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Volte Client On Windows Platform

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Abstract— **Long Term Evolution (LTE) is a 4G technology developed by the 3GPP standards. Pre-LTE networks, 2G/3G/EDGE/HSPA/UMTS were used for data in conjunction with circuit switched GSM for Voice calls. Since LTE being only packet switched, for voice calls VoLTE that is based on IP Multimedia Subsystem (IMS) framework is the solution. LTE network has more advancement such as higher data transfer rate up to 100 MBPS [1], higher bandwidth, low latency, more efficient use of the network resources and lower operational cost compared to pre-LTE networks. In the existing solution, the Application Processor, directly calls the services from Service Adaptation Layer (SAL) of the IMS framework, bypassing the Universal Terminal API (UTA) layer in VoLTE client on Windows platform. The proposed work implements UTA sublayer between Application Processor and IMS framework, replicating the behavior of Target Hardware/Modem platform to Windows platform. This enables the Application Processor to call all the services of IMS framework using UTA layer instead of calling it from SAL directly. Thus, porting Modem platform specific UTA layer to Windows platform. The implementation also covers GUI enhancements, to adapt to Windows Platform. The results achieved shows that, debugging and development effort reduced from 75% to 25% of time. It also allows to verify the UTA services on Windows platform without using any Target Hardware/Modem platform and Network Simulators, thus completely eliminating dependency on hardware resource.**

I. INTRODUCTION

Modern cellular networks are required to support both voice and a large volume of data traffic over network. The reason that made operators to move from pre-LTE network to LTE is to meet the rapid growth in data traffic [1]. But the LTE network does not support circuit switching services and it depends on the IP Multimedia subsystem for supporting both voice and SMS services. These both services using LTE networks drives a major revenue to operators. So VoLTE is chosen as the best solution to support VoIP and SoIP services.

There are several reasons behind using Voice over LTE network as VoLTE provides high definition voice because it uses 13KB codec compared to pre-LTE network which uses only 8KB codecs. It provides Rich communication services including Voice call, Voice message, image sharing, file sharing, video call etc. It also enables faster call setup times, true device interoperability and improved battery life over other VoIP apps such as Skype [2]. To support Voice over LTE (VoLTE), 3GPP standards defined IMS framework has been chosen. The IMS client framework has its own set of interfaces which can be used to develop applications that use IMS for voice and SMS services. VoLTE solution has proposed using these IMS interfaces when a voice and SMS service over LTE network is requested.

VoLTE makes use of LTE technology which is a 4G technology developed by 3GPP standards. LTE in comparison to pre-LTE networks uses only packet switching technology. Whereas pre-LTE network, uses circuit switching technology. In case of circuit switching technology, a dedicated connection has to be established before making a call and this connection has to be reserved for entire duration of the call. But, in case of packet switching, the data is sent in the form of packets and it chooses the best available path towards the destination without establishing a prior connection. If the connection breaks down in case of circuit switching, it has to be reconnected, whereas in later, packets make use of other available efficient path [3]. In the case of VoLTE, even Voice is carried as a data packet over network.

VoLTE Client on Windows directly calls the services from SAL layer bypassing UTA layer. Any changes made in Application Processor Layer directly affects the SAL layer of IMS framework, which is not an effective solution on windows. Hence, the goal is to port Modem platform specific layer called UTA to Windows Platform to replicate the behavior of Modem on Windows.

The porting is done by implementing APIs called as UTA-IMS APIS which are part of UTA and IMS. The implementation enables the Application Processor to call all the services of IMS framework using UTA layer instead of calling it from SAL directly. The implementation also covers GUI enhancements, to adapt to Windows Platform. The results achieved shows that, debugging and development effort reduced from 75% to 25% of time. This also, allows to verify the UTA services on Windows platform without using any Target Hardware/Modem platform and Network Simulators,

thus completely eliminating dependency on hardware resources.

II. LITERATURE SURVEY

A comprehensive review of the literature that is available in the domain of LTE, IMS, VoLTE, and SIP is very useful. This helps the researchers to have a better understanding of the system that is already existing and also gives a fresh perspective about the system being developed.

VoLTE is the form of VoIP that uses Session Initiation Protocol (SIP) control messages, Session Description Protocol, RTP audio encapsulation to connect LTE network to IMS device framework [5].LTE is based on 3GPP standards, transfers voice signal similar to user data over IP datagram.

Most of the operators are aggressively moving from 3G to LTE as LTE offers many significant and efficient advantages. With LTE, the user can enjoy both voice and LTE speed data [6]. LTE provides high data rate and improved quality of service .LTE also provides Single Radio voice Call Continuity (SRVCC) which ensures voice continuity between LTE and Pre-LTE networks. LTE is deployed using high definition and enhanced voice services codec. LTE design has greater delivery service for voice, video and multimedia to end users [7].

IMS framework enables both wired and wireless to provide rich communication services to a new generation .It provides the facilities both in circuit switched and packet switched networks. The main idea of IMS is to provide internet services using cellular technology. The cellular phones already have all the facilities provided by the Internet [8].

SIP defines several messages, which includes INVITE, 100 trying, 180 Ringing, OPTIONS, BYE, REGISTER, ACK, 200 OK, CANCEL, MESSAGE etc. Each of these SIP message contains request line, header and body. All these SIP message signals are used in VoIP, SoIP and Supplementary services provided by the VoLTE client in Windows Platform. Python and Practical Extraction Report Language (Perl) languages are used for parsing SIP messages as it is a textual protocol [9].

Once after the connection establishment, media is transmitted between sender and receiver streaming over UDP that provides an unreliable, unordered datagram service. TCP does not perform well in case of real media transmission so most VoIP environments use UDP for media streaming. Therefore, to provide the metadata necessary to arrange data in received order, media is encapsulated with a Real-Time Transport Protocol (RTP) header. Sequence number and time stamp in the header part of RTP, lets the receiver to reassemble the stream in the correct order as it is received [10].

In existing solution, IMS client provides only basic services. The services such as voice, presence, contact management and messaging. In future IMS is required to support extensive services which are integrated to the existing IMS framework. Therefor the proposed solution defines a sub layer called UTA and UTA-IMS API's that acts as GUI for the IMS client to use the VoIP and SoIP services. This new layer implementation provides multiple levels of interfaces without affecting the IMS SAL and core software.

III. ARCHITECTURE VOLTE CLIENT ON WINDOWS

Application Processor uses legacy AT commands to invoke the voice and SMS services directly from Service Adaptation Layer (SAL) layer of IMS framework. SAL layer is responsible for providing APIs to Application Processor for realization of the services provided by IMS Device Framework. SAL layers also has inbuilt support for multiple applications. The layer may combine services of multiple service enablers to provide a feature for the applications to use. Any changes made in the Application Processor/GUI directly affects the SAL which was not effective solution. Architecture of existing VoLTE client solution is depicted in Fig 1.

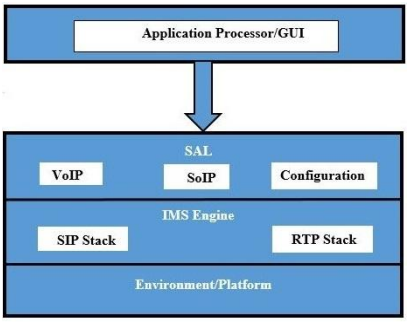

Fig. 1 Existing Architecture of VoLTE Client on Windows

But, in the case of existing Target Hardware/Modem Platform, Application Processor/GUI uses legacy AT commands and UTA interfaces to invoke the voice and SMS services, irrespective of the access network being used. This is done to avoid making any changes on the application layer which already uses the UTA interfaces does not affect the SAL layer of IMS framework.

Hence, the proposed solution is to port/replicate Modem specific UTA layer to Windows platform which does not currently exists. This is done by implementing UTA layer between Application Processor/GUI and IMS Framework in VoLTE Client on Windows platform as shown in Fig 2.

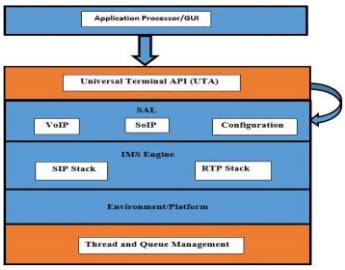

Fig 2 Proposed Architecture of VoLTE Client on Windows

In the proposed solution, UTA services are ported to Windows platform by inserting UTA-IMS Sublayer that handles the UTA and IMS interface calls and their parameter mapping in the correct sequence in which they are required in a particular call scenario. The APIS that mapped between UTA and IMS are called as UTA-IMS APIS. Thus, Modem Platform specific UTA services are ported to Windows Platform. •

Thread and Queue management is deployed to handle the requests and responses across application and IMS framework SAL layer provides implementation for the Voice over IP (VoIP), SMS over IP(SoIP) and supplementary services. VoIP services includes Mobile Originated (MO) call, Mobile Terminated (MT) call and VoLTE conference call. SoIP services include MO and MT SMS. Supplementary services provides options such as call hold, call resume and call forwarding.

IV. METHODOLOGY

To run VoLTE Client on windows platform, IMS server should run on local host. Then Session Initiation Protocol (SIP) is used to establish the session between VoLTE client and IMS server. Once after session establishment, VoLTE client has to register with IMS server to enable VoIP and SoIP Services. The registration can be done using either of the following IP-CAN's- Cellular and Wi-Fi mode. The registration enables, VoLTE client to make use of VoIP, SoIP and supplementary services. The IMS server renders the status of VoLTE services to VoLTE Client based on the choice made by the client. The status includes Voice call status, SMS notification, Call hold duration, active calls, call history etc.

Following are the major components of the proposed system:

- Task manager/Thread and Queue Management
- Registration services
- Voice services
- SMS services
- Supplementary services

Task Manager is deployed to handle the requests and responses across application and IMS framework. Task manager works asynchronously and serially to handle the requests and responses from application and IMS framework. To achieve the asynchronous and serial processing of requests, in task manager a client message queue is deployed and client worker thread operates on the message queue. When the asynchronous messages enter the message queue, the client worker thread processes each message in the queue serially. • UTA-IMS Registration provides the interface to register for Voice services, SMS services and supplementary services. This service brings the IMS service state to online from offline.

UTA-IMS voice services provide the interfaces for voice based services like MO(Mobile Originated/ Outgoing), MT(Mobile Terminated/Incoming) calls, multiple party calls, call hold/ resume, call transfer, conference etc. When any voice based service is requested by the application using the UTA interfaces and IMS is selected as the active domain to make calls, Application Processor will call these UTA-IMS interfaces for processing the voice services request. These UTA-IMS interfaces in-turn call IMS Framework interfaces to initiate an outgoing call.

UTA-IMS SMS provides the interface for SMS functionality like receiving SMS and sending an SMS. UTA-IMS handles the request and response for an outgoing and incoming SMS between UTA and IMS framework. It handles SMS in PDU mode where the message is sent as hexadecimal encoded binary string.

UTA-IMS SMS provides the interface for supplementary services such as call hold/ resume, call transfer etc.The precondition to put a call on hold is an active call must present. Supplementary services can be used by both sending party and receiving party. The implementation of UTA layer in between Application Processor/GUI and IMS framework is shown in Fig 3.

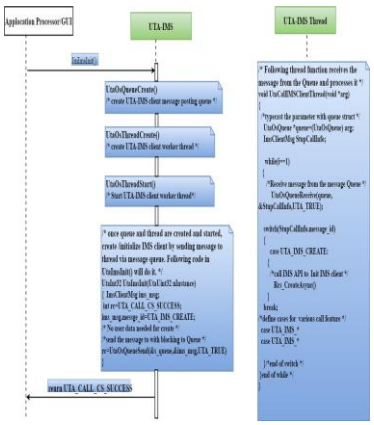

Fig. 3 UTA-IMS Layer Implementation for Task Manager

The colored part in figure 6.1 shows the implementation of task manager in VoLTE client to enable UTA layer instead of SAL layer directly. ImsClientMsg contains the user- which is passed in the message posted by Application Processor or IMS into the message queue.

UtaCallIMSClientThreadFunction is the UTA-IMS worker thread function which handles messages posted in the queue and acts upon them based in the message ID received. This function also acts as a context-switcher between UTA and IMS framework.

When request is made from Application Processor to UTA IMS, a message is posted to the UTA IMS message queue. The thread function then receives the message using the queue's handle, which is passed in the function as its argument, in its own thread context, hence, totally decoupling Application Processor from these calls. After receiving the message in the UTA IMS thread, the request is forwarded to the IMS Framework, and waited for the response which is always asynchronous .On receiving response again a message is posted to UTA IMS thread, decoupling the response handling from the IMS Framework. The response is forwarded to UTA layer in the UTA IMS thread context which in turn forwarded to Application Processor.

V. RESULTS

The analysis is carried out to check whether the mentioned functional and non-functional requirements are met. In order to verify the results obtained Intel reference boards were used.

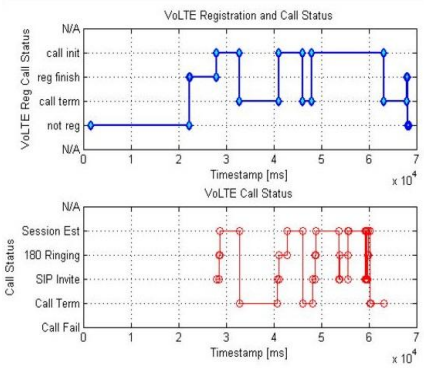

Fig 4 Graph for VoLTE Registration and Call Status

The graph shows the status of VoLTE Registration and call Status including SIP messages.

Considering the evaluation metrics and comparing the proposed system with existing system, inferred the following results as shown in below table I. The metrics included are human hours /effort spent, network resources and verification strategy used for verifying the UTA services. The results achieved shows that, debugging and development effort reduced from 75% to 25% of time. It also allows to verify the UTA services on Windows platform without using any Target Hardware/Modem platform and Network Simulators, thus completely eliminating dependency on hardware resources. The result also shows that reduction in man hours shows that there is a reduction in power consumption and PC usage which directly reduces the cost.

TABLE I Results Obtained after porting UTA layer in VoLTE Client on Windows.

Parameters	Solution without UTA-IMS in VoLTE client on Windows Platform	Solution with UTA-IMS in VoLTE client on Windows Platform
Debugging Effort In Man Hours(per log/issue/run)	75% of Effort	25 % of Effort
Development Effort	Repetitive	Only once
Dependency on Target Hardware	Dependent	Independent of Target Hardware and Network simulators
UTA Services Verification on Windows Platform	Not possible	Possible as UTA layer implemented on windows platform
UTA Layer existence	Only on Modem platform	Exists on both Modem and Windows platform

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