

Provision of Caller Ring Back Tones for IP Multimedia Platforms

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Abstract—Customised Caller Ring Back Tones (CRBT) are used to entertain callers by playing a media clip while the callee's phone is ringing. CRBT involves the mobile operator replacing the standard audio clip with a clip selected by the user, in this case the callee. The service may be offered by 3rd party application providers, but can also be offered by mobile operators themselves. CRBT service can be supported by different mobile network infrastructures including the circuit switched GSM networks and IP multimedia networks such as IMS. These networks need integration of additional components to provide the CRBT service. 3GPP has standardized the IMS architecture, which comprises transport, control and application planes. SIP interface to application can enable 3rd party application providers to offer value added services such as IPTV and CRBT. RTP packets conveying media for these applications would be streamed across transport plane connections. This paper presents the design and implementation of CRBT on IMS networks. It presents considerations for deploying both CRBT and reverse CRBT. The design adopts the architecture where an IMS application server is used to control CRBT service, while the media is stored and served from an RTSP media server. We utilize the Fraunhofer Fokus open source IMS core and UCT IMS client for implementation. Test results are geared to proof of concept; performance tests show minimal added call setup delay of 15 millisecond.

Keywords IMS, CRBT, MNOs, CSCF, MGW, SIP Protocol

I. Introduction

When a subscriber A calls a subscriber B, the Mobile Switching Centre is responsible for routing the call to the receiver. If subscriber B is available and the call can be routed to their handset, then subscriber A gets to hear the standard operator ring-back tone as the call session is established between them and the receiver. Once the receiver (subscriber B) picks the call, the ring-back tone is terminated and a call session established for the duration of communication. The design of customized caller Ring-Back Tone (RBT) enables a mobile subscriber to select a preferred tone from a list availed by the service provider. Thus CRBT is a customizable ringtone or music that a subscriber may subscribe to via a hotkey or USSD code to replace the default ring back tone when the subscriber is called [10]. The CRBT service replaces that standard ring-back tone with a selectable music such that, when the subscriber A

calls subscriber B, subscriber A gets to hear the music that has been selected by B as opposed to the default tone by the network provider. This service is usually provided as a premium rate service. The Caller Ring-Back Tones are currently offered mostly through the GSM core network. Figure 1 illustrates GSM call session establishment when CRBT is enabled. IMS has been standardized to replace ...

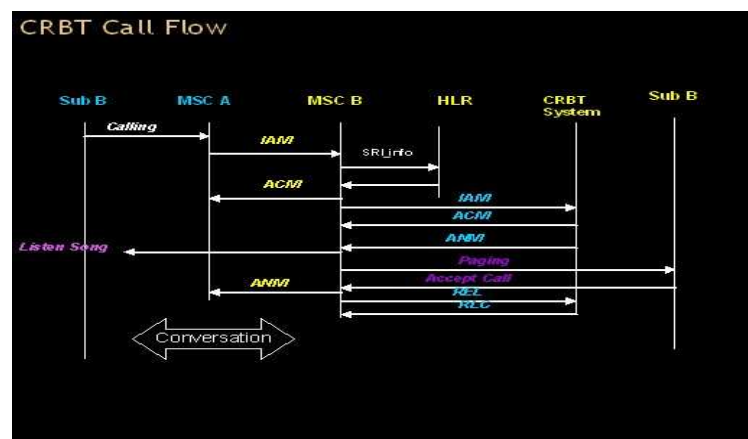


Figure 1: CRBT call Flow

IMS widely known as the IP Multimedia Subsystem is an all IP multimedia and telephony core network defined by 3GPP and 3GPP2 standards and organizations based on Internet Engineering Task Force (IETF) Internet protocols. IMS is a set of standards and specifications that describe the operation of the Next Generation Networks (NGN) and their architecture for implementing IP based telephony and multimedia services. It defines the complete architecture and framework that enables the integration on different kinds of media including voice, video, data and mobile network technologies over an IP-based infrastructure. IP Multimedia Subsystem is access independent [9] and supports IP to IP sessions over wireline IP (cabled network), the wireless networks (802.11 network standards), WIMAX network (802.15), CDMA packet data along with GSM/EDGE/UMTS and other packet data applications.[3]

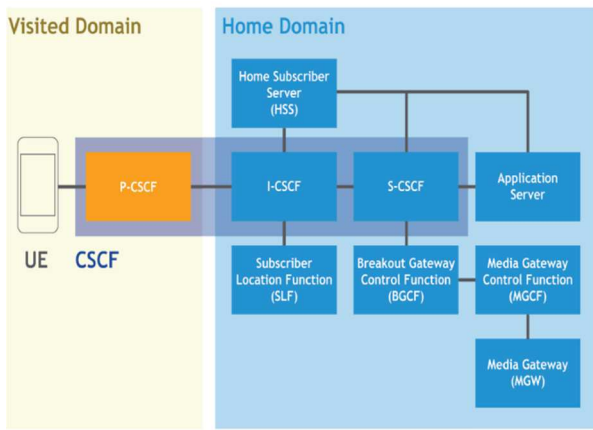


Figure 2: IMS network components

II. Literature Review

The IP Multimedia Subsystem (IMS) was initially defined by the 3G.IP industry forum and the architecture brought it to the 3rd Generation Partnership Project and announced in the Release 5, with SIP as the signaling protocol. Consequently, the 3GPP2 has based their CDMA2000 Multimedia Domain System on the 3GPP IMS, adding support for the CDMA2000 network. Subsequent 3GPP releases added more functionalities to the initial standards. Release 6 added interworking support with WLAN (IEEE 802.11) while the next release (Rel. 7) further added support for fixed networks. Originally designed to evolve UMTS networks to deliver Internet Protocol multimedia to mobile users, IMS has become the core component within LTE, cable TV and next generation fixed telecoms networks. IMS is the only standardized way to deliver IP-based services that are enabled by a common core network for all media. It provides Users with attractive, communication services, over multi-devices across multi-access technologies.[6]. 3GPP works closely with the IETF to ensure maximum re-usability of internet standards and preventing fragmentation of IMS standards.

A. Current Scenario: Provision of CRBT over GSM Networks

The CRBT service is currently offered through the GSM core network as a value added service. The original architecture of the GSM network would not support this service and therefore, minimal adjustments had to be made to support the necessary media servers and gateways required to support the CRBT services.

1) Outgoing Call Process

1. Mobile Station (MS) sends called number to BSS
2. BSS sends called number to MSC
3. MSC checks VLR and asks BSS to allocate resources for the call

4. MSC routes the call to GMSC
5. GMSC routes the call to local exchange of the called user
6. Ring back tone is routed from called user to MS via GMSC, MSC, BSS as the caller awaits the called party to receive the call
7. The ring back tone is terminated once the Called party receives the call.

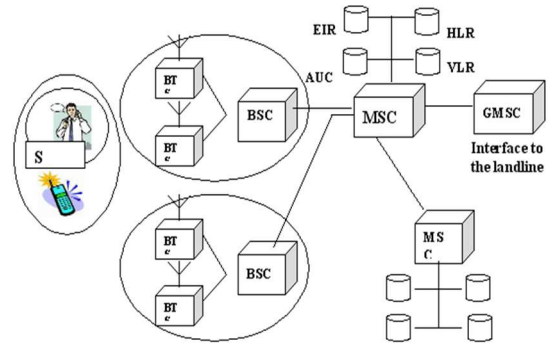


Figure 3: Original GSM architecture

To support the CRBT service, there are additional integrations to the original GSM architecture. These integrations can be from the Mobile Network Operator or a third party digital media content organization. The additional components include the Ring-Back Tone Application server (which includes the Media/content server) and a service provisioning server that will handle subscriber requests through a web portal. This provisioning server may also act as the USSD gateway for subscription through the USSD codes.

The CRBT service is integrated with the Mobile Switching Centre to handle call signaling in the call set up process. The Call flow is described below:

- When a call is received from a subscriber A to a subscriber B, the switching Centre looks for the information on subscriber B's subscription to the CRBT service from their record in the Home Location Register (HLR).
- If there exists a subscription to CRBT Service for Subscriber B in the HLR, the MSC puts the Calling Party's call on Hold in the MSC and forward the call on the SIP interface to CRBT server.
- The MSC may then transfer the call terminating role to the CRBT server, which will monitor the called Subscriber's signaling until the call is received or the MSC retains the call termination role and keeps

updating the CRBT server on the status of the call to subscriber B.

- The CRBT Server retrieves the called subscriber's service profile from its database, this includes the file name of the ring back tone that the subscriber has selected.
- RBT Server then plays the tone, after retrieving the tone file from the Media Server. The selected tone can either be the global tone set by the customer or a Caller ID specific tone if the tone is set so by the subscriber.
- The tone is then played from the Media Server and is sent to the Media Gateway (the caller MSC) address sent by MSC to CRBT server in the initial SIP signaling.
- At the end or by interrupting the tone, RBT server may play an automated IVR prompting the caller to select the played or playing tone their new ring back tone by pressing a Hot-Key combination. This is the case if the caller is also a subscriber of that phone content service. In the case that the CRBT service provider is the MNO, then all subscribers get the IVR.
- If the Caller presses the hot-key combination, the CRBT server sets the selected tone as the RBT of the calling party. This is done by updating the calling party's service profile in the database.
- When the called subscriber receives the call, the MSC sends either a SIP BYE message (if the call was terminated by the SIP server) or a SIP Cancel Message (if tone was played in Early Media Phase) to the CRBT server. The ring back tone is then disconnected. The session is then established between the calling party and the called party

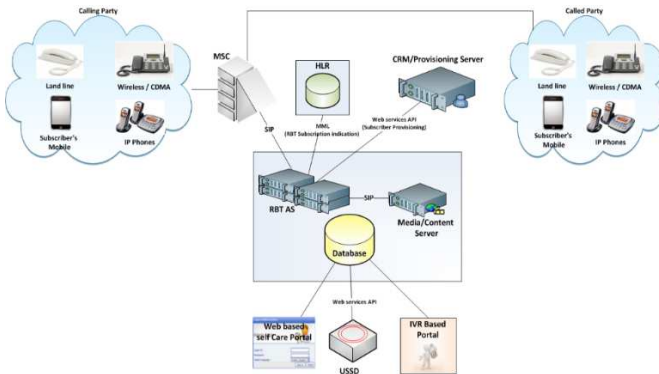


Figure 4: CRBT service in Circuit Switched GSM networks

2) Integration with the Provisioning Server

The provisioning server is responsible for handling subscription requests from the users. It may provide a web portal for clients as well as act as USSD gateway through which potential subscribers can access the service through the predefined USSD short codes. The CRBT server needs to integrate with the customer provisioning system. When a subscriber therefore subscribes to CRBT the provisioning system uses the web-services based API from the CRBT platform to provide access. Similarly, the Provisioning invokes the CRBT platform API to de-provision the subscriber on CRBT platform when required; this is when a subscriber requests to be purged from the service.

3) Integration with the Home Location Register

The CRBT server also integrates with the HLR to update subscriber records. It uses the interface and the API exposed by HLR to indicate in the Subscriber's profile details that the user is subscribed for the CRBT service. Similarly, when a subscriber is de-provisioned in CRBT, the platform updates the HLR.

4) Integration with USSD gateway

The RBT server may need integration with the Operator's USSD gateway to receive and interpret USSD short codes and interpret them. The short codes may be used by subscribers to select particular Ring Tones and subscribe or unsubscribe to the service. [10]

B. Proposed Scenario: Provision of CRBT through the IMS Core

The same service can be provided through the IMS core in Next Generation Networks and or the 4G network where the network is All IP including the local loop

1) Process of the IMS call set up to the PSTN or a Circuit Switched Network

- An IMS user called the Caller party, initiates a call to a PSTN phone number.

2) IMS to PSTN Call Routing through the BGCF

- The Calling SIP phone sends INVITE to P-CSCF. The message will normally include the codecs available for the communication channel, the called UE RTP port number and IP address.
- Origin P-CSCF forwards the request to the origin S-CSCF whose IP address was acquired during the Registration Process. The origin P-CSCF then acknowledges the INVITE message to Caller UE
- Since the PSTN number cannot be converted to a SIP address by the S-CSCF, the Called party is identified as member of an external Circuit Switched Network

and therefore the request is forwarded to the Border Gateway Control Function (BGCF) for routing of the call.

- The BGCF then selects a Media Gateway Control Function to terminate the call or routes the call to another BGCF (serving the destination Network) to select the MGCF to do the termination of the call.

3) IM-MGW Initial Setup

- The MGCF asks the IM-MGW to reserve an outgoing channel to the called party and a new context including the Codecs, the IP addresses and the RTP port numbers
- The MGCF returns the media stream capabilities of the destination along the signaling path in a "183 Session Progress". The IM-MGW "Common Codec List", IP address and the RTP port number are included in the message.
- The IM-MGW creates a circuit switched connection that uses TDM which is associated with the RTP port for communication between the two systems. The IAM message is forwarded from the MGCF to the termination point of the PSTN

4) Caller Media PDP Context Activation

- The caller confirms the Codec in the PRACK and the IM-MGW is updated on the Codec used. It responds back with the acknowledgement received at the Caller end. An Update is also made to the called party and acknowledged. Since caller PDP Context Activation is over, notify the called end in UPDATE message. The called end replies back with 200 OK.

5) Ringing

- The MGCF forwards called party alerting indication in 180 ringing message towards the Caller.
- The ring back tone is fed to the calling subscriber. The IM-MGW converts the tone into RTP. The UE converts it back to the ring back tone and feeds it to the calling subscriber. The Caller acknowledges the 180 ringing with PRACK message towards MGCF which in turn acknowledges the PRACK message with 200 OK message.

6) Conversation Mode

- The final response, 200 OK, is sent by the MGCF over the signaling path when the subscriber has accepted the incoming session attempt. The Caller then sends the final acknowledgement in ACK message towards MGCF.

- Bidirectional voice path is now through. The IM-MGW converts RTP to voice and vice versa. UE also maps audio to RTP and back. The Caller sends BYE towards MGCF when the calling party hangs up.
- The MGCF acknowledges with 200 OK message towards Caller [5].

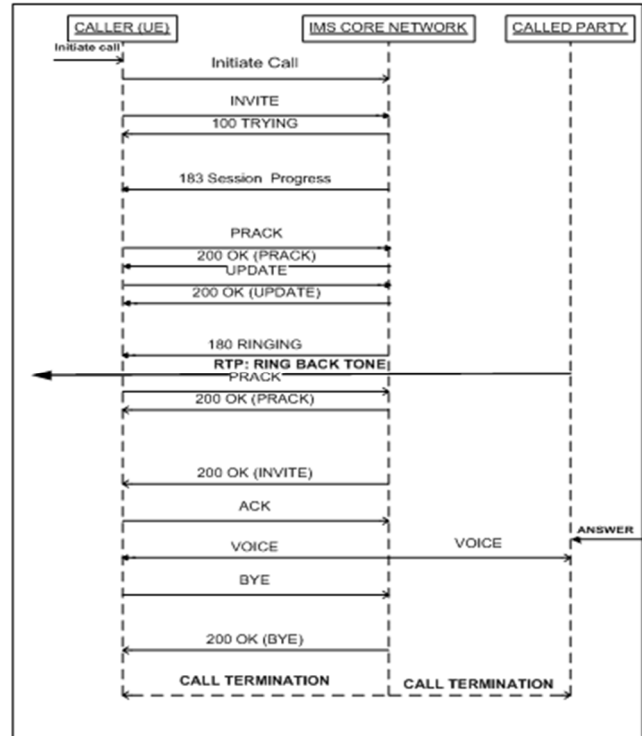


Figure 5: Call set up process IMS to PSTN

C. Implementing the Caller Ring Back Tone in the IMS to PSTN call Set Up

To implement the CRBT in this type of call, the integrations will be done such that the Ring Back tone is accessed in the Ringing Phase of the call set up. The integrations of the CRBT system will need to integrate to the Switching server, the subscriber database, the MGW and the MGCF. However, this will require other network nodes such as the CRBT Application server and the subscriber profiles database. Therefore the new components is described below

The switching server, is a core element of a CS-based PSTN/ISDN emulation component, which is responsible for call control, media resource control, call routing, user profile and subscriber authentication, authorization and accounting.

The MGCF has internal functions. It handles the Media Gateway that is responsible for the necessary media conversions between the IMS core and the PSTN network

The CRBT-Application Server is a core component to implement CRBT service logic. It responds to service request,

Enquiries on ring tones based on call information and subscriber's preferences, and controls media negotiation.

The Media Server stores media files, interacts with CRBT-AS and provides ring tones to users. For legacy terminals, media files are converted to audio streams (e.g., audio extraction from other media formats), and then offered to the calling party.

The Service user profile database holds the subscribers' subscription information and ring tone playing rules (as user profile) may be stored

When the Switching server receives a call directed to Subscriber B, the switching server checks whether the Subscriber B is a CRBT service customer according to the subscribers' subscription information from the Subscriber profile database. If B is a CRBT subscriber, the call server then triggers the CRBT service through the CRBT-AS according to the service provision policy (for example, trigger the service after receiving ringing indication for the subscriber B). Then CRBT-AS requests the Switching server to establish a media connection to subscriber A from the media server through the IM-MGW, and notifies Media Server to play the corresponding ring-back tone (to the Caller Party). This comes after the 180 Ringing Message that indicates that the channel of the communication has been set up between the called party and the caller). The IM-MGW under the MGCF instructions, converts the ring back tone to the RTP format for the tone to be received by the Caller SIP phone. When Subscriber B answers the call, the call server notifies CRBT-AS to stop CRBT and connects the caller (user A) to the User B.[8]

D. Process of call set up from one IMS User to another IMS User

This sequence describes the call setup of a call from one IMS subscriber to another IMS subscriber. The calling subscriber is in one IMS supporting network. The called subscriber is in another IMS network. The call flow focuses on the IMS routing of SIP dialog.

The major steps in the call flow are include the Initial SIP INVITE, the first response to the SIP Invite and the PDP context set up and activation.[7]

1) Initial sip invite

- The SIP phone sends the invite to called party identified by specific SIP address. The message contains Route entries for the client and the S-CSCF address that was extracted from the Service-Route header in the Registration process. Specific port initially set up are used for security purposes. "To" and "From" headers are also included in the message.
- The P-CSCF acknowledges the INVITE and the "100 Trying" message indicates that the call setup progress
- The P-CSCF updates the Via and Route-Record headers and forwards the request to the Called UE.

The secure port is included in the Via address specification to identify the channel path. The message also includes the media authorization token to be passed to the GGSN (I-CSCF) in the Packet Data Protocol context activation request

2) IMS Routing First Response to Sip Invite

- The Called UE replies indicating that the session is in progress. The contact address is set as its own IP address. The Via and the Record-Route headers are copied from the received INVITE to be indicate the intended recipient.
- Like the other nodes, the Origin P-CSCF removes its own identity from the Via header. The P-CSCF also updates the Record-Route header to include the protected port number in its entry. This forces the terminal to send all responses using the protected IPSec SA for secure communication. The message also includes the media authorization token.

3) PDP Context Activation and Audio/Video Path Setup

- The Caller now sends a PRACK (Provisional Response Acknowledgement) to inform the called subscriber about the selected Codec. This message also indicates that the resources needed to meet the quality of service requirements of the session are not available.
- The called subscriber acknowledges the PRACK. The message also indicates that quality of service for the session is not met for the called subscriber as well.
- Since the caller PDP context has been activated, the caller notifies the called end that the caller can now meet the minimum quality of service requirements in both directions in the bidirectional channel created (send and receive).
- The caller replies back to the called user. The Local QoS field is still set to none since the called PDP context activation has not been completed yet.
- Since all the required resources are in place now, the called subscriber is can be rang s as to notify the user about the incoming call.
- Inform the caller that the called subscriber is being rung. This serves as an implicit indication to the caller that the QoS at the called side has also been met. This tone can be customized using a Customizable Multimedia Tone (CMT) also referee to as a Caller ring back tone.

- The then caller acknowledges the ringing message with a PRACK and the Called party acknowledges this PRACK as well.
- The called subscriber then answers the call.
- The Caller is then notified that the call has been answered and the connection is complete.
- The caller then acknowledges the "200 OK" message that the call was answered and therefore both users move to conversation mode. [4]

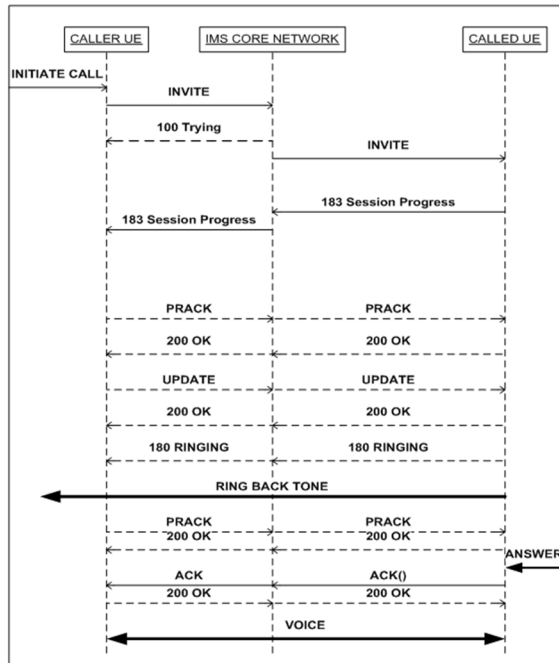


Figure 6: IMS to IMS call set up process

E. Implementing the Caller Ring Back Tone in the IMS to IMS call Set Up

In the IMS based network, the following entities are involved in the provision of the customizable Caller Ring Back tones

Serving call session control Function (S-CSCF): The S-CSCF handles all the functions related to session control and routing of messages. It establishes, monitors, supports and releases multimedia sessions and manages the user's service interactions. The SCSCF interacts with the CRBT_AS to provide CRBT also known as the Customizable Multimedia Ring.

Service Subscriber profile Database: The subscribers' subscription information and ring tone playing rules (as user profile) are stored in this database.

Caller Ring Back Tone Application Server (CRBT-AS): CRBT-AS is a core component to implement CRBT/CRT

service logic. It responds to CRBT/CRT service request, enquiries on ring tones based on call information and subscriber's preference, and controls media negotiation.

Media resource control function (MRCF): MRCF controls media resource processing functional and allocates MRPF ring tones to play to CMR users.

Media resource processing function (MRPF): MRPF stores all the media files, interacts with Application server and provides ring tones to users. This acts as the media server for the CRBT platform in the case that the service is provided by the same Mobile Network Operator.

In this functional model, when S-CSCF receives a call to a subscriber B, it checks whether the subscriber B is a CRBT service subscriber according to the subscription information in the Subscriber Profile Database. If the subscriber is a CRBT client, S-CSCF triggers the CRBT service from the Application servers. The Application server may then instructs MRCF to establish media connection with the caller and play ring-back the selected tone to the caller according to service provider policy i.e. play ring-back tone after receiving ringing indication from Subscriber B (After the 180 Ringing Message). When B answers the incoming call the CRBT_AS signals to the MRCF to stop the CRBT and the call session connection is established between the two IMS user.[8]

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