Quality of Geo Web Services – Elements, Measures, Procedures

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Abstract

Geo Web Services (GWS) like for example the OGC WMS and WFS are widely used nowadays especially within the many regional, national and international Spatial Data Infrastructures (SDI). Therefore the quality of these Geo Web Services gains more and more importance. But till now there is no commonly accepted quality model for this purpose although an OGC work item related to this has been established recently. Within a project for the SDI of the Geographic Information Service of the German Federal Armed Forces we have defined elements, measures and related procedures to describe and to determine the quality of Geo Web Services and to deliver quality information (metadata) to the users. Some of the results of the project are outlined in this paper.

Keywords: Quality of Geo Web Services, Measures for Quality Elements, QoS Metadata

1. Background

In the last decades a lot of effort has been yield to establish regional, national and international Spatial Data Infrastructures (SDI), in Europe according to the INSPIRE[1] directive. For the implementation of SDIs more and more Geo Web Services (GWS), based on specifications of the Open Geo-spatial Consortium (OGC), are used. With the growing number of used GWS, especially the Web Map Service (WMS) and the Web Feature Server (WFS), a growing awareness regarding quality aspects can be observed. According to ISO 9000 quality is understood *as "the degree of a set of inherent characteristics which fulfil requirements"*. In consequence the Quality of Service (QoS) information has to provide these "characteristics" and to match the needs of service requestors with those of the service providers. To be able to provide this quality information a so called quality model including the elements describing the QoS as well as measures for the element are needed. A provider should also know how this information can be gained. These QoS metadata on the services enable users to decide if a service is usable for them or not. The QoS Requirements for general Web Services as well as the basics of Web Services are discussed for example in (Rajendran and Balasubramanie, 2009).

For the QoS of general Web Services there are a number of proposals available, e.g. by W3C (W3C, 2003). This proposal focuses on general Web Services, without any geospatial consideration. Related to Geo Web Services there are some proposals developed in SDI projects, e.g. within INSPIRE

[1] https://inspire.ec.europa.eu/

(INSPIRE, 2013). But till now there is no commonly accepted quality model for this purpose although an OGC work item related to this has been established recently[2].

Within a project for the SDI of the Geographic Information Service of the German Federal Armed Forces we have studied a number of different proposals and found out that the definitions of the identical elements are not consistent there and that the approaches are not fulfilling the requirements of the users in our project. Therefore we defined elements, measures and related procedures to describe and to determine the quality of Geo Web Services and to deliver quality information to the users. The proposal has been presented to OGC already and will be discussed within the working group in future. Some of the results of the project are outlined in this paper. In the next section we discuss some general issues of QoS and present the QoS model. After that the determination of the QoS information is outlined as well as the concept how the information is transferred to the user. Finally some conclusions are given.

2. Quality of Services – general issues and quality model

During the last years we have investigated some issues related to QoS intensively. We have set up a testbed for Geo Web Services and we have investigated the performance and capacity of Geo Web services, which are of course depending from each other. The quality (e.g. the performance) depends on the setup of the service, the available resources of the hardware etc. If the quality of the service was checked and the results were not satisfactory, the setup of the service can be improved, by e.g. increasing the resources of the hardware. This is part of a general procedure for measuring the quality of a Geo Web Service, which has been introduced.

More details about this procedure / evaluation workflow, the set-up of the testbed and the investigations related to performance and capacity can be found in (Schmid and Reinhardt, 2015) and the literature given there.

In our project we now have extended this work to a more general quality model and have defined workflows for the determination other quality elements also.

To define the set of quality elements workshops have been performed with the provider and users of the services to gain information on their requirements. The results in a very compacted form:

1) User wants to download data via a browser or other software (e.g. GIS). (and wants to know which software is interoperable with the service)
2) User wants to get a correct response at any time.
3) User wants to get the response in a reasonable time.
4) User wants to use a service, which complies to a certain security level.
5) If no data can be sent, the user wants to know why.
6) From a providers point of view a service has to be in line with the IT policy (regulatory)

This lead to the general requirement that a set of quality elements have to describe the QoS and must be provided to users (as service metadata) that they can decide if the quality of the service is sufficient for them or not.

[2] http://www.opengeospatial.org/projects/groups/qosedwg

The developed Quality of Service model is given in table 1.

Name	Definition	Measures/Information
Accessibility	Represents whether the web service is operational, meaning that the service is capable of serving the client's requests.	Percentage of successful requests
Interoperability	Describes with which client software the service can be used.	Textual information
Regulatory	Describes to which standards and regulations the service complies with.	Textual information
Security	Describes, which security measures are taken into account for running the service (security level), e.g. related to authentication, authorization, encryption	Textual information
Robustness	Describes how incomplete or false inputs are handled.	Textual information
Correctness of response	Percentage of responses that are correct. The precondition is, that a valid request was send to the service and a response was send to the client, which is not an error message.	Percentage of requests with correct answers
Performance	Time that the server needs to handle the maximum amount of requests with the given reliability.	Average elapsed time from sending a request to getting an answer
Capacity	Number of requests the server is able to handle in a certain time interval	Average number of simultaneous requests which can be handled in a certain time interval

Table 1: Model of the Quality of Services

This model is a proposal, provider can decide themselves if all elements are mandatory.

3. Quality of Services – Workflow issues and dissemination

With regard to the length of this paper only the workflow to determine the accessibility value of a service is outlined shortly here.

Figure 1 demonstrates the request from a client to a server in a common Client/Server architecture. A Web Service is available if a service request succeeds or returns information within a predetermined time frame. In figure 1, the connections 1 to 3 represent the route of the user's request to the service. Connections 4 to 6 on the other hand represent the route of response from the service to the client. Connections 1 and 6 are connections from the user to the World Wide Web (WWW) or the network and back. The connections 2 and 5 represent the connection to the server and the response from the server respectively. Although a server can be reached, this does not mean that the service is also available. It is possible that the service is accessible from the server, but has no connection to the WWW or the network and thus has no use for the client.

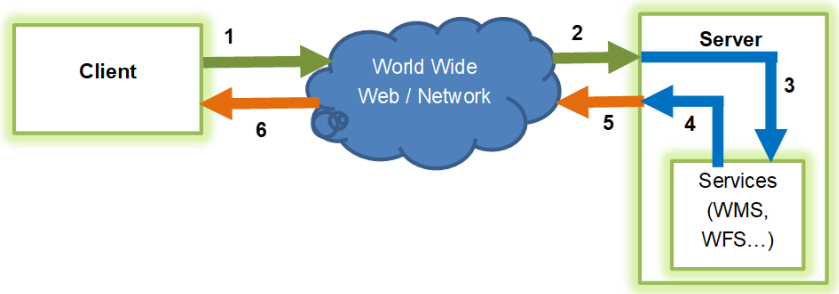

Figure 1: The route to services from a client.

To measure the accessibility of services, service requests must be sent and the responses have to be analysed. Here also the Sub-services, also called requests (e.g. Get Capabilities or Get Map for WMS) must be considered. For sending the requests methods like SNMP or Ping can be used. Further it has to be decided how long the test period is chosen (maybe 24 hours) and what is the interval between the requests (maybe 5 seconds). In our case a Java client was written to perform this requests. Finally equation 1 can be used to determine the value for the accessibility. This value can be calculated for the sub-services and as an average over all sub-services for the service itself.

$$\text{Accessibility} = \frac{100 \ x \ No.of \ successful \ requests}{No.of \ total \ requests}$$

Equation 1

Figure 2 gives an example how the accessibility info can be encoded in XML.

```
<accessibility service = WMS uom="%">
   <GetCapabilitiesValue> 99.00 </GetCapabilitiesValue>
   <GetMapValue> 98.52 </GetMapValue>
   <GetFeatureInfoValue> 99.83 </GetFeatureInfoValue>
   <CombinedValue> 99.12 </CombinedValue>
</accessibility>
```

Figure 2: Accessibility metadata

Finally the QoS service metadata has to be transferred to the user. This can be done by extending the Get Capabilities document or by a separate Get Quality Info request and a separate document which has to be send after this request and includes the QoS metadata. In our case we decided to take the option mentioned last, because of a better clearness. The request for the new GetQualityInfo service for the WMS looks like following:

- WMS = host/geoserver/ows?service=wms&version=1.0.0&request=getQualityInfo

For the complete QoS metadata (WMS and WFS requests) an XML schema has been developed which can´t be presented here with regard to the length of the paper.

4. Conclusion

We have presented a proposal for QoS metadata as a base for further discussions and procedures to determine the related values. Quite a number of practical tests have shown that the concept and the related tools are applicable.

5. Acknowledgements

The project was financially supported by the Geographic Information Centre of the Bundeswehr (German Federal Armed Forces) which is gratefully acknowledged as well as the contributions of M.Sc. Imran Hossain, M.Sc. Charlotte Kunz and M.Sc. Pascal Jarcyk.

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All Web resources have been checked on June 12-14.