 1. Response times and file sizes of services to requests (Test1)

According to first test results, Geoserver service responses with 428.67 kbyte/sec average speed, Mapserver service responses with 453.78 kbyte/sec average speed, ArcGIS Server service responses with 252.83 kbyte/sec average speed to client. It is being observed that, average response times of Geoserver and Mapserver services are close to each other (Geoserver 6.80 sec, Mapserver 6.88 sec) and response time of ArcGIS Server service is greater (ArcGIS Server 12.02 sec). For ArcGIS Server service, that this much difference at first test, probably arises from using “mxd” file.

In the second test, obtained response times and file sizes of responses for the services are shown in Table 2.

WMS	Data Size (kbyte)	Request No.										Avg
		1	2	3	4	5	6	7	8	9	10	
		Response Times (sec)										
Geoserver	1599	3.4	3.4	3.0	3.4	2.9	3.6	2.7	3.6	3.4	3.3	3.32
Mapserver	1947	3.2	3.2	3.5	3.1	3.4	3.9	3.2	3.5	3.6	3.1	3.42
ArcGIS Server (jpg)	1584	3.2	3.0	3.3	3.1	3.3	3.3	3.1	3.1	2.8	2.7	3.13
ArcGIS Server (mxd)	1736	5.1	4.8	4.8	4.4	4.8	4.4	4.8	4.5	5.0	4.6	4.77

Table 2. Response times and file sizes of services to requests (Test2)

According to second test results, Geoserver service responses with 481.63 kbyte/sec average speed, Mapserver service responses with 569.29 kbyte/sec average speed, ArcGIS Server (jpg) service responses with 506.07 kbyte/sec average speed, ArcGIS Server (mxd) service responses with 363.94 kbyte/sec average speed to client. It is being observed that, average response times of Geoserver and Mapserver services are close to each other (Geoserver 3.32 sec, Mapserver 3.42 sec). It is being observed that response time of ArcGIS Server service, created by “jpg” file, is better than other service (ArcGIS Server (jpg) 3.13 sec) and response time of ArcGIS Server service,

created by "mxd" file, is higher than other service (ArcGIS Server (mxd) 4.77 sec).

The hypothesis of that response time of ArcGIS Server service is much more than other service at first and second test, could result from using "mxd" document, was confirmed.

#### 4. RESULTS

WMS can be easily formed by using raster and vector data with Geoserver software. That metadata is prepared by service to user, makes easier to understanding OGC standards. A seen trouble at the GetFeatureInfo request is obligation of using capital letter for "width" and "height" parameters. For example, if width=800 expression is in request that sent to service, service send error message to client. According to the OGC standards service should not be sensitive to upper-lower case. Moreover, not indicating that Geoserver software supports WMS 1.3.0 (Web Map Service) standard, leaves user in difficult situation.

In the Mapserver software, for inexperienced users it is difficult to introduce layers that will be used by service. Service's metadata and software settings are hard because these are made with file. For advanced users this is became an advantage. Because many attributes of service, which is created by ready menus, are not possible to access. User can make any changes when file structure is used. Mapserver service requires "map" parameter in addition to parameters that are necessitated by standards in GetMap request. This is seen as a disadvantage in respect of software. Because to made user prepare an additional file except for standards, reduces availability of software.

ArcGIS Server software, allows forming WMS easily to users. By software, an advanced user will require different programs to be able to make changes in the layer metadata. In application studies, WMS has not been formed with ArcGIS Server software by using "shp" file that known as vector data format. WFS was formed by transferring features that are in "shp" file to "mdb" file. To be able to service more than one raster files with a WMS, ArcGIS software's "mxd" file, which has these raster data, must be introduced to service. ArcGIS Server software creates WMS for each introduced raster file. Therefore, map requests of more than one raster layers are able to made from service that formed with "mxd" file. Software holds metadata of formed service in different file. User must introduce metadata of layers by creating itself or must use "mxd" files to be able to make change in metadata of service's layers. It is observed that performance of ArcGIS service formed by "jpg" file is better than performance of ArcGIS service formed by "mxd" file.

According to results that obtained from performance tests of software, response time of Geoserver service is 3% better than Mapserver service (Second test; Geoserver 3.32 sec, Mapserver 3.42 sec) were determined. A similar result was revealed in tests carried out by Aime et al (2008) (Geoserver 486 ms, Mapserver 659 ms). In case WMS, which was created by ArcGIS Server software, uses "mxd" document, response time is higher than other WMS (Second test at 4.77 sec); in case WMS uses directory names of data, response time is better than other WMS (Second test; 3.13 sec) were determined.

According to these results, if a user, who wants to create WMS, is not advanced user, it is not recommended to use the Mapserver software. Inexperienced users can use Geoserver or ArcGIS Server software. Those, who want to use the ArcGIS Server software, should know they will become dependent on specific data and file formats. Also the user should know that

data format, which was shown as source, will effect WMS performance importantly.

Our institutions which are producing geographic information, can service their geographic information easily, through appropriate services to OGC standards. Our institutions which need geographic information, can obtain needed information easily by using this services. So that repetitive production of the same data is prevented. Both our country and our employees get benefit in point of time and cost. In addition, by using and sharing geographic information at the same standards, interoperability and coordination can be ensured.

#### References from Journals:

Yang, P., Cao, Y. and Evans, J., 2007. WMS Performance and Client Design Principles. *Journal of GIScience & Remote Sensing*, 44(4), pp. 320-333.

#### References from Other Literature:

Aime, A., Deoliveria, J., 2008. Comparing the Performance of Open Source Web Map Servers. In: *OpenGeo*, New York.

Aktas, M.S., Aydın, G., Fox, G.C., Gadgil, H., Pierce, M. ve Sayar, A., 2006. Information Services for Grid/Web Service Oriented Architecture (SOA) Based Geospatial Applications. In: *Community Grids Lab*, Indiana, pp. 1.

Bakırtaş, T., Elefante, D., Mataracı, O. and Akküçük, U., 2005. Ulusal Mekânsal Veri Altyapısı (UMVA) Oluşturulması ve Yönetimi. In: *TMMOB Harita ve Kadastro Mühendisleri Odası 10. Türkiye Harita Bilimsel ve Teknik Kurultayı, 28 March-1 April 2005*, Ankara, pp. 10.

#### References from websites:

<http://geoserver.org> (accessed 29 May. 2009)

<http://mapserver.org> (accessed 04 Jul. 2009)

[http://presentations.opengeo.org/2008\\_FOSS4G](http://presentations.opengeo.org/2008_FOSS4G) (accessed 14 Aug. 2009)

<http://terraserver-usa.com> (accessed 14 Aug. 2009)

<http://tr.wikipedia.org> (accessed 13 Aug. 2009)

<http://www.esri.com> (accessed 04 Jul. 2009)

<http://www.iso.org/iso> (accessed 13 Aug. 2009)

<http://www.isotc211.org> (accessed 13 Aug. 2009)

<http://www.mortbay.org/jetty> (accessed 13 Aug. 2009)

<http://www.opengeospatial.org> (accessed 19 Nov. 2008),

Beaujardiere, J.(Editor), 2006. "OpenGIS Web Map Service WMS Implementation Specification / Version: 1.3.0". <http://www.opengeospatial.org> (accessed 15 Mar. 2006)