NEW WEB SERVICES BASED ON-THE-FLY SMIL GENERATOR ARCHITECTURE FOR HIGHLY AVAILABLE ELEARNING PRESENTATION

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Abstract: Learning objects are usually targets to transfer from one repository to another or subject to modifications due to the unavailability of the server running the repository. Synchronized Multimedia Integration Language (SMIL) has recently become increasingly important in eLearning environments to integrate learning objects into a synchronized complex multimedia web presentation. However, this standard specification lacks the ability to provide alternative links in the case of repository unavailability and may occasionally lead to broken links. An outline of various aspects of the design and implementation of web services based on-the-fly SMIL generator architecture (WSOSGA) is presented in this paper. WSOSGA consists of three tiers which cooperate together in a simple way to search for multimedia learning objects both locally and in the internet, rank them based on learning objects (LO) author considerations, generate and publish the corresponding SMIL document and its XML profile. The latter will be used by the web services tiers on the target web server to generate SMIL documents on-the-fly. The major advantage of WSOSGA is thus achieved to give SMIL presentations high availability in eLearning instructional content.

1 INTRODUCTION

Technology enhanced learning has become one of the most important applications of the multimedia information network (Meleis, 1996). Learning experiences by electronic technology are expanding rapidly since the World Wide Web (WWW) technologies have been adapted in the eLearning process. Learning Objects (LO), which may form digital or non-digital entities, are the base components of eLearning systems. They can be used, reused or referenced during technology supported learning. However, integrating heterogeneous LOs such as video, audio, text, and pictures into a standard format is a considerable challenge. It requires the organization of LOs in both spatial and temporal dimensions and subsequently supporting a hypertext structure to provide interactivity. Several solutions, including MHEG (Prie, 1993) and HyTime (ISO/IEC et al., 1997), have been proposed to resolve this challenge, but the Synchronized Multimedia Integration Language (SMIL) remains the most suitable standard for the creation and management of multimedia presentations (W3C Recommendation).

Link management has been examined thoroughly through display of links to a particular object, detection of dangling links, and display of links relevant for selected structure or channel view items (Rutledge et al., 1999). Existing tools for writing SMIL documents such as Smily, provide a powerful and controllable authoring environment close to the well-known WYSIWYG paradigm used by usual word processors (Kodali et al., 2004) A modification to SMIL in order to enhance its performance lead to the new unbreakable synchronization constructs SMIL version (uSMIL), where parallel and sequential constructs require that all their components be played out, otherwise or none is played. Nonetheless, no solutions were provided to dynamically substitute the broken links (Muriel et al., 1999)

In addition, SMIL provides a set of XML tags for building interactive multimedia presentation that may include animations and hyperlinks. SMIL is not an attempt to specify the data formats of time-based media; but rather it provides a way for authors to

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schedule operating time-based media within documents. The multimedia LOs are usually referenced by simple URL hypertext links and stored on distributed repositories. These repositories may not be available at all times due to hardware or software malfunctioning, which subsequently lead to broken links.

Furthermore, the newer version 2.0 of SMIL contains modules referred to as structure, layout, media, content control, linking, timing and synchronization, animation, time manipulations, transition effects and meta information. Unfortunately, none of these modules deal with the problem of repository unavailability (Sampaio et al, 2001).

In this paper, the design architecture and implementation of web services based on-the-fly SMIL generator architecture (WSOSGA) is presented. The proposed WSOSGA architecture consists of three tiers which are synchronized to search for multimedia LOs both locally and in the internet. The new design is able to rank, generate and publish the corresponding SMIL document and its associated XML profile. This gives the web services tiers on the target web server the ability to generate SMIL documents on-the-fly. The major advantage of WSOSGA is thus achieved to give SMIL eLearning instructional content presentations high availability.

2 SYSTEM ARCHITECTURE

The proposed new architecture is presented in Figure (1). The architecture consists of three tiers. The first tier is for the client which includes the SMIL editor that is used to compose SMIL documents. This tier can search for LOs in distributed repositories. The SMIL editor will also rank LOs of the same category and generate a corresponding XML profile which includes the alternative links that will be used in case of repository unavailability depending on the ranks selected. Tier two is the Master Web Service (MWS) which is responsible for the on-the-fly generation of SMIL documents based on XML profile. The last tier is Image-Video-Audio-Text (IVAT), which is a set of dynamically multithreaded web services responsible for the process of checking the availability of multimedia objects on the specified repositories.

From an architectural viewpoint, WSOSGA has two different use cases, one from the authors of SMIL documents viewpoint and the other from the users of SMIL documents viewpoint. The client tier handles the processes of the author's use case, while the middle and backend tiers handle the processes of user's case.

2.1 Client Tier

The client tier consists of the SMIL user interface editor which is utilized to compose documents based on SMIL 2.1 specifications (W3C Recommendation). These specifications divide the document area to several regions using the <region> tag (Synchronized Multimedia on the web). Each region is dedicated to one type of the multimedia objects, mainly image, video, audio, and text. The SMIL editor acts as a web services client with search capabilities through local and distributed repositories for LOs that match the user criteria.

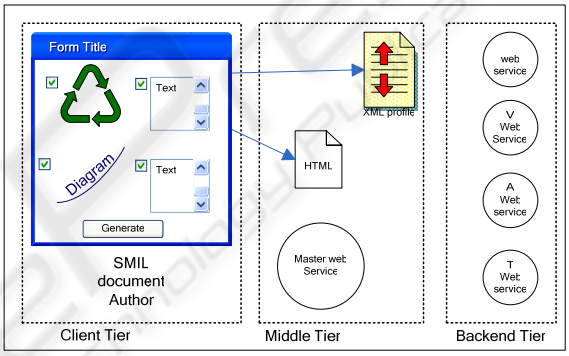

Figure 1: WSOSGA architecture and SMIL document author's use case.

A list of retrieved LOs will be shown to the user to rank based on specific considerations. Rank weights will be used as the base to substitute the alternative LOs links in the case of repository unavailability. The SMIL editor will generate an HTML file and a corresponding XML profile for each document to be published on the web server. The HTML file will have a server side call for the MWS in the middle tier as illustrated in Figure (1). The XML profile will thus be used by the MWS as an entry parameter to generate the SMIL document on-the-fly.

2.2 Middle Tier

Middle tier contains the MWS, which is hosted on the web server and can act as a web service client. While users browsing the multimedia presentation, a HTTP request for the corresponding HTML file will be generated. The HTML will initialize a SOAP, http://www.w3.org/TR/ws-addr-soap, server side call for the MWS with the corresponding XML

profile as a parameter. Once the MWS is invoked, it will parse the XML profile and starts generating the SMIL document. The MWS will make a synchronous SOAP call for the corresponding IVAT web service in the backend tier throughout the generation process if a clear URL reference is encountered, as in shown in Figure (2). The list of links for LO that was ranked by SMIL document author will be passed as a parameter for the IVAT web services: I, V, A, and T corresponding to the object type: Image, Video, Audio, and Text. The MWS will generate SOAP synchronous calls to the corresponding IVAT web service as the number of alternative links to each individual LO in XML profile; each link will be processed in a separate thread of the corresponding IVAT web service.

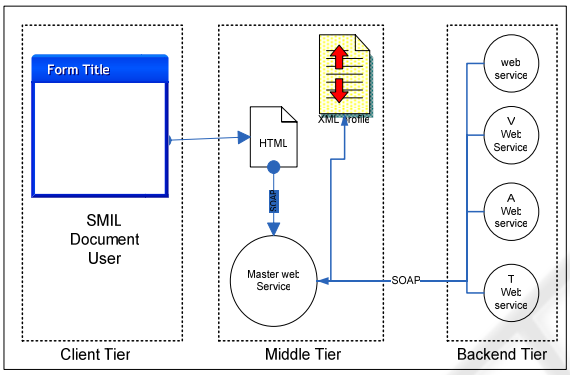

Figure 2: WSOSGA SMIL document user's use case.

2.3 Back-end Tier

Back-end tier consist of the IVAT web services, which are a dynamically multithreaded web services. IVAT web services are used to check the availability of the corresponding LOs. Once the IVAT web service received the SOAP asynchronous call from the MWS with the list of links to the corresponding LO as a parameter, a new thread will be invoked to process each link. The thread will check the availability of the LO by trying to retrieves it. The first thread returns with confirmation will kill the rest of the threads to maintain reasonable server performance and returns a confirmation message to the MWS. The confirmation message includes the link to the highly available LO. In this way, the MWS will generate the SMIL document on-the-fly with a committed available link to LOs, and return back to the user. Thus, the three tiers are cooperating to achieve the on-the-fly generation of highly available SMIL presentations while maintaining adequate system performance.

3 RESULTS AND DISCUSSION

Microsoft.Net 2 framework was chosen as a platform to implement the proposed WSOSGA system due to its simplicity, availability and low cost, in addition to its maturity and wide spread popularity. The SMIL editor was however implemented as an ASP.Net web application while the Internet Information Server was used to host the web application because of its ease of web-service deployment and its main characteristics as being user friendly. The web search algorithm to retrieve LOs from local and distributed repositories was an important parameter of proposed system. It was consequently decided to utilize the TREC Ad-Hoc Algorithm, http://www.w3.org/TR/ws-addr-soap, in the WSOSGA as means of Learning Objects retrieval because link-based ranking schemes outperforms keyword-based algorithm by a large margin. Such queries are quite prevalent in web search. This leads to an efficient ranking of LOs in the SMIL editor. The SMIL editor has been tested in typical network environment. Its search capabilities were compared to existing SMIL editors such as Fluition, http://www10.org/cdrom/papers/317/, GriNS Pro Edition for SMIL 2.0, http://www.realnetworks.com/products/editorpro/index.html and PresenterOne http://www.realnetworks.com/products/presenterone/index.html. The results show that this new SMIL editor outperforms traditional SMIL editors in a number of aspects, mainly speed and query quality. Integrating the proposed SMIL editor with commonly used eLearning platforms such as WebCT, Moodle and CourseWork would be a valuable element in enabling authors to rank their existing LO efficiently. This would also be an important step towards the standardization of the proposed WSOSGA system.

Master Web Service, which is the core of middle tier, was implemented based on standard web services technology in Dot.Net framework and hosted on the web server where HTML and XML profiles are hosted. The MWS here acts simultaneously as client and server by responding to SOAP requests form ASP.Net client. At the mean time, it implements the proxy file of the IVAT web services. This scheme reduces the processing overhead of mapping and results in increasing the speed of individual IVAT web services calling. The amount of overheads generated is minimized compared to the standard method of hyper linking LOs in which the clear URL appears in HTML file format. The remaining overheads that have been

created as a result of both SOAP calls to MWS and IVAT web services should be measured to estimate the processing overhead and network traffic. Measurement, which has been performed using Ipswitch WhatsUp Professional Premium tools, shows a significant increase in network traffic. In addition, the level of processing overhead caused by parsing XML profile was found acceptable because of the implementation of multithreaded MWS.

The backend tier was hosted on a separate web server, in order to maintain the system at a normal performance level. Subsequently, asynchronous SOAP calls to IVAT web services were used and each link availability was checked in a separated thread. This resulted in a highly efficient system performance and increased LOs availability. A further advantage of this scheme to the client is the transparency achieved by hosting middle tier and backend tier servers in the same LAN where the network traffic takes place.

The overall system performance may be further improved by incorporating means such as caching mechanisms. The high availability of LOs it offers remains its major advantage which makes the proposed system an efficient architecture for implementation in standard eLearning platforms, particularly from authors' perspective. Its integration in such platforms should seriously be considered.

4 CONCLUSIONS

A new system of web services based on on-the-fly SMIL generator architecture was proposed to provide high availability of learning objects for eLearning presentations. The system consists of three tiers designed to search for multimedia learning objects, publish and generate the SMIL documents on-the-fly. The system may be considered as an efficient method for implementation in standard eLearning platforms. Its speed, which is degraded by its inherent on-the-fly mechanism, may however be improved by incorporating means, such as caching mechanisms, in order to make it a competitive candidate for integration in popular eLearning platforms such as WebCT, Moodle and CourseWork.

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