How to assure the quality of services of an SDI

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Cómo asegurar la calidad de los servicios de una IDE

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Abstract

To establish a reliable SDI, measuring, improving and communicating information about the Quality of Service level is a key success factor. The criteria should include availability, performance and capacity of the SDI components. Having said that, the big challenge has been to develop a standard way of communicating the expected Quality of Service level to the end users.

Methodologies and tools discussed here aim to solve the issues above by: Testing the capacity of services to meet requirements (like INSPIRE View and Download Services); Keeping track of uptime and performance; Identifying trends affecting service level and availability; Validating the service through the check of the capabilities document against INSPIRE and OGC Standards; Establishing thresholds for indicators and setting up alerts and warnings; Measuring the impact of implemented improvements to end users.

Concluding, by doing fine-tune adjustments to the infrastructure according to the findings discussed above, will lead to an effective optimization of investments in the SDI, which ultimately brings more development to the related region.

Resumen

Para establecer una IDE fiable, el medir, mejorar y difundir información sobre el nivel de calidad de sus servicios es un factor clave de éxito. Los criterios deben incluir la disponibilidad, el rendimiento y la capacidad de los componentes de la IDE. Dicho esto, el gran reto ha consistido en desarrollar una manera estandarizada de comunicar información sobre el nivel de calidad de servicio esperado a los usuarios finales.

Las metodologías y herramientas discutidas aquí tratan de resolver el problema mencionado arriba: verificando la capacidad de los servicios para cumplir los requisitos INSPIRE, como los delos servicios INSPIRE de visualización y descarga; haciendo un seguimiento de su disponibilidad y rendimiento, identificando tendencias que afectan al nivel de servicio y disponibilidad; validando los servicios mediante el chequeo del documento de capabilities con los estándares OGC e INSPIRE; estableciendo umbrales para indicadores y estableciendo alertas y avisos; midiendo el impacto en los usuarios finales de las mejoras implementadas, y para concluir, haciendo una sintonización fina de la infraestructura de acuerdo a los resultados encontrados mencionados más arriba, lo que conduce a una optimización efectiva de las inversiones en una IDE, que finalmente proporciona un mayor desarrollo para la región.

Keywords: SDI, spatial web services, interoperability, quality of service, reliability of service, performance of service, web map service, web feature service, OGC, INSPIRE.

Palabras clave: IDE, servicios espaciales, interoperabilidad, calidad de servicio, fiabilidad de servicio, rendimiento de servicio, Servicio Web de Mapas, Servicio Web de Objetos Geográficos, OGC, INSPIRE.

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1. INTRODUCTION

The volume of spatial data collected keeps increasing rapidly with ever more powerful and more detailed ways for observing and simulating our environment and the human behaviour. Continuously available Spatial Data Infrastructures (SDIs) are required to create usable information from the vast amount of data by effectively querying and using it from a site possibly located on the other side of the world. A good SDI makes it possible to discover, filter, acquire and interact with spatial data required for a particular use case in a reliable, efficient and easy-to-use manner. A good example of this is the Infrastructure for Spatial Information in the European Community (INSPIRE), which legally mandates the EU member states to ensure that spatial data services and data sets are interoperable (figure 1) within the European Community.

2. METHODOLOGY AND RESULTS

Large scale Global and national SDIs are not the only technical environments, where up-to-date spatial data needs to be reliably available at all times. Spatial information is also a fundamental part of room, household, vehicle or office scale sensors and control networks taking an essential role in the Internet of Things (IoT). Keep the service health up (figure 2) is very important in this kind of networking environments, where hardware and software components manufactured by different vendors need to establish ad hoc connections, discover the capabilities of each other and communicate mostly in an automated manner.

The technical standards aiming at increased interoperability of spatial data, services, and applications created by OGC and INSPIRE form a solid base for well-functioning Spatial Data Infrastructures. However, the technical capabilities of a particular software and hardware components alone is not enough to guarantee a fully functional and reliable distributed spatial data infrastructure. Even the most interoperable and advanced SDI components can be configured and connected sub-optimally, making their use difficult, inefficient and unreliable as parts of an SDI. As within any computer system, the SDI components and the networks connecting them also occasionally suffer from technical failures, which temporarily renders them unusable or unreachable for all or some of the users. The field of Quality of Service (Picture 3) deals with estimating, reporting and improving the experienced quality of communication between the components of distributed systems to inform users leveraging their capabilities to solve real-world problems.

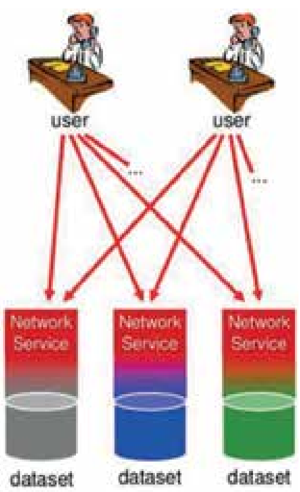


Figure 1. Interoperability scheme

Service health	Now: ●	Last 7 days	Year 2017
Availability		100%	100%
Total downtime		0 hours	0.1 hours
Pre-announced service interruptions		0 hours	0 hours
Unexpected downtime		**0 hours**	**0.1 hours**

Figure 2. Service health

Figure 3. Quality of Service

To establish a reliable SDI, measuring, improving and communicating information about Quality of Service criteria is one of the key success factors. These criteria include availability (figure 3), performance based on the response time (figure 4) and capacity (figure 5) of the individual SDI components. Mature tools for measuring analysing the QoS of these do exist, but there is little to no support for a standardised way of communicating the expected QoS level of the services to the end users.

Methodologies and tools exhibited here aim to solve the issues above by:

Testing the capacity of services by generating realistic loads of requests per second, ranging from light to heavy use (figure 5), so that bottlenecks can be identified and removed, and services can be prepared and modified in order to meet capacity requirements like those defined for INSPIRE View and Download Services. The tests typically send thousands of requests to the server(s) under test within a relatively short period of time. The requested area of the place-related requests, like the ones using WMS GetMap or WFS GetFeature operation, is varied from one request to another to ensure

Figure 4. Performance of a service based on response time

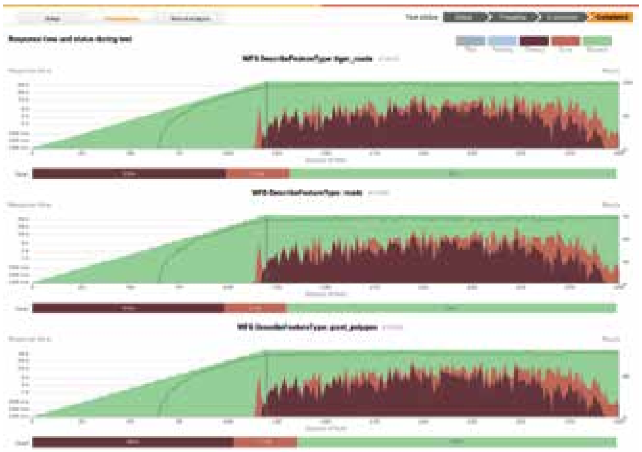


Figure 5. Test of capacity using realistic loads

realistic test data results. The variation algorithm leverages the technology of generating requests in a way that the request area variation helps to verify the functionality and efficiency of any caching or tile pre-calculation scheme that has been configured to improve the service performance;

Keeping track of uptime by registering the service interruptions (figure 6) for the services in the range as well as looking at the number of requests that were hindered due to service interruptions shed some light to the level of the quality of the service delivered to users;

Identifying trends affecting service level and availability (figure 7). By combining the information of most popular services with the ones with biggest changes in speed for the same period, you may find associations that can help to take more effective decisions finding from where the issues are coming;

Validating the service capabilities document against INSPIRE and OGC Standards (figure 8). Validation is embedded for use for WMS Implementation Specification v1.3.0, WMTS Implementation Specification v1.0.0 and INSPIRE View Services v3.1. Validation test suites for compliance with other OGC specifications are available at http://cite.opengeospatial.org/teamengine/. These are included for the relevant parts in the new INSPIRE validator at http://inspire-sandbox.jrc.ec.europa.eu/validator/ (work in progress);

Establishing meter thresholds for indicators (figure 9). Each organisation typically has their own thresholds for the Quality of Service of the services they use, whether the services are owned by themselves or provided by external parties. The follower organisation specific response time and error amount

Figure 6. Keeping track of uptime

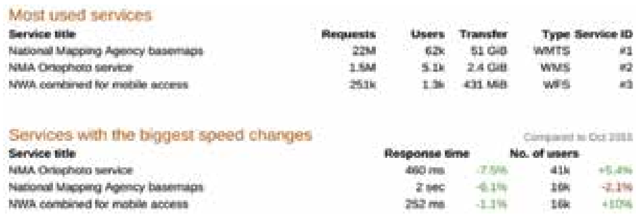
thresholds for a service are specified by an indicator. Indicators take the monitoring information produced by one meter, and derive the value for the current Quality of Service status for the service based on the monitoring results produced by that meter.

And setting up alerts and warnings (figure 10). When an indicator changes the Quality of Service status of a service from "OK" to "Warning" or "Error", it creates an alert and records this alert event in the monitoring database.

Measuring the impact of the implemented improvements to end users: One useful measurement that can be made after the implementation of a change which is expected to improve the speed of the services is the impact of saved time by users of the service or group of services included in the count. In the picture (figure 11) below we show the difference of a particular month to the previous 6-month average response time multiplied by the monthly requests, counted for all services included, e.g. The results can be incredible;

3. CONCLUSIONS

As conclusions, the Quality of Service can be maintained as high as reasonably possible by implementing some fine-tune adjustments to the infrastructure, based on the information generated by some intelligent analysis of both the performance and usage of the services combined, as the findings discussed above. Also, the utilization of customized



Most used services

Service title	Requests	Users	Transfer	Type	Service ID
National Mapping Agency basemaps	22M	62k	51 GiB	WMTS	#1
NMA Ortophoto service	1.5M	5.1k	2.4 GiB	WMS	#2
NMA combined for mobile access	251k	1.3k	431 MiB	WFS	#3

Services with the biggest speed changes — Compared to Oct 2015

Service title	Response time		No. of users	
NMA Ortophoto service	460 ms	-7.5%	41k	+5.4%
National Mapping Agency basemaps	2 sec	-6.1%	16k	-2.1%
NMA combined for mobile access	252 ms	-1.1%	16k	+10%

Figure 7. Trends in usage affecting service level

Figure 8. Validation against OGC and INSPIRE

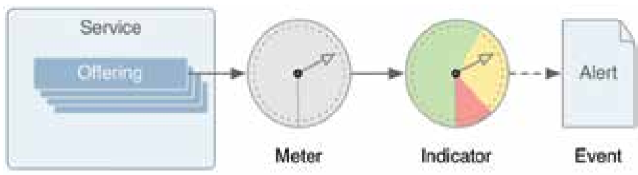


Figure 9. Service meters and indicators

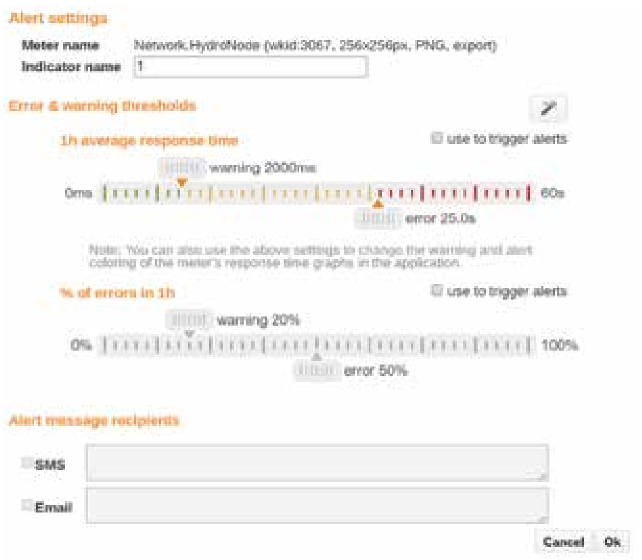


Figure 10. Alerts and warnings for service-level indicators

Figure 11. Time saved by users

reports and dashboards with easy and friendly visualization of indicators by the management level, aligned with the overall strategy of the organisation, can lead to a virtuous loop of optimization of investments for the SDI in an automated fashion, generating benefits to internal and external, private and public users, ultimately bringing more development to the correspondent city, region or country.

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