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STUDY PAPER

ON

Telephony Application Server

INDEX:

"This study paper discusses firstly about details of Telephony Application Server, its types & location in IMS network. The aim of this study paper is to briefly explain the need & use of Telephony Application Server."

1. Introduction

For last few years, the telecom industry is seeing a transformation, where the boundary between fixed & mobile broadband service providers are mixing. Inthe past, subscribers had multiple service provider relationships, and these are now able to get most of services by a single service provider. In today's era, mobile phones have various multimedia capabilities & multi-purpose utilization which ultimately demanding rich-media, interactive services. For this purpose, the traditional issues of network infrastructure are giving way to new issues of service delivery and execution infrastructure, which requires standards, based services across multiple platforms, networks, and applications.

One of the most viable options is to transform their network using an IP Multimedia System. The IMS supports multiple Application Server for telephony services. The Telephony Application Server (TAS) is a back-to-back SIP user agent in IMS that maintains the call state.

The TAS contains the service logic which provides the basic call processing services including ***digit analysis, routing, call setup, call waiting, call forwarding, conferencing, etc.*** The TAS provides the service logic for invoking the media servers to support the appropriate call progress tones and announcements in various stages of call.

2. Telephony Application Server

Basically IMS has three main layers. These are transport, control, and service/Application layer. The IMS supports multiple application servers for telephony services in its Service/Application layer. An IMS application provides a specific service to the end user. IMS end-user services include multiparty gaming, videoconferencing, messaging, community services, presence, and content sharing. Depending on its implementation, a telephony application server is required that can host one or many different applications.

TAS performs the following functions:

(a) It runs all application logic that manages the workflow associated with routing incoming calls so that they are always routed to the preferred device.
(b) It initiates all call related events to the client.
(c) It provides personal call history records of all calls that user makes and receives.
(d) It handles all call and flow control for audio conferences.
(e) It manages all user and configuration data.
(f) Some data is provisioned into the system as part of the initial configuration, while other data is managed by the user.
(g) Together with Media Server component provides limited audio conferencing capability. Primary use case is for small ad-hoc meetings. This capacity is configurable.
(h) Provides ability to provision remote administrative features.
(i) Provides SIP Registrar and Proxy service for the embedded soft phones.

In IMS, there can be three types of Telephony Application Server in Service/Application Layer depending on the requirements & for different-different application/services.

(a) SIP application server,
(b) OSA application server, and
(c) Camel service environment.

All above three servers may be combined in one unit which can also be called as Telephony Application Server. The IMS architecture enables an IMS service provider to deploy multiple application servers in the same domain. Different application servers can be deployed for different applications. TAS integrates voice, video, instant messaging, presence, mobility, conferencing and collaboration over any network and any device.

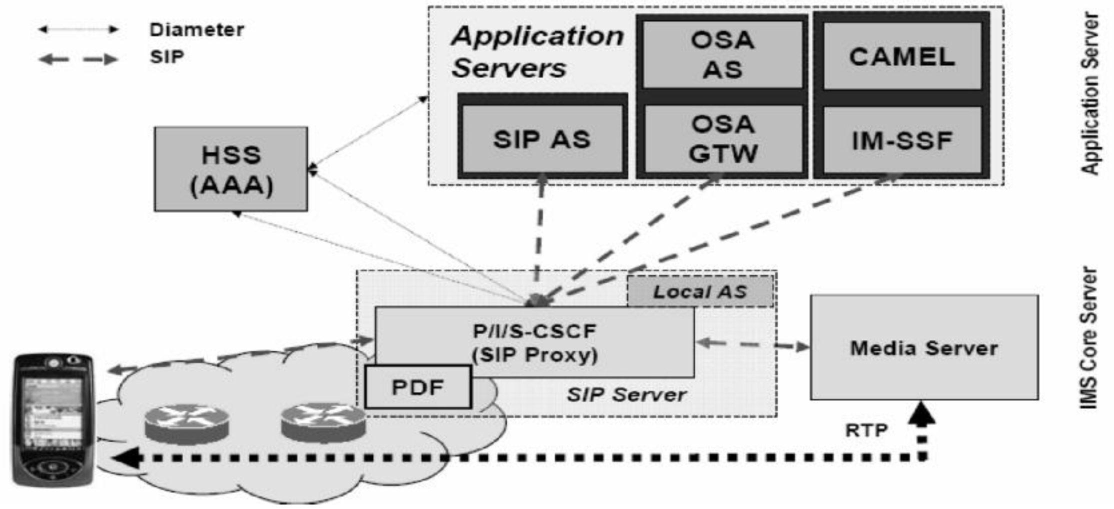


Figure 1: Application Servers

CAMEL: Customized Applications for Mobile Networks Enhanced Logic

HSS: Home Subscriber Server

OSA AS: Open Services Architecture AS

OSA GTW: Open Services Architecture Gateway

IM-SSF: IP Multimedia Service Switching Function

PDF: Policy Decision Function

2.1 SIP Application Servers

SIP application servers are generally B2BUA (back-to-back user agents). It can act as redirect servers, proxy servers, originating user agents or terminating user agents. This has SIP signalling capabilities and are directly involved in the call's signalling flow. This receive SIP messages from the S-CSCF (Serving Call Session Control Function) and parse them. Similarly, they generate SIP messages and send them to the S-CSCF.

The application server translates an IMS service's execution in the SIP application server into a sequence of SIP procedures, such as sending invite requests and reacting to SIP responses. For services requiring media interaction, the SIP application server invokes the multimedia resource function control (MRFC)capabilities. It is intended for new services. A multitude of widely known APIs (CGI, CPL, SIP Servlets) is available.

There may be a chance in which, SIP-AS is co-located on the CSCF and this may be useful for simple services. Doing this, may be beneficial for the Service Availability and the Service Performance.

2.2 OSA Application Servers

OSA application servers can provide the same services as the SIP application server but have no signalling capabilities and aren't directly involved in the SIP calls' signalling flow. They communicate with the S-CSCF through the OSA-SCS(service capability Server), which maps SIP messages into invocations of the OSA API (also called Parlay) and back. OSA SCS provides access and resource control.

From an S-CSCF perspective, the SIP application server and the OSA SCS exhibit the same behaviour. The OSA application server also has access to the HSS data, but only through the SCS. The SCS implements the Diameter protocol, so it can read and update data records based on the OSA application server's requests. The OSA application server mainly implements external services that could be located in a visited network or a third-party platform.

2.3 CAMEL Services via Camel Support Environment (CSE)

It is used for the support of existing IN Services (provides service continuation). Customized Applications for Mobile Networks Enhanced Logic (CAMEL) services can be reused in the IMS architecture through utilization of the IP Multimedia – Services Switching Function (IM-SSF).

The IM-SSF provides the interworking of the SIP message to the corresponding CAMEL, ANSI-41, Capabilities Application Part(CAP) or Transaction Capabilities Application Part (TCAP) messages. The number portability is done through ENUM server, that populates the Number portability data(NPDB), and when ENUM server is queried for the terminating call it prepends the LRN number if any.

CAMEL provides legacy intelligent network services in 2G and 3Gnetworks. The services are based on proven and reliable IN technology, but, they are expensive and limited in evolution. On the other hand, SIP application servers provide multimedia conferencing services and they are integrated with HTTP. They exploit the Internet technology with is cheaper and also, the service creation is easier. But, SIP application servers are not yet proven for carrier grade services.

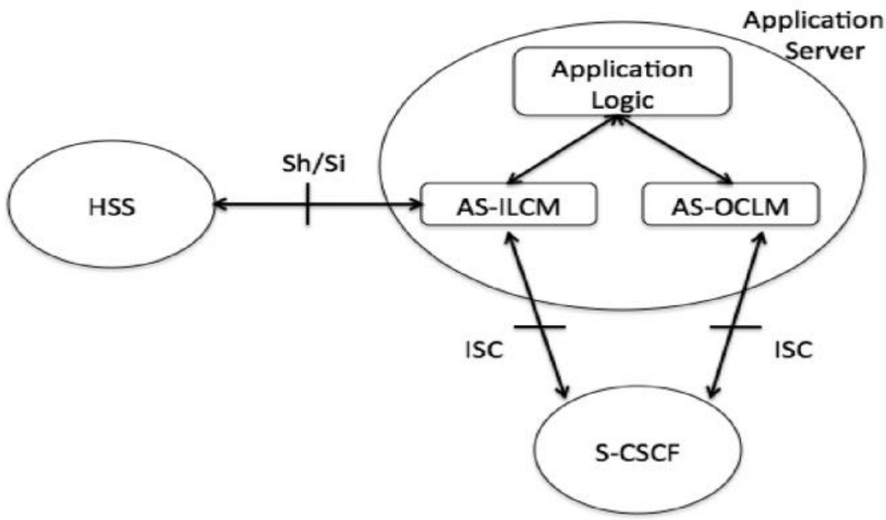
Open Service Access is an API which could be mapped to both CAMEL and SIP. It's a proven technology which reuses existing services in NGN. It is the method of choice for supporting 3rd party application.

3. Internal Working of Telephony Application Server

The Telephony Application Server uses filter rules to decide which of the many services deployed on the server should handle the session. During the service logic's execution, the application server can communicate with the HSS to get additional information about a subscriber or to learn about changes in the subscriber's profile. The application server uses the Diameter protocol to communicate with the HSS.

A functional model showing interaction between the S-CSCF and the TAS is in Fig. 2. Every UE-originating incoming request, from the S-CSCF, is handled by the AS-ILCM; this interacts with the application logic to report the call state information. Depending on the service that is being provided, the application logic may instruct the AS-OLCM to modify the request if needed. After processing the request, the AS-OLCM may send this request back to the S-CSCF.

In both cases, the TAS handles and interprets the SIP messages forwarded by the S-CSCF and translates end-user service logic into sequences of SIP messages, which it sends to the parties involved, again through the S-CSCF. The S-CSCF decides whether it should forward an incoming initial SIP request to a given application server. The decision it makes is based on filter information received from the HSS.



AS-OLCM: Application Sever - Outgoing Leg Control Model
AS-ILCM: Application Server - Incoming Leg Control Model
S-CSCF: Serving Call Session Control Function
HSS: Home Subscriber Server

Figure 2: Telephony Application Server functional model

4. Location of TAS in IMS architecture

IMS (IP Multimedia Subsystem) provides services in a standardized & proper way. It provides a future-proof architecture that simplifies and speeds up the service creation and provisioning process, while enabling legacy interworking. In a broader term, it enables a secure migration path to all-IP architecture that meet end-user demands for new enriched services. The IMS standard is based upon the widely adopted Internet standard technology called "Session Initiation Protocol" (SIP). SIP is at the heart of the IMS network architecture, providing the real-time, peer-to-peer, multiparty and multi-media capabilities.

It allows interoperability among various provider networks, open standard interfaces between network elements, and interoperability between infrastructure and applications from different vendors across all access types.

The IMS architecture and SIP signaling is flexible enough to support a variety of telephony and non-telephony application servers. Application servers host and execute the services and provide the interface with the control layer using the SIP protocol.

IP Multimedia Subsystem – IMS is a Next Generation Network architecture which is located in Control layer of NGN architecture. Next Generation Network moved towards full IP- based network. Hence, NGN – IMS has common service control architecture. IMS has three layers: transport, control, and service.

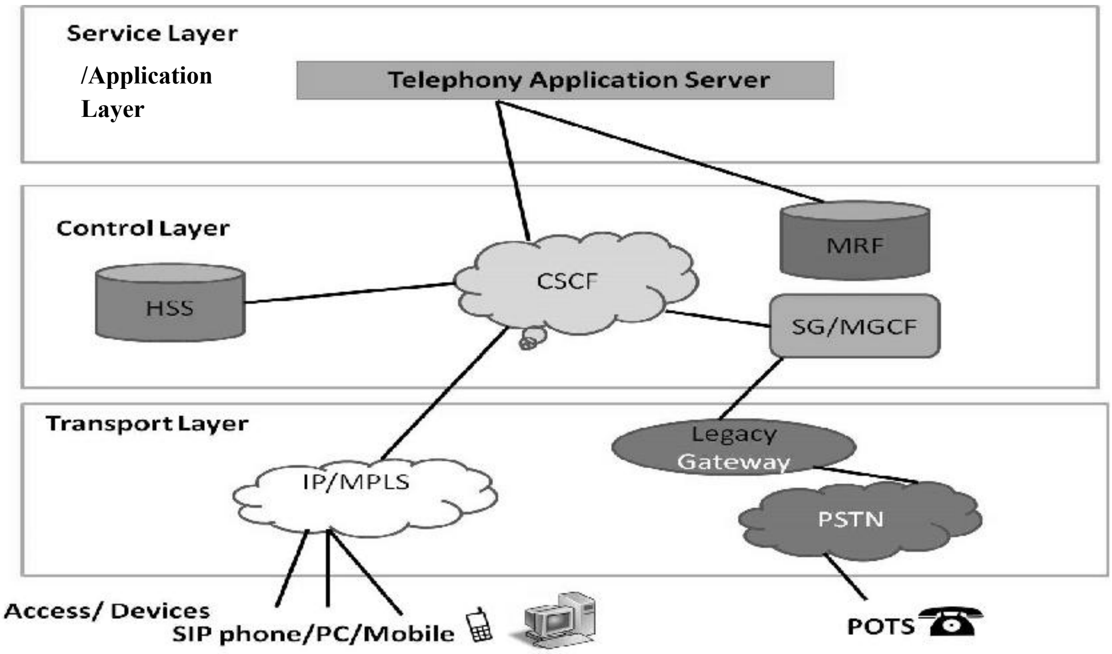


Figure 3: Layers in IP multimedia subsystem (IMS)

Transport layer. It is the network-access layer. It connects different IMS devices and user equipment. The transport layer enables the IMS devices for placing and receiving calls to and from the PSTN or other circuit-switched networks through the media gateway. The transport layer establishes the IP connectivity of user equipment.

Control layer. It is main layer and its functions are specified as part of the IMS architecture. The main component at this layer is the CSCF (Call Session Control function). There are three types of CSCF; the proxy CSCF(P-CSCF), the interrogating CSCF (I-CSCF), and the Serving CSCF (S-CSCF).

The **P-CSCF** is a SIP proxy entity which is used as first entry point of contact for the IMS terminal. IMS terminals discover their corresponding P-CSCF as part of their network connectivity procedure. It sits on the path of all signalling messages of the IMS terminal and passes SIP registration to the correct home network and SIP session messages to the correct S-CSCF after registration.

The **I-CSCF** is a SIP proxy which is located at the administrative IMS domain's edge. Its IP address is published in the domain's DNS server, so remote servers (such as a P-CSCF in a visited domain or an S-CSCF in a foreign domain) can find it and use it as an entry point for all SIP transactions to this domain.

The **S-CSCF** is the central node for signalling plane. It registers users and provides services to them. It routes SIP requests, provides billing information to mediation systems, maintains session timers, and interrogates the HSS to retrieve authorization, service-triggering information, and user profiles.

The HSS contains the database of users. It supports the IMS network entities that handle the calls or sessions. It contains subscription-related information (user profiles), authenticates and authorizes users, and can provide information about users' locations.

The Media Resource Function provides media functions in the IMS architecture (such as playing announcements or recording voicemails). The IMS standard decomposes the function of this into two elements. The *media resource function controller* interprets information from the S-CSCF. MRFC control the *media resource function processor* (MRFP).

The breakout gateway control function(BGCF)determines the next hop for routing SIP messages that can't be routed by the S-CSCF. It selects a media gateway control function (MGCF)that will route the call to the PSTN through a media gateway.

Service layer. The transport and control layers provide an integrated and standardized network platform to let service provider's offer various multimedia services in the service layer. The service layer contains the telephony application servers for various applications, which provide the end-user service logic.

5. TAS Requirements

IMS Telephony Application servers should fulfil following basic requirements

(a) Support for a wide range of end-user services.

By supporting a wide range of services, application servers can provide a single solution platform. Both fixed service and mobile service shall be both supported in TAS. The TAS shall support providing services for subscribers from both fixed and mobile access. The subscriber type shall cover VoLTE, ICS (for VoLTE roams to 2G/3G coverage), fixed VoIP, V5, POTS, ISDN, TDM and IP PBX. Application Server (with integrated IM-SSF) support most CAMEL and CAP (for existing SCP)/MAP (for HSS) protocols to inherit the IN services smoothly.

(b) Rapid service creation and deployment.

Rapid service creation is crucial to success in the marketplace. Service providers should be able to rapidly specify, design, test, and install new services. Application Server should support registration originated from the third party and keep the state known. Application Server should support modifying call number and its attributes during the call.

(c) Easy service customization and tailoring.

Service providers must be able to change the service logic rapidly and efficiently. Users/ Customers also demand control of their own services to meet their individual needs.

(d) Independent evolution of services and network infrastructure.

Services should be defined independently of a specific network technology (SIP). Conversely, the service architecture's flexibility should facilitate the exploitation of new technologies.

(e) Support for multiplayer (or open) environments.

The application server should support services, software, and hardware components from different vendors while maintaining interoperability. Application Server should support interconnection with S-CSCF for service triggering through standard ISC interface compliant with TS 24229-870. Application Server should support interconnection with User Data Centre for retrieving/updating the subscriber service data through Sh interface.

Application Server should support non-transparent data in Sh interface defined in 3GPP Rel-8 TS 29.364. The non-transparent data is understood both syntactically and semantically by the HSS and AS. The non-transparent and standard format facilitates interoperation among AS supplied by the same, or different, vendors. It also enables the service consistency when user roams between CS and LTE domain and change the service setting from different domain.

Application Server should support standard SOAP to integrate the 3rd party application. Application Server shall support highly efficient downloading on Sh interface and IVR announcement control on Sr interface.

(f) Universal service access.

Users must be able to access services independently of the physical location and types of terminals being used. Application Server should work as B2BUA mode for the service handling. Application Server should support handling service by TEL URI and SIP URI for E.164 number.

6. TAS's Application in a different way

The TAS is an IMS Application Server providing support for a minimum set of mandatory MultiMedia Telephony (MMTel) services as defined by 3GPP e.g. supplementary service functionality. The Telephony Application Server may support multiple functions as following, which can reduce CAPEX/OPEX, and improve the operation efficiency of service provider/operator.

- MMTel AS (Support telephony basic and supplementary services)
- SCC AS(Service Centralization and Continuity Application Server)
- IM-SSF (Support IN service triggering to SCP via CAP and MAP)
- IP-SM-GW (Transport level interworking for SMS over IP)
- Anchor AS (This is basically SCC-AS)s
- SCP function (Used for CAMEL re-routing for those MSC not enhanced with ICS, it is also called Anchor AS.)
- XCAP Server (for Ut interface)
- Centrex, . Business trunk access via SIP

6.1 Use of TAS as Anchoring Purpose

When a subscriber roams & want to access in the CS network, then with the 'anchor' service enabled, the Telephony application server allocates IM routing numbers (IMRNS) to their calls and routes the calls to the IMS network for processing. This allows the subscriber to experience IMS services while on the IMS network.

The principles for centralization and continuity of services in the IMS in order to provide consistent services to the user regardless of the attached access type. In order to support this principle, originated and terminated sessions via the CS or PS domains need to be anchored in the Service Centralization and Continuity Application Server (SCC AS) in the IMS.

6.2 TAS with capability of IP SM GW

It is possible toIntegrate IP-SM-GW (IP Short Message Gateway) functions in the TAS. In this, MAP/Sh interface is used to HLR/HSS for registration and SMS MT routing. MAP interface to SMSC for SMS MO & SMS MT procedure are used. This capability is responsible for IP SMS/ CS SMS conversion. The benefit of this is that legacy SMS service runs without any user experience impact.

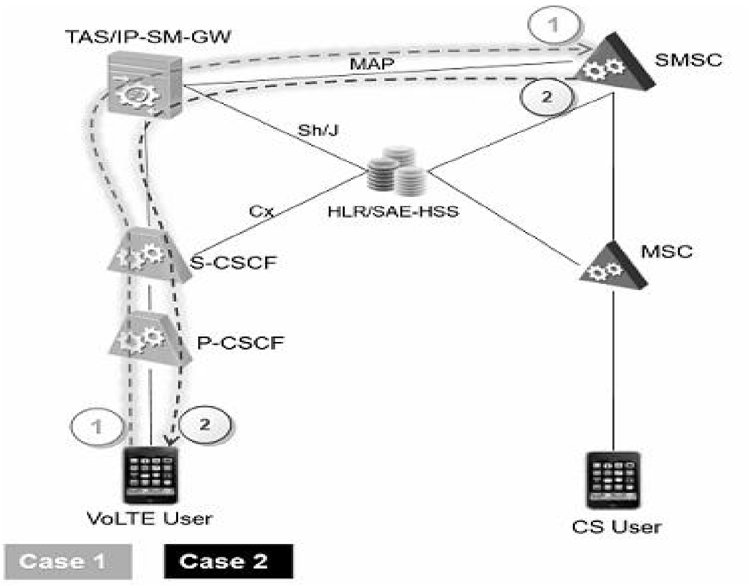


Fig 4 : IP-SM-GW in TAS

6.3 TAS used with USSD gateway

Application Server shall support USSD-GW functionality to transfer IP USSD message towards USSD centre. It is 3GPP standard compliance solution (24.390, 24.080) which integrated USSD module in TAS. TAS embedded with IP-USSD-GW module may realize call related supplementary services.

The limitation of 3GPP standard (24.390) is that it defines only UE Initiated USSD. For Network Initiated USSD, it only defined an AS can send USSD (INVITE) to UE, but not define USSDC to UE (the domain selection is not defined). In this case, other service providers/ operators use SMS to replace network initiated USSD. Inherit existing USSD related services in bank, stock exchange and etc.

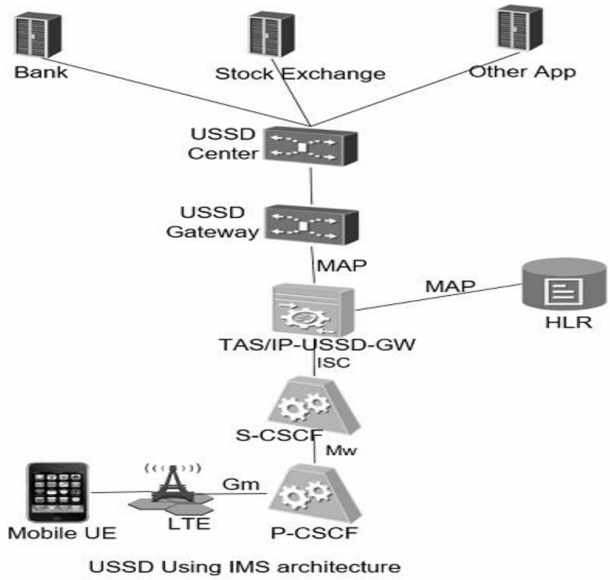


Fig 5: TAS for USSD messages

6.4 TAS used for Multiple IN/SCP Triggering:

IM-SSF handles Multiple IN services. A TAS, embedded with IM-SSF, supports to trigger multiple IN platforms based on CAP and MAP. Both MO and MT support multiple IN triggering. Some specific commands are used for configure the subscriber IN profile to multiple service code for multiple IN triggering

6.5 TAS used in Location Information Retrieval:

There are two solutions of location information retrieval i.e. PCRF based NPLI and TAS based NPLI (Network Provided Location Information). When an INVITE is received, SBC (P-CSCF may have SBC capability generally) can use the Rx interface to PCRF for location information with the bearer establish. This procedure can be used for both originating call and terminating call.

When TAS receives a INVITE, if there is location based services (such as IM-SSF for IN triggering, or Call Barring based on location), it will send the UDR to HSS for 4G location information (PS domain) and 2G/3G location information (CS domain).

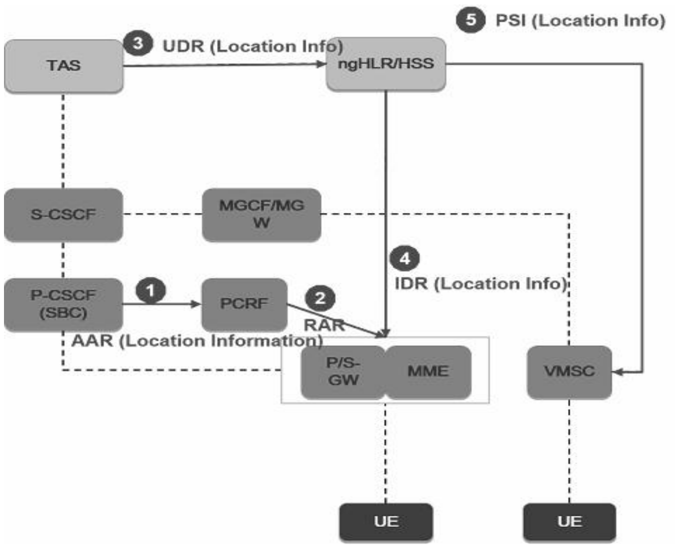


Fig 6: Location Information Retrieval

7. Call Flow with TAS

The simple registration process is described in two stages:

Stage 1

1. The UE (user equipment) sends a SIP REGISTER message. This message includes a public User ID, the private user ID and the home network SIP URI.
2. The P-CSCF finds, with the help of DNS, the home network entry points (I-CSCF). The P-CSCF forwards the REGISTER request to that I-CSCF.
3. The I-CSCF queries the HSS to find out if there is an already allocated S-CSCF to this user.

4. The HSS returns either the address of the S-CSCF allocated to this user or a set of capabilities that will help the I-CSCF to choose an appropriate S-CSCF for this user.
5. The I-CSCF may choose a new S-CSCF or use an already allocated one. In both cases, it forwards the REGISTER request to that S-CSCF.
6. The S-CSCF informs the HSS that this S-CSCF is taking care of the user.
7. The HSS returns one or more authentication vectors.
8. The S-CSCF challenges the UE.
9. The I-CSCF forwards the SIP response.
10. The P-CSCF forwards the SIP response to the UE.

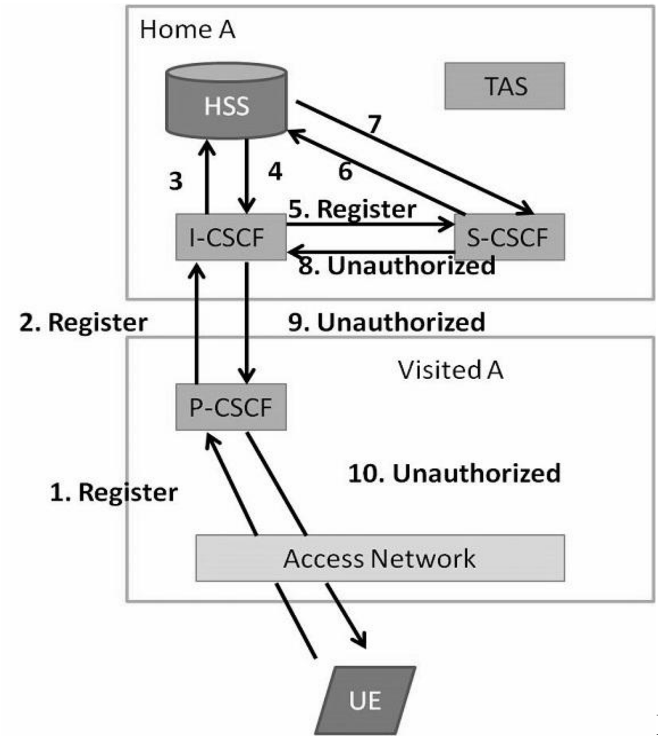


Figure 7

Stage 2

11. The UE calculates the credentials, includes them into the REGISTER request, and sends it to the P-CSCF.
12. The P-CSCF finds, with the help of DNS, the home network entry points (I-CSCF). The P-CSCF forwards the REGISTER request to that I-CSCF.
13. The I-CSCF queries the HSS to find out if there is an already allocated S-CSCF to this user.
14. The HSS returns the address of the S-CSCF allocated to this user.
15. The I-CSCF forwards the REGISTER request to that S-CSCF.
16. The S-CSCF informs the HSS that this S-CSCF is taking care of the user.
17.The HSS returns the user profile containing the filter criteria.
18. The S-CSCF evaluates the filter criteria, and may contact, if needed, one or more application server. In this example, the filter criteria indicate that an application server has to be informed about the user's registration. The S-CSCF creates a new REGISTER requests and sends to an application server.
19. The AS acknowledges the reception of the REGISTER request.

20. The S-CSCF informs the UE about the successful registration.
21. The I-CSCF forwards the response.
22. The P-CSCF forwards the response.

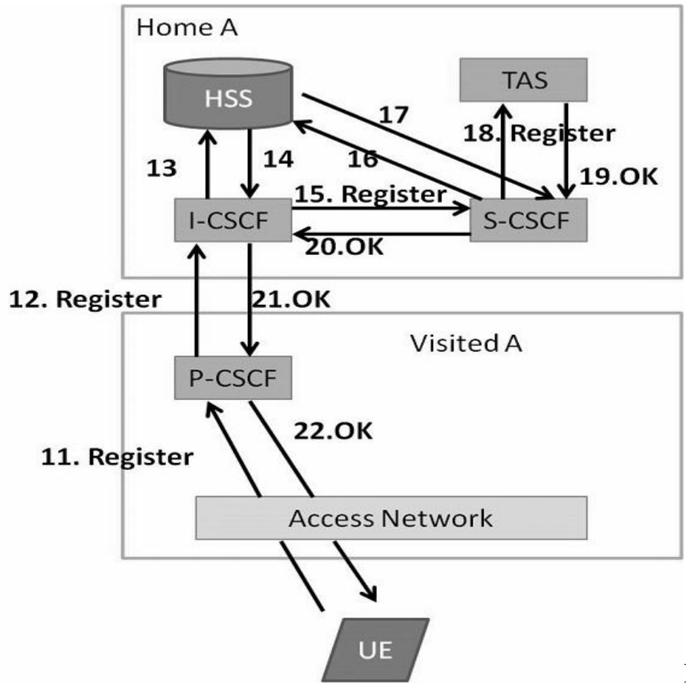


Figure 8

8. Conclusion

Though IMS was defined by the 3rd Generation Partnership Project (3GPP) in Release 5 & 6, originally for 3G/UMTS mobile networks in a decade ago, but is now becoming a reality with the rollout of IMS based LTE network. Recently Voice over LTE (VoLTE) services has been launched by operators in India. The IMS network supports multiple access type's including GSM, WCDMA, CDMA2000, Wireline broadband access and WLAN.

The capability of IMS to deliver faster transmission of voice & data, including standard calling features, messaging as well as various enriched services, ensures more deployment of the technology in future. The IMS is already considered a foundation for LTE deployment.

In the IMS architecture, Telephony Application Servers host and execute the IMS service logic. These servers can be SIP application servers, open services architecture(OSA) application servers, or a Camel service environment. Some technologies used in telephony and voice-over-IP (VoIP) application servers are also applicable to IMS application servers, but such servers have some unique requirements that could limit the extent to which these technologies can meet them. There is no standard based internal architecture of Telephony Application Server. The different technologies have different versions. The SIP servlet approach is currently the most popular application server technology.

9. Abbreviation

AS-ILCM	Application Server - Incoming Leg Control Model
AS-OLCM	Application Sever - Outgoing Leg Control Model
CAMEL	Customized Applications for Mobile Network Enhanced Logic
CSCF	Call Session Control Function
HSS	Home Subscriber Server
iFC	Initial Filter Criteria
IMEI	International Mobile Equipment Identity
IMPI	IP Multimedia Private Identity
IMPU	IP Multimedia Public Identity
IMS	IP Multimedia Sub System
IP-SM-GW	IP Short Message Gateway
IM-SSF	IP Multimedia-Service Switching function
IMSI	International Mobile Subscriber Identity
INAP	Intelligent Network Application Part
ISC	Reference point between S-CSCF and AS (SIP based)
MRFC	Media Resource Function Controller
MSISDN	Mobile Subscriber ISDN Number
NGN	Next Generation Network
OSA-GW	Open Service Access-Gateway
POTS	Plain Old Telephone System
SCC AS	Service Centralization and Continuity Application Server
Sh/Si	Diameter Protocol
SIP	Session Initiation Protocol
SOAP	Simple Object Access Protocol
TAS	Telephony Application Server
TMSI	Temporary Mobile Subscriber Identity
URI	Uniform Resource Identifier
USSD	Unstructured Supplementary Service Data
VoLTE	Voice over LTE
WLAN	Wide Local Area Network
XCAP	XML Configuration Access Protocol

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