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E/M-Learning in IMS Based NGN Environment

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Abstract

In this paper the possibilities for implementation of E-learning and M-learning in networks based on IMS NGN architecture are described. To make learning system useful for end users (teachers, students, trainees) we have defined new elements for IMS platform These elements are servers/functions like Learning Content Deployment Functions, Lecture Management Function, Lecture Management Desktop.

1 Introduction

There were new standards defined by ETSI TISPAN about operator networks. New networks which should replace existing ones will be probably based on Next Generation networks/IP Multimedia Subsystem (IMS). These networks can offer wide portfolio of new services, especially high quality multimedia services that can be used also for learning sphere

Learning is very complex and complicated process. If we would like to teach somebody effectively, we must use huge amount of information media. The IMS offers technical solutions to offer multimedia sources like plain text, formatted text, images, audio tracks, video tracks, animations, 3D models, etc. These sources are only subset of all available sources. In real life, there can exist much more learning sources, but if it is not possible to transfer it to a digital form, it can not be used in IMS. Multimedia can offer learning for wide range of people, independent to age, place, country, salary. Especially for immobile people it is much easier to access learning materials.

Materials sharing

For materials sharing we can use these services:

Offline materials – are passively taken by student and processed at his own customs

- Texts, Images, Video loops, Sound tracks, 3D models can be placed on web server and downloaded to any client device.

Online materials – is a set of materials offered by some moderator or teacher in a concrete sequence. All materials are only support for presentation and lecture. Learning process can be enriched by comments and observations of all participants.

- Texts, Images can be send to end user as a message. Audio and Video are transferred by online services (telephony, video telephony). Graphical materials can be drawn online by hands on virtual whiteboards.

2 Learning system

Basically for e-learning we can use HTML application. It is also possible to use some existing e-learning system (e.g. Moodle). For using existing e-learning system, it must be extended by some functionality, which is needed to handle IMS specific functions.

If the system is designed as self learning system, it is usually HTMLbased application. Student can individually choose his own speed of lesson taking. Here teacher is using offline sources, that are deployed to different IMS and non IMS elements.

If the lessons are designed like set of interactive lectures, teacher must use Lecture Management Desktop (described later). From this desktop, he can start lecture and then all participants are invited automatically. Necessary part of lecture is camera and IPTV subsystem, which transfers live stream from camera to all participants. During the lecture, teacher can send messages with links to useful materials. Messages can be read during or after lecture.

3 IMS based E/M-learning

As it was mentioned before, the IMS is an universal platform, which can offer wide range of online services. But it is difficult to manage all application servers needed for learning by teacher separately. So, to provide a complex learning system for teachers and students it is necessary to implement learning like new service in the top of the platform at application layer. This service will manage all necessary processes and connections with other servers and participating devices.

Services to be used for learning

- WEB service – for materials storage.
- IPTV – for high quality materials storing and transfer. for online lectures transfers
- VoIP – for transfer of speech, video, interactive participant's comments and their notes.

4 IMS based IPTV

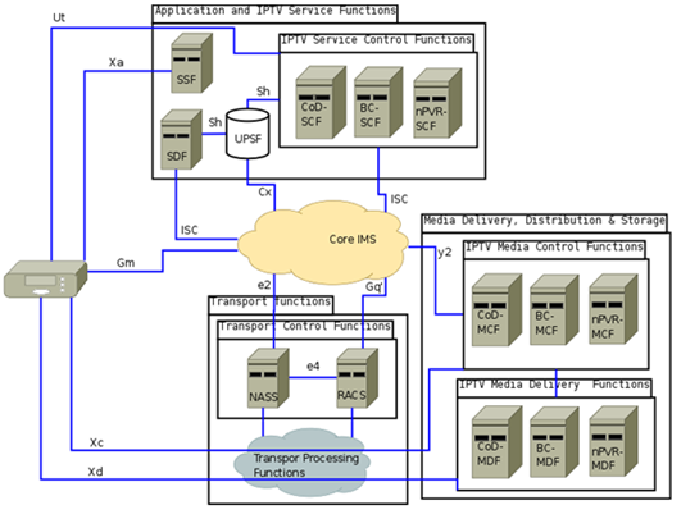

Fig.1. IMS based IPTV architecture

Service Discovery and Selection Functions (SDF and SSF)

The service list available for certain User behind certain UE is provided by Service Discovery Function (SDF) and Service Selection Function (SSF).

The main task of the SDF is to provide personalized service discovery and the SSF provides the service selection information, e.g. a list of available services that the UE can browse and select.

Service Control Functions (SCF)

The SCF provides the service authorization during session initiation and session modification, which includes checking IPTV user's profiles in order to allow or deny access to the service with providing the credit limit and credit control.

SCF is also responsible for selection of relevant IPTV media functions for a given session.

User Profile Service Functions (UPSF)

The UPSF holds the IMS user profile and possibly IPTV specific profile data. It communicates with IPTV Service Control Functions and with the Core IMS. When multiple instances of a UPSF exist, the Core IMS and the IPTV Service Control Functions may use the services of a Subscription Locator Function (SLF) to fetch the address of the UPSF.

Media Control and Delivery Functions (MDF and MCF)

IPTV Media Control Functions are responsible for controlling of media flow from MDF to clients.

IPTV Media Delivery Functions are responsible for delivery of content to client. MCF reports current status to MDF. The MDF can be used also for transcoding of specific device requirements. MDF is storing frequently used content (cache) and user specific content. MDF is basically the place where nPVR content is stored [2], [3].

5 Learning Service Functions

Learning Content Deployment Functions (LCDF)

This is a set of functions needed for content deployment of new content to correct functional block of IMS. It is responsible for correct deployment and provisioning setup. This point is also responsible for management of existing content and profiles. Because of there is no standardized interface for management of IMS elements, there must be used proprietary management for it. To create an open system management it should be based on SOAP and shared folders technology (smb, NFS). All data will be transferred by SOAP. The content will be first uploaded to shared folder, and afterward processed with SOAP command.

Deployment of content is different for each content type.

5.1.1 Deployment of Content on Demand (CoD)

CoD is mostly stored in the big disc arrays in network of operator. It is necessary to provide access for CoD MDF to this storage space. LCDF must than take content from operator, adapt it to required parameters (codec, bitrate, etc.) and store it directly on storage. Than it must contact management interface of CoD MDF and submit information about this content to it. Another place where content must be registered is SSF a SDF database. Metadata, rights and URLs to content, must be stored in SSF and SDF. LCDF than must contact this elements and put this data and parameters to it.

Because of in IMS network, there can be a huge amount of end devices with different capabilities and screens, it is necessary to deploy video content in more profiles. It is recommended to define closed group of profiles at the beginning and than transcode all content in all profiles and deploy it.

5.1.2 Deployment of Live lecture

Life lectures are organized from desktop, but before it is necessary to deploy live streams from camera(s) like new channels to IPTV system, and arrange permissions for students. CoD, MDF, SSF, SDF elements must be managed.

5.1.3 Deployment of Images/Text

The text and images can be stored directly in storage, from where it will be served to students by WEB server. This storage can be internal HDD in WEB server or external storage outside the WEB server.

The text will be stored in HTML format. The LCDF must support all content management functions. The LCDF must be also able to adapt all html formatted text to different formats, which are acceptable by end devices, e.g. MMS for mobiles.

Images must be adapted to some predefined formats. Here we also need to take in mind, that end devices can be different and therefore, also images must be stored in predefined profiles (formats) belonging to group of similar devices.

In past the processor power was not so big to draw vector graphics, but today devices have no problem to draw vector graphic and also this graphic files can be plain text (e.g. SVG). So it is recommended to use vector graphics images, because it can be adapted then to all screen resolutions very easily without quality lost.

Learning Content web server (LCWEB)

The LCWEB server has an access to text content storage and serves it to students via http or https protocol. To limit access to this content it is necessary, so that the web server requires authentication using sip account and check access to content based on HSS profile of authenticated user. To improve normal HTML browser for learning purpose it is necessary to extend normal protocol tags to: link to content, link to bookmark, link to conference, link to shared desktop (only for lectures).

Then text content can be read by the student. At any point there can be link or embedded object. This link can take student to CoD and show him video. Also this links can take student to bookmark, which is time point in certain CoD content.

Lesson Voice&Video server

Focusing on user view the main purpose of this server is to provide call features, e.g. voice call or video call, but also educational voice content which is played to all users during a created session.

From the provider perspective the server consists from these main parts:

5.1.4 SIP Application server

Server cases about conference policy and plays the role of Back-to-Back User Agent (B2BUA) which is necessary for supervision of live sessions and for the conference features.

In case a teacher wants to create live session a call requisition can be send to all of required participants. It means that phones of participants will ring and when the participant take up the phone a voice announcement will be played to him. Subsequently, by pressing a chosen key he can accept or reject invitation. For announcements a short RTP streams will be used (see MRFP). This case is using Lossely Coupled Conference. It means the conference is without coordinated signaling relationships amongst participants. Loosely coupled conference is use especially for distribution of multicasts to all required parties or participants [5].

Users or participants who want to join a session can use also so called conference URI. It use Tightly Coupled Conference scenario in which a teacher, referred to as a focus, maintains a dialog with each participants of lesson. The focus plays the role of the centralized manager of the conference.

5.1.5 Media Resource Function Control (MRFC)

MRFC supports procedures for media control of SIP based conference scenarios and determine media capabilities of the MRFP. The MRFC/AS determines which media flows should be used for the session, and which codecs should be used for each participant of those media flows [6].

The server is also providing a Media resource related functions. These functions are logically separated in IMS architecture, but they can be also components of application nodes. Media related functions are MRFP in position of RTP mixer and Conference Bridge.

5.1.6 Media Resource Function Processor (MRFP)/RTP mixer

RTP mixer consists from Media server features, implemented on MRFP responsible for mixing of RTP streams from all users attended the session and also for playing an announcements to all conference members (e.g. announce a join).

RTP mixer is not used for mixing of special session such us instant messaging here, but dedicated server is used for that (see Lesson messaging&presence server) as it's using SIP signaling messages, not the media itself.

5.1.7 Conference bridge

The conference bridge is responsible for delivering of upper-mentioned RTP streams. Conference bridge features are provided by MRFC and MRFC. If users have User equipment (UE) with camera device then also video stream is mixed and delivered to all participants.

Lecture messaging&presence server

Server is mainly responsible for all features related to messaging services. It means, users can communicate to each other during a session without an interrupting a live video or audio stream. Only LMD is creating a group chat preferences and who can access it. Messaging services are very useful in case of putting questions for presenters (teacher) if live streaming is used.

Presence service is mainly important for seeing who's online and attend a lecture. Presence features are not required for delivering a content of lecture but it's comfortable from usage perspective to see attendee's status. In other words, it provides conference notification service – accepts subscriptions from participants and generates notifications to all of them.

For purpose of learning only delegated users can access the conference, so anonymous user will be not accepted.

In IMS architecture a SIP protocol is preferred solution for messaging system. There is important that IMS interaction with other services is triggered at that control plane, by the Serving-Call Session Control (S-CSCF).

There is an IMS based conferencing architecture depicted on the Fig.2.

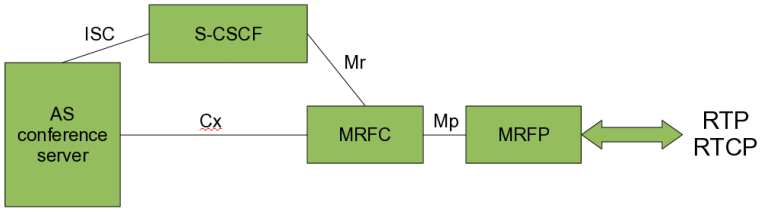

Fig. 2 - IMS based conferencing architecture

Lecture Management Desktop (LMD)

To manage lecture by teacher, it is necessary to use some device (PC) for management of content flow. It is not invoking all actions directly, but it is only client of LMF (Lecture Management Function). Than LMF is actor of all commands. LMD is only place, where teacher can get information from

students during lecture. If the student wants to put some question, it will be shown on LMD, and it is up to teacher when to put place for student. The LMD is also source of video stream for shared desktop.

Lecture Management Function (LMF)

The Lecture Management Function is a server responsible for managing of all application services that are used in created lesson. Services are hosted on separate application servers:

- Live TV from IPTV subsytem
- Web content server
- Voice&Video server
- Presence and messaging server

LMF is capable to send commands to these servers for setting up lesson/lecture preferences. Upon on preferences server will manage lesson for users that was assigned by the LMD.

Note, that server is not communicating with Home Subscriber Server (HSS) directly because of corresponding servers have a direct access to user profile. All user related data that are needed for authenticating him to the service are stored on HSS only, but the application data related to the specific service can be stored on she server where the service is hosted.

The work described here was focused on the re-usage of existing components of IMS. Because of IMS IPTV has not defined interfaces and elements for management, and we need to add some elements and functions to the existing architecture which is needed to reach the e/m-learning approach.

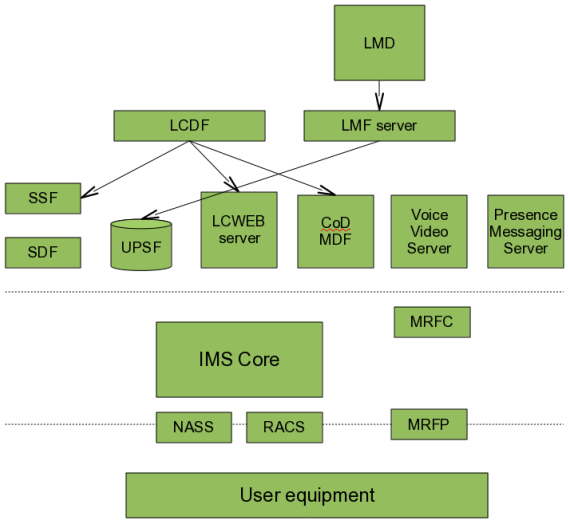

Fig.3 – E/M-learning architecture based on IMS architecture

6 Further propositions

The topic about E/M-learning is very wide. In our work, we have not focused our research activities to define all interfaces regarding management of IPTV in details. We defined entities and protocols between them. It would be good to describe concrete parameters of SOAP protocol. Also missing part is to choose and describe whiteboard and remote desktop protocol.

7 Acknowledgment

This paper presents also some of the results and acquired experience from various research projects such as NGNlab project [7], European Celtic-EURECA project Netlab [8], Leonardo da Vinci projects: MLARG [9] and Train2Cert [10], AV project: Converged technologies for next generation networks (NGN) No. AV/4/0019/07, Slovak National basic research project VEGA No. 1/0720/09.

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