

SCORM-compliant SMIL-enabled Multimedia Streaming E-Learning System in Java EJB Environment

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ABSTRACT

The emergence of the SCORM specification has shed a light toward standardization of e-learning which makes the reusability and interoperability of learning resources feasible. However, the existing SCORM-compliant asset model is over-simplified; only few asset types are defined. On the other hand, W3C's declarative-style SMIL is becoming prevalent in designing Web-based instructions with the consideration of temporality and spatiality of the presentations. In addition, advances in real-time multimedia technologies can further vitalize these instructions. In this study, we propose a SMIL-enabled asset model with the enhancement of multimedia streaming. To render SCORM-compliant SMIL-enabled streaming contents, a Java applet-based SMIL RTP/RTSP LMS system is designed in the Java EJB environment to tackle the issue of platform interoperability. The resulting system demonstrates an encouraging direction towards more vivid and interactive SCORM-compliant e-learning.

Keywords

SCORM, e-learning, SMIL, multimedia streaming, EJB

1. INTRODUCTION

The rapidly increasing expansion of the Internet has brought dramatic impact to one's life and education alike. E-learning differentiates from the traditional learning in its ability to train anyone, anytime, and anywhere attributed to the openness of the Internet. Without the temporal and spatial limitation, one can have an independent and individual learning space. In general, digitalized courseware is managed by the so-called Learning Management System (LMS), which educates learners in the courseware and keeps track of their learning behaviors. However, most courseware in different LMS environments cannot be interoperable directly, which impedes the attempt to share learning resources. In addition, the heterogeneity existing in the different LMSs is another impediment. It is inconvenient to monitor and evaluate learner's behavior from one environment to another. All these hinder the sharing of learning resources including LMSs and the contents. The emerging SCORM (Shareable Content Object Reference Model) standard has been developed to overcome these hurdles. The objective of the specification is to facilitate the interoperability between SCORM-compliant contents and SCORM-compliant LMSs, and to make the valuable resources become durable, interoperable, accessible, and reusable [1].

The present asset model of SCORM is over-simplified in supporting multimedia presentations; vivid multimedia streaming contents are usually excluded. In addition, designing the

SCORM-compliant streaming contents is not a trivial task. Synchronized Multimedia Integration Language (SMIL) [2], built on XML, proposed by W3C provides a simple way to design multimedia presentations in a similar manner to HTML documents. The SMIL specification meets three requirements of multimedia document models, namely temporal, spatial and interaction. To vitalize the asset contents of SCORM, this study proposes a new asset model based on the SMIL and RTP/RTSP standards so that the features of spatiality, temporality, interaction, and streaming control can be added into assets. The extended asset model conforms to SCORM, and thus any SMIL-enabled asset can be imported to LMS and can communicate with LMS to track the learners' learning progress. Moreover, to facilitate the interoperability of sharable course contents and LMS, we develop a LMS on the top of Enterprise Java Bean (EJB), a distributed component-based computing environment, for realizing SCORM-compliant SMIL-enabled multimedia streaming contents.

2. SMIL-ENABLED MULTIMEDIA-STREAMING ASSETS

In SCORM, the mechanism of Content Packaging is designed for packing instruction contents and the navigation sequences. In a content package, the portion of "organizations" specifies the content structure and the browsed sequence of this content. The "resources" session describes the instruction materials needed in this content, such as the type and physical location of each physical file. To create a SMIL-enabled asset, one may define an unlaunchable asset, which refers to a physical filename ending with ".smil" (see Table 1, for example).

Table 1. The unlaunchable SMIL-enabled asset

```
.....  
<!--unlaunchable asset-->  
<resource identifier="R_U1"  
  type="webcontent" adlcp:scormtype="asset">  
  <file href="resource/intro.smil" />  
</resource>  
.....
```

The `intro.smil` resource defines the rendering sequence of text, image, and sound objects, RTP/RTSP streams synchronously in different regions. Table 2 illustrates a porting of the resource.

3. SCORM-COMPLIANT LMS IN EJB

Figure 1 shows the system architecture of the LMS in the EJB environment for realizing SMIL-enabled streaming assets. Initially, the client has to download an API Adapter applet from the Object Web Server. The applet is an EJB component responsible for communicating with the LMS Server to access learning resources. There are five enterprise Java beans in LMS

Server on the EJB container. **UserEJB**, an entity bean, is in charge of confirming the legality of users and maintaining information of the users. **cListEJB**, an entity bean, maintains the list of instructions available in LMS so that students may choose the courses they like to browse. **ReadEJB**, an entity bean, tracks and records the learning behavior of each student in the data model defined in SCORM's RTE in the background. This bean plays the most important role in the proposed LMS. **C2SYSEJB**, a session bean, allows teachers or system administrators to import courses or update course contents. In detail, this EJB object is responsible for unzipping the content package (a PIF file) of instructions, analyzing the imsmmanifest, and allocating all physical files in appropriate locations in a content repository. Moreover, this session bean is the interface between EJB client and CourseEJB. **CourseEJB**, an entity bean, endorses the C2SYSEJB bean to access the content repository database. In the implementation, this entity bean is wrapped by CourseEJB in a session bean therefore one can access all the business functionalities without the overhead of polling the entity bean.

Table 2. The content of SMIL resource: intro.smil

```

<seq repeat="1">
<par endsync="last" repeat="1">
  <rtp id="img-1" region="main"
  src="rtp://224.0.0.1:999/audio"
  dur="250s" fill="remove" />
</par>
<rtsp region="main"
src="rtsp://163.18.16.220/ProgID=1036806870"
dur="250s" fill="remove" />
</seq>

```

In order to support manipulating multimedia streams, SMIL Parser parse SMIL-enabled assets and extract embedded multimedia objects. If the extracted object is a RTP object, RTP Handler will be invoked to receive RTP media streams, synchronize audio and video stream, and render them in the client screen [3]. On the other hand, when client obtains a RTSP object, RTSP Remote Controller is additionally called. Initially, RTSP Server returns a SDP (Session Description Protocol) message, which describes the information of RTP media to be transmitted. After parsing the SDP data by SDP Parser, RTP Handler receives and consumes the RTP streams. During the playback, RTSP Remote Controller handles the RTSP protocol between client and RTSP Server. Besides, the client may issue the Play, Pause, Fast Forward, Rewind, or Stop command to control the streams.

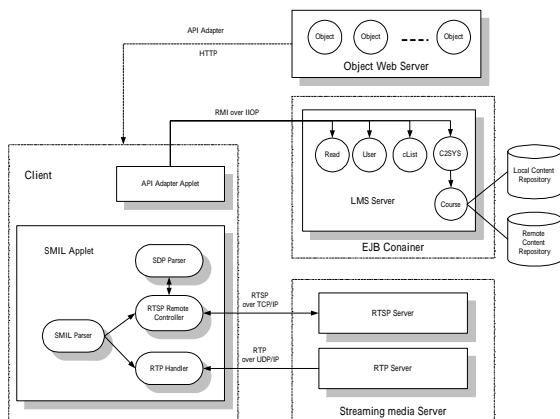


Figure 1. The proposed LMS architecture in EJB environment

4. EXPERIMENT

The proposed SMIL-enabled multimedia streaming e-learning system has been experimented on the JBoss-3.0.3_Tomcat-4.1.12 EJB server [4]. Figure 2 illustrates the snapshot of browsing SMIL-enabled RTP/RTSP multimedia assets with a VCR-like control bar.



Figure 2. The presentation of SMIL-enabled RTP/RTSP asset

5. CONCLUSIONS

This paper proposed a SMIL-enabled asset model, which allows W3C's SMIL documents with multimedia streaming objects to be embedded in instructions. We developed a Java applet-based SMIL player and LMS for realizing and rendering such assets on the learner's Web browser. To handle the interoperability issue of LMSs, the developed LMS was built in the Java EJB component-based computing environment. With the SMIL-ability and the streaming multimedia objects of assets, instruction contents could be more vivid and interactive. The proposed asset model is adherent to the SCORM standard; thus it can be sharable, reusable, accessible and durable. The next research direction is to enhance the proposed LMS by incorporating a directory service such as LDAP (lightweight directory access protocol) so that the remote SMIL-enabled assets can be interoperable and sharable.

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7. REFERENCES

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