INTEROPERABILITY QUALITY IN REPOSITORIES OF LEARNING OBJECTS

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ABSTRACT

There is currently a great proliferation of learning object repositories, the main objective of which is to reuse the teaching content they contain. Whether putting together the content, implementing the repository or deciding upon the search system to be used, compliance with a series of standards and specifications is necessary if these repositories are to work properly. The majority of these standards are based on web services and SOA. This article analyzes how we can ensure the quality of this web services in the scope of interoperability between learning object repositories.

KEYWORDS

e-learning, repositories, interoperability, standards, web services, QoS.

1. INTRODUCTION

Digital repositories, in the broadest sense of the term, are used to store any sort of digital material. However, digital repositories for learning objects are much more complex in terms of what needs to be stored and how to store it. The purpose of a digital learning object repository is not simply to store and distribute learning objects, but to allow them to be shared by different users and, above all, to make it easier to reuse them in different training activities. From the point of view of users, the advantage of these repositories consists in having access to the content stored in them. For this to be possible, the content must be put together by means of certain procedures, norms and standards whose application is aimed at encouraging the reuse of the learning objects. Moreover, the repository itself must follow a series of specifications and standards which enable the content it stores to be searched and facilitate interoperability with other repositories.

These specifications and standards are based on web services and service-oriented architecture (SOA) to ensure interoperability; if these services haven't sufficient quality may be detrimental to the operation of learning platform that students are using. In the following sections of this article, the different specifications and standards in the area of interoperability will be treated and how we can ensure their quality.

2. INTEROPERABILITY AND WEB SERVICES

The IEEE defines interoperability as the ability of two or more systems or components to exchange information and to use the information exchanged. In the field of learning object repositories, there are specifications and standards (hereinafter "norms") which enable the exchange of the teaching contents they store and consequently achieve the reuse of those contents in different training projects.

These norms may be classified as follows:

1. Norms geared towards building and defining the learning object itself, that is to say, its content and metadata.
2. Norms geared towards the search for learning objects by making it easier to locate resources in different repositories.

3. Norms designed to assist in the design of repositories whose aim is interoperability and which therefore specify software architecture for their construction.

The Web services constitute a reusability mechanism of distributed software components. They can be registered and published in the Web, and they make use of open and standard protocols of Internet, like HTTP, XML, UDDI, SOAP and WSDL, that solve the interoperability problem among the different technologies and software platforms.

2.1 Quality of Service

With the great proliferation of web services in the current use of Internet has made necessary the creation of requirements capable of quantifying the quality of a service [1]. In this way, service suppliers can be classified according to its quality. The requirements for measuring the quality of web services can be found in the different layers of the QoS stack (Figure 1) and cover issues such as performance, reliability, scalability, availability, accessibility, interoperability and security. Below are the most significant.

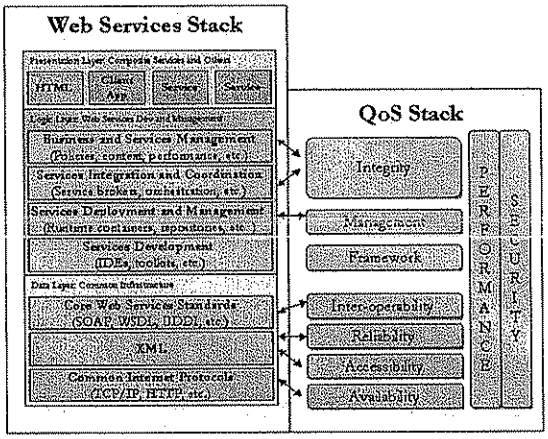

Figure 1. Quality of Service Stack

The performance of a web service represents how fast a service request can be completed. Web services should be provided with high reliability, which represents the ability of a web service to perform its required functions under stated conditions in a specified time interval. Scalability represents the capability of increasing the computing capacity of service provider's computer system and system's ability to process more users' requests, operations or transactions in a given time interval. Capacity is the limit of the number of simultaneous requests which should be provided with guaranteed performance. Robustness represents the degree to which a web service can function correctly even in the presence of invalid, incomplete or conflicting inputs. Web services should be provided with the functionality of exception handling and should be handled properly. Accuracy is defined as the error rate generated by the web service. Integrity for web services should be provided so that a system or component can prevent unauthorized access to, or modification of, computer programs or data. Accessibility represents whether the web service is capable of serving the client's requests. Availability is the probability that the system is up and related to reliability. Web services should be interoperable between different development environments used to implement services so that developers using those services do not have to think about which programming language or operating system the services are hosted on. With the increase in the use of web services which are delivered over the public Internet, there is a growing concern about security. Security for web services means providing authentication, authorization, confidentiality, traceability/auditability, data encryption, and non-repudiation.

3. INTEROPERABILITY SPECIFICATIONS AND STANDARDS

Within the world of e-learning exists a set of norms (standards and specifications) to ensure interoperability between different learning systems and more specifically those related with learning object repositories [2]. Of these set of norms we will focus primarily on those that use of web services technology as the basis for its construction.

The first standards are aimed at the generation, documentation and packaging of learning objects. Its main feature is the description of the object using metadata. The main norm to comply in the description of the metadata of a learning object is LOM. With respect to packaging, we outline the two most used standards today that are SCORM and IMS Common Cartridge belonging to a broader standard called Digital Learning Services Standards. Interestingly, in the Common Cartridge has added a new feature not present so far in the educational content packaging IMS call Web Service Authorization. It consists of an authorization protocol based on Web services that enables the editor of a package to control access to their contents.

One of the basic pillars of interoperability between learning object repositories is the ability to search their contents. Recently, search systems have evolved from only working in one repository to working simultaneously in various distributed repositories; this is known as "federated search". In this kind of search is widespread to use of web services, so that these services act as intermediaries between different learning objects repository. A proof of this is found in the standard SQI [3]. Examples of repositories that implement federated search through SQI can be found in Merlot, Ariadne or GLOBE.

SQI was defined by the CEN (European Committee for Standardization). It forms part of a public initiative known as the CEN/ISSS Learning Technologies Workshop, whose commitment it is to guarantee interoperability between learning object repositories. Thanks to these efforts, three APIs (Application Programming Interface) appeared: Learning Object Interoperability Framework, Authentication and Session Management and Simple Query Interface Specification. SQI uses XML as the language for receiving information requests and for returning the results. It also highlights the SPI (Simple Publishing Interface) standard, also devised by the CEN. This is an API for publishing data and metadata in a repository. It provides a simple protocol which is easy to implement and integrate in already existing systems.

Finally it is noted that service-oriented architectures (SOA) are starting to be uses massively for building e-learning systems and learning object repositories. We may find a number of interesting norms for the design of these systems to ensure interoperability and to be defined as the architectures of computer systems that support them. The most interesting is IMS Abstract Framework, a framework that covers the entire range of possible e-learning architectures that could be constructed from a set of services based on SOA. It focuses on support for distributed training systems and one of its principles is interoperability.

On the other hand we find CORDRA that is one of the most detailed architectures. An open, standard-based model, it allows designed software systems which are intended for the discovery, sharing and reuse of teaching material through interoperable repositories. From Ariadne, an architecture has been proposed for repositories which implement SQI-based federated searches.

4. ENSURE QUALITY IN INTEROPERABILITY

After studying the main requirements that ensure quality in Web services standards and specifications, and more important in the field of interoperability of learning object repositories, we can conduct a study of how we can apply these requirements to ensure quality. We start with the design and construction of the information system that represents the repository of learning objects. The system will have a service-oriented architecture (SOA) as well as being compliant with the directions provided to us by major institutions such as IMS or Ariadne. We must apply the following requirements to ensure the quality of the final system: robustness, exception handling, accuracy, integrity, accessibility, interoperability and security.

As discussed in the previous section, federated search of learning objects are a basic pillar in the interoperability of repositories. It is precisely this kind of search where we must ensure quality. Consider a user who searches for a very general subject. It can happen that an answer to this type of search is very slow due to the amount of learning objects found or because of the large number of repositories queried. To alleviate this problem, we can restrict the search to only those repositories that ensure good quality. But the question is how do you measure the quality of a repository?

When we added a repository to a federated search system, we must try to measure its quality clearly. This we will require a series of tests on the repository. The tests consist in measuring the performance requirements, reliability, capacity, robustness, exception handling, accuracy, accessibility, availability and security of Web services that implement the SQI specification. It would also be interesting to know whether the repository has fully implemented the specification, because as we showed in [4] not all repositories fully implement the specification.

Performance is measured by running various queries in the repository of learning objects under evaluation. These searches will be conducted so that the number of learning objects matching the search parameters is sufficient to have results of various types, i.e., conduct searches ranging from very general concepts to more practical, in order to have a wide range of test cases. Reliability is measured by the number of faults detected in a given time interval. The capacity is given by the parallel execution of several searches to determine the maximum number of simultaneous searches that the repository can support, in accordance with acceptable performance. The robustness and handling of exceptions may be quantified when searching with incorrect input parameters and examined the response of service in the form of received error codes, pre-set by SQI. The accuracy is given by the exactitude in search results and failures. The accessibility and availability represent the reliability of the repository and will be provided by the repository's capacity to respond satisfactorily to all search requests are made, and can quantify how many have failed or have presented invalid results. Finally we have the issue of security, this is given in a straightforward manner in the management of those learning objects subject to copyright and even payments associated with their use. Tests should be conducted to ensure both the protected application and the payment of these learning objects.

Therefore, the administrator of a federated search system should perform a battery of tests such as those posed above to each repository, and then, classify them by their quality. In that way, users will be able to search only in quality repositories. It's also possible to assign a weight to each of these formal requirements, so that any requirement can gain importance in relation to others.

5. CONCLUSION

The proliferation of standards and specifications based on web services that focus on interoperability between e-learning systems, and more specifically of learning object repositories, is very wide. For this reason, it is essential to provide techniques and mechanisms to ensure quality of these services.

We can say that to build a fully interoperable e-learning system or a learning object repository of quality, it must be compliant with a series of very clear rules and enforce quality requirements, previously stated. The steps to follow to have a quality and interoperable repository can be summarized:

1. A service-oriented architecture must be employed, the analysis and design software which will host system,
2. SQI specification compliance is mandatory to integrate the repository in a federated search system
3. Quality requirements must be implemented over deployed web services.

The use of web services and service-oriented architectures are an essential part of many norms that the main public institutions in the world of e-learning publish. Therefore, it is essential to implement quality measures to ensure that the resulting systems are good enough to meet customer needs.

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