Abstract

In this paper, we present an IMS (IP Multimedia Subsystem) Client framework design, which provides a single platform for voice, data and multimedia applications. We have developed an IMS Client framework based on 3GPP IMS standards with an integrated version of messaging services, streaming services and Push-to-X services with the establishment of multiple sessions for text, voice, video and streaming. The IMS client framework includes IMS Engine, IMS Library and Connection Manager, which can be customised and optimised for interfacing with third party audio/video codecs and signalling/media protocols like SIP, RTP, RTCP and RTSP. With this flexible design client framework, any new applications could be easily integrated and customized for providing unified services.

Keywords: IMS Client, 3GPP, UMTS, Push-to-View, Video Telephony, Home Networking, DRM.

1. Introduction

The IP Multimedia Subsystem (IMS) is an open standard, operator friendly, multi-media architecture for mobile and fixed IP services. The IMS allows operators to build an IP-based service infrastructure that will enable easy deployment of rich multimedia communication services. The aim of IMS is not only to provide new services but to bundle all the services that the Internet provides. IMS is intended to address the following network and user requirements:

a. Deliver end-to-end real-time IP-based multimedia communications such as voice and video telephony services.
b. Provide fully integrated real-time communications, such as live streaming and Voice over IP.
c. Enable multiple services and applications for interactive response. For example, video conferencing and instant messaging can be combined with presence service.
d. Fast facilitation of communication sessions like changeover of an instant messaging session into a voice session with the click of a button.

The advantages of IMS over existing systems are:

a. The core network which is independent of a different Radio Access Technology.
b. Integrated mobility for all network applications.
c. Easier migration of applications from fixed to mobile users.
d. Faster deployment of new services based on standardized architecture.
e. User profiles management in a central location.

We propose IMS Client solution based on 3GPP and OMA standards, based on which the users can have voice, data, and video services. The IMS Client will be provided as a ready-to-go component, pre-integrated on reference mobile platforms. The IMS Client framework consists of a IMS Engine which enables the number of applications including Multimedia Messaging, Instant Messaging, Push-to-View and Push-to-Video ("see-what-I-see"), IMS Library which includes various protocols like SIP, RTP/RTCP and RTSP and the connection manager for providing interface with the IMS engine and IMS Library. The IMS client also serves as a platform for developing new applications, with well-defined open API interfaces.

2. IMS Client Framework

The IMS Client framework is shown in fig (1) and it provides the following functionalities:

- Enables any type of media session to be established (e.g. text, voice, video etc.)
- Sessions to be dynamically modified 'on the fly' (e.g. adding a video component to an existing voice session)
To realize the above functionalities we require a major module called SIP (Core) Module, which builds various functionalities like Invite, Registration and Authentication with the IMS server. The basic functionalities of IMS Client are as under:

- Send and receive
- Store and forward support
- Message history support
- One-to-one and One-to-many services
- Multiple session handling
- Media Control
- PoC (Push 2 Talk on connect) services
- Group List Management service
- SIGCOMP
- Binary Encoding/Decoding of SIP Messages
- PoC based floor control

The following are the potential services, which can be provided from the IMS Client framework:

- Multi-user: Video conferencing, document sharing
- User to User: Voice, Video, Text, Push-to-Talk, gaming etc.,
- Server to User: Presence, content browsing, Multimedia streaming
- User to Server: SMS/EMS, MMS.

The IMS framework consists of three important sub layers as shown in fig (1):

- IMS Engine
- Connection Manager
- IMS Library

3. IMS Client Software Architecture

The IMS Client framework software architecture and the associated software modules are as shown is fig (2):

3.1 IMS Engine

IMS Engine will contain the following Software modules for providing various services from the application layer:

- Signalling module handles signalling for the SIP Sessions and services.
- Media module provides support for media control for various voice, video and data services. This includes interfaces to various codecs for multimedia applications. It also provides the support for any specialized applications like voice bridging and conferencing. It also has an interface with the QoS manager for monitoring QoS for individual sessions.
  - Codec Manager, which is part of the Media Module has interface with various codecs, primarily AMR speech audio codec and MPEG-4 video codec. The actual transfer of the media (audio, image, video) is carried out by the media module.
- QoS Manager measures and monitors the parameters for a session established for various services and to maintain the reliable transmission media for various services.
- Presence module provides the user the presence information for others who are registered to the GLMS (Group List Management Server) and subsequently subscribed to the Presence server.
- Control module is used to exercise control over the home appliances in Push-to-control application. The control module generates the status request/control commands and interprets the response received giving an
indication of the status of the devices to the user from the Home Server.

- **Instant Messaging** has recently proved to be an extremely attractive application for both business and private users. IMS offers the opportunity to introduce feature-rich SIP-based instant messaging that provides all the benefits of the mobile in a single application.

- **Short Message service (SMS)** is a part of GSM/UMTS/CDMA messaging, which allows user to send and receive short text messages.

- **Multimedia Messaging Service (MMS)** is a messaging service that can contain still images, text, voice or audio clips, video clips, and presentation information.

- **Group List Manager** embedded in the IMS Client provides the user to manage the user's data on the network database, which is shared by all the users.

- **Synchronized Multimedia Integration Language (SMIL)** is a mark-up language for building time-based, streaming multimedia presentations that combine audio, video, images, and text.

- **Floor Control** is a control mechanism used in Push-to-Talk over Cellular (PoC) application, which arbitrates requests from the User Equipment’s (UE) for the right to speak. Floor control has seven control messages (Idle, Request, Grant, Taken, Release, Deny, Revoke) to ensure singular access to the PoC media resource. This is a request/grant procedure, ensuring that only one user is using the PoC media at a given time.

- **IMS Identity Module** will contain various information like Private user Identity, Public user Identity (SIP URI by which other parties know the subscriber), Home Network Domain Name, P-CSCF Address etc.,

- **DRM Agent**: DRM agent is responsible for the following operations:
  
  ✓ DRM Agent checks for the *rights file* and if available, it checks for the validity of the rights. If the rights file is not present or if the rights are expired, it activates the ROAP Engine to acquire the rights.
  
  ✓ If the rights are validated, DRM agent decrypts the DRM protected file from the content encryption key using the AES algorithm.

- **ROAP (Rights Object Acquisition Protocol) Engine** acquires the rights object. When the ROAP Engine receives trigger from DRM agent, it initiates the ROAP protocol exchange and generates Rights Object consisting of key information to encrypt the key and other necessary rights to use the content.

- **Security module** provides the security related services to the DRM client. This module has a set of algorithms like AES, Base64binary and Hash algorithm, required by the DRM client.

### 3.2 Connection Manager

The functionality of Connection Manager is to provide an interface between IMS Engine and IMS library. It handles the signalling and the user data for the various services initiated by the user. The Connection Manager is configured automatically based on the services provided by the service provider to adapt to either SIP based or non-SIP based services.

### 3.3 IMS Library

**IMS library** will contain bearers for the IMS client engine for providing various services. The library comprises of the various stacks & protocols like SIP, SMS, WAP, RTP/RTCP, RTSP, SDP, HTTP, SIGCOMP and SMTP.

### 4. IMS Services

The IMS client framework supports various services. They are: Push-to-X Services, Messaging services and Video Services. The following section explains about the detailed functionality and execution of these services as provided by the IMS client framework:

#### 4.1 Push-to-X Services

The Push-to-X Service is characterized by a half duplex form of communication whereby one user will communicate with other users by pressing a button on a mobile terminal. The Push-to-X services are Push-to-Talk, Push-to-View/Video, Push-to-Control etc. In this section, we describe more about Push-to-Control service.
4.1.1 Push to Control

The entire Push to Control system as shown in fig (3) is based on simple client/server architecture and can be divided into three parts:

- Mobile client
- Home Server
- Device controller

The client sends the request to the Home Server requesting for the status of the devices. The server queries the status of the devices by contacting the device control circuit and sends it to the client. After getting the status, the client sends suitable control messages to the server, which in turn changes the status of the devices based on the user requirement.

The device control circuit shall consist of microcontroller with any of the transceivers like Home RF, Bluetooth or Wireless LAN, connected to appliances. The controller circuit will change the status of the devices according to the control messages sent by the mobile client.

4.1.1.1 Push-to-Control Client Architecture

The Push-to-Control application as shown in fig (4) makes use of SIP stack for sending SIP messages through various packet data cellular networks like GPRS/UMTS/CDMA2K. Initially, both the SIP client at the Home Server and the mobile SIP client get registered with the SIP server. The SIP server does the authentication of both the clients.

The mobile client first sends an "INVITE" message, through the signalling module, to the Home Server, requesting for the status. The status of the devices in different rooms are obtained in the "200 OK" response of INVITE. The command message containing device status to be changed is sent by the client using the DO message [9]. The change in status of the device is sent by the server back to the client via the "200 OK" message.

4.2 Messaging Services

Messaging client architecture as shown in fig (5) is responsible for sending SMS, EMS or an MMS as per users request. Short Messaging Service (SMS) is part of the 3GPP/3GPP2 specification and allows short text messages to be sent or received via mobile phones. Multimedia Messaging Service (MMS) is a messaging service for the mobile environment standardized by WAP forum and the 3rd Generation Partnership Program 3GPP.

The main modules involved in Messaging Client are:

**SMIL Module:** This module generates the SMIL file depending upon the way the MM is composed. SMIL holds the timing and layout information of the composed message that helps the player to play out the media objects in a choreographed way.

**MMS Encoder/Decoder:** This module encodes the Multimedia Message (media objects and SMIL file) to be sent as per WSP standards in case of Mobile Originating and vice-versa in case of Mobile Terminating.

**Codec Manager:** This module has interface with codecs that helps the player to encode/decode the media objects present in Multimedia Message.

For both SMS and MMS, the client has to register with IMS network according to IMS registration procedure before any transactions. IMS network would maintain a mapping between the IP address and the MSISDN of the registered clients.
**SMS Stack:** This module encodes the Short Message to be sent as per 3GPP standards [3GPP TS 24.011, TS 23.040].

If the mobile handheld were registered with IMS network, it would receive the SMS in the form of a SIP MESSAGE method as described previously. The UE would extract the MMS ID present in notification and then would retrieve the corresponding MMS from the MMSC using this MMS ID through the IMS network.

### 4.3 Video Services

#### 4.3.1 Video Telephony

Video Telephony in IMS is a 2-way conversational Video communication, which uses SIP as a signalling protocol and RTP/RTCP as a Media Transport/Control protocol respectively.

Video Telephony application as shown in fig (7) establishes the session with the SIP server in the IMS Network through the Signalling Module. Once the session is Registered, Presence Module will be updated with the list of the user’s who are all registered with the SIP server. Then to establish a one-to-one or one-to-many Media session, the application will send invite to the SIP server by interacting with the Media Module, which in turn queries about the codec’s information with Codec Manager and QoS for the session with the QoS Manager respectively. Once the end user accepts the request, Audio/Video control system will be invoked and Media sessions will be created through RTP for sending and receiving Audio/Video data. The Audio and Video should share the same NTP (Network Time Protocol) clock source so that lip synchronization can be achieved using the RTP time stamps.
Video Telephony Client has been already developed on circuit switched domain (3G-324M) and many Service Providers are giving enough bandwidth to support this feature. Support for Video Telephony in IMS is purely on a Packet Switched domain, which will be more flexible in terms of session establishment (SIP) and bandwidth utilization.

5. Conclusion

In this paper, we have presented the IMS client framework, which provides an all IP based service delivery environment for mobile multimedia services (Push-to-X services, Video Services and Messaging services etc.) provisioning as an integrated structure. The IMS Client framework can be effectively utilized for the enhancement and customisation of 3G applications to provide seamless converged services for unified access across cellular networks, with the support of an IMS server at the service provider’s end.

6. References

[1] TS 22.228 Service requirements for the IP multimedia core network subsystem; Stage 1.
[2] TS 22.250 IMS Group management; Stage 1
[4] TS 22.800 IMS Subscription and access scenarios
[6] TS 23.107 Quality of Service (QoS) principles
[7] TS 23.207 End-to-end QoS concept and architecture
[8] TS 29.208 End-to-end QoS signalling flows
[9] Sip Extensions for communicating with Networked Appliances (draft-tsang-sip-appliances-do-00.txt)
[8] RFC 3550 RTP/RTCP
[10] RFC 2327 Session Description Protocol
[13] TS 24.228 Signalling flows for the IMS call control based on SIP and SDP; Stage 3
[14] TS 24.229 IMS call control protocol based on SIP and SDP; Stage 3.