IMS Homework

Due: Tuesday 14 Dey

Submit a maximum of 4 pages to describe IMS with details including

- What is the purpose and tasks of IMS?
- Why an operator needs IMS and what is the relation with core network?
- What is the IMS structure?
- What are the key protocols of IMS?

A reference to introduce IMS can be found below.

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Introduction to IMS

March 2007

White Paper

Aimed at person – to person communication, IMS is the only standardized way to deliver IP-based services that are enabled by one common core and control for all types of networks. It provides Users with attractive, communication services, over multi-devices across multi-access technologies.

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1 Executive summary

IMS (IP Multimedia Subsystem) enables and drives efficient converged service offerings. It is the key to delivering multimedia services with telecom-grade quality of service across fixed and mobile accesses. It creates new opportunities for operators who want to deliver attractive, easy-to-use, reliable and profitable multimedia services – including voice, pictures, text and video, or any combination of these – with existing services. Users benefit by being able to enjoy attractive converged multiple services regardless of access network and device.

Service success is very much dependent on the ability of operators to create and deliver an experience that fulfills or exceeds users' expectations. To maintain their position as service provider, operators need to climb up the value chain and take a more active part in service delivery. IMS is designed precisely for that purpose.

IMS is access-independent: it is the only open standardized way to deliver IP-based consumer and enterprise services, enabled by one common core and control, to the fixed, mobile and cable communities. It combines the quality and interoperability of telecoms with the quick and innovative development of the Internet. IMS does this by making the unique values of the telecom industry easily available to the application development community.

When implemented according to agreed standards, IMS enables operators to mix and match equipment and applications from multiple vendors, and enables mobile users to access their personal set of services wherever they roam, whichever operator network they are connected to.

IMS includes the tools and functions needed to handle numerous non-standardized services in a standardized way – ensuring the interoperability, access awareness, policy support, charging, security and quality of service functionality required to meet consumer demand for attractive and convenient offerings. Essentially, application servers are implemented above the standardized IMS architecture.

IMS is developed to interwork with existing networks. This paper describes an IMS architecture designed to meet the needs of telecom operators in the new converged multimedia environment. The Call Session Control Function (CSCF) and the Home Subscription Server (HSS) are the essential nodes in the IMS system. The control signaling routed by the CSCF is the IETF Session Initiation Protocol (SIP). The HSS provides the user profile database to manage user authentication and authorization for the subscribed services.

2 Introduction

A new communication culture is emerging, driven by trends such as Internet-based presence-enabled chat and video sharing. Communications behavior increasingly revolves around the sharing of everyday life experiences – anywhere, anytime, and on any device. At the same time, one of the key pillars of the telecoms industry is the global interconnect agreements for services like telephony, SMS and MMS. Successful mass-market uptake of any new service requires interoperability between operators, networks, and devices – which, in turn, is built on ensuring support for global standards.

A key challenge for operators is to continue to build and expand upon this successful business model, while taking advantage of the great opportunities the new communication culture brings.

With IMS, operators can combine the best of both of these worlds – the quality and interoperability of telecom with the quick and innovative development of the Internet. This is achieved in IMS by making the unique values of the telecom industry available to the application development community, while at the same time securing the delivery of well-known applications like telephony and messaging according to the successful and profitable telecom principles.

IMS offers a standardized way to deliver convenient IP-based consumer and enterprise services to fixed, mobile and cable community – enabled by one common core and control. It is the cornerstone of the evolution of current networks to a single, all-IP based network where all types of services (messaging, telephony, etc.) and media (voice, video, pictures, text etc.) can be integrated into a single user experience.

For consumer, IMS opens communication options that seamlessly combine ongoing voice sessions with multimedia elements (sharing video while talking, for example) or enrich shared applications with voice communication (for instance, talking while playing a multiplayer game). It will also be possible to change the communication mode smoothly during an ongoing session, in contrast to today's more or less 'fixed' communication modes.

3 Why IMS?

'Why IMS?' is one of the top strategic questions for any operator these days. There are many good answers, but perhaps the key one is that IMS delivers innovative multimedia services over fixed and mobile networks using open standards. IMS addresses key issues such as convergence, service creation and delivery, service interconnection and open standards. IMS can allow an operator to retain its existing business models, or evolve towards new ones.

3.1 An enabler for convergence

One key benefit of IMS is that it enables true convergence, and interworks in several dimensions – across fixed and mobile access – in the service layer, control layer and connectivity layer.

The IMS architecture provides for a number of common functions that are generic in their structure and implementation, and can be reused by virtually all services in the network. Examples of these common functions are group/list management, presence, provisioning, operation and management, directory, charging and deployment. Securing these common functions provides many benefits: less parallel development; more reliable systems as key functionality is already mature and field-proven; and higher-level abstractions for service developers, enabling them to focus on the actual application and not the surrounding details.

The traditional network structure – with its service-unique functionality – is very complex and costly to build and maintain as the number of services grows. Separate implementations of each layer must be built for every service and the structure is replicated across the network, from the terminal via the core network to the other user's terminal (as shown in Figure 1).

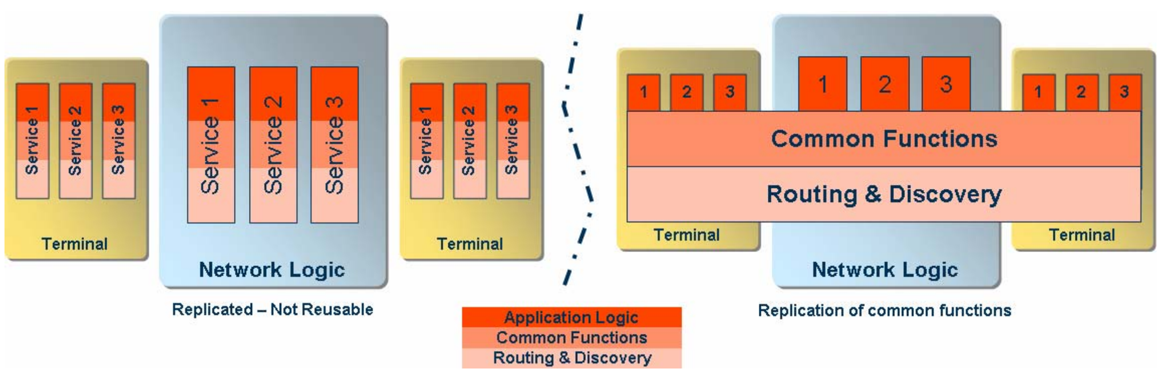

Figure 1. Vertical service versus horizontal service implementations.

3.1.1 Common control and application layer

Common enablers and services – such as presence, push-to-talk and telephony – are equally equipped to work in both the fixed, mobile and converged worlds and, more importantly, bridge the gap between them. Whether the subscriber is using a mobile device or a PC client to communicate, the same presence and group list functions are utilized. Additions or changes to a buddy list will be reflected directly on any device that the user logs on to.

3.1.2 Access-aware networks

Different services have different requirements. Some services demand high bandwidths, some demand low latency, others demand high processing power in the device. This means that in order for different services to be executed properly, the network has to be aware of the different characteristics of the access methods.

Multi-access functionality is inherent in the IMS architecture. If this is extended with access-aware control and service logic for multimedia services, IMS offers a way for fixed and mobile operators finally to deliver true fixed–mobile convergence (FMC). This will enable the delivered service to be adapted to the characteristics and capabilities of the user's current device and network access method.

3.1.3 Network convergence

Enabling one single integrated network for all access types is a significant benefit of the IMS network architecture for the operator. IMS improves service quality and facilitates efficient introduction of new multimedia services based on IP. An IMS network has common mechanisms for functions such as network management, provisioning, charging and control for all types of networks. Reliability and security can also be maintained by ensuring that future networks have the same quality of service (QoS) that users experience today.

The IMS network elements at the borders with access networks isolate the IMS core from specific access network QoS aspects. They also provide access-specific policy control such as fraud protection, QoS assurance and user address reachability.

Although the actual requirements tend to be different for each particular access network, to a large extent the same issues tend to arise. The main differences are visible both in vendor-specific solutions and in the different access standardization bodies, even though lately greater effort has been put into getting more alignment between standards for similar access types.

3.2 Fast and efficient service creation and delivery

With the introduction of IMS architecture, many functions can be reused for fast service creation and delivery that can be accessed through standardized means. IMS services are hosted by Application Servers and various aspects of service control are defined. For example, IMS defines how service requests are routed, which protocols are supported, how charging is performed and how service composition is enabled.

In a non-IMS network, services are specified and supported by a single logical node, or set of nodes, performing specialized tasks for each specific service. Each service is an island, with its own service-specific node(s). The only possible way to interface between services – for example, for service composition – is through protocols specific to each combination. In the absence of any common service framework, each service is typically designed, tested and implemented from scratch, and must be separately maintained and upgraded.

In IMS-compliant solutions, systems are designed to support multiple Application Servers. This means the same infrastructure can be utilized for new services, with the implementation effort focusing on the actual service and not on basic features. Also, it is simple and efficient to enable a new service for an IMS user: all the required infrastructure (authentication, authorization, charging, etc.) is already in place.

3.2.1 Easy access to services

In IMS, the sign-on and authentication process becomes simpler, both for operators and subscribers. For instance, subscribers can use an ISIM card for authentication to the IMS network. However, once authenticated through IMS, the subscriber is able to access all the other IMS services that he or she is authorized to use. Authentication is handled by the Call Session Control Function (CSCF) and Home Subscription Server (HSS) as the user signs on. When it receives a service request, the Session Initiation Protocol (SIP) application server can then safely assume that the user has been authenticated.

In the non-IMS world, by contrast, each service often has its own way of authenticating users, which may be standardized or proprietary. It might not authenticate the user at all, relying instead on lower-level authentication.

3.2.2 Scales independent of the traffic mix

IMS services are primarily intended to address a mass market, with telecom-grade quality of service. In addition, IMS also needs to provide support for a complex service mix – for example, different service bundles that meet specific customer needs. These service bundles will most likely have different numbers of users, with different user behavior, which will affect dimensioning of the network.

In this situation, IMS network architecture offers a big advantage, since it is designed to scale independent of the traffic mix. This means that the CSCF capacity can grow in proportion to the number of subscribers, and that the number of SIP application servers can grow in line with service usage. In addition, the amount of interdomain – for example between Voice over IP (VoIP) and PSTN – can grow as services that utilize these capabilities are introduced.

3.3 Service interconnection and open standards

As we have seen previously, IMS enables the creation of a wide range of services. However, the key issue is to enable delivery of these services across the whole operator community. The IMS standard helps operators create and secure interconnect agreements of a multitude of services (as shown in Figure 2). To create and secure interconnect agreements on every single service is traditionally an extensive and tedious task. By contrast, IMS enables the industry to agree upon a few key mechanisms for interconnection.

A key concept in IMS is Communication Services: standardizing a few basic communication patterns that can then be provided as application building blocks. Communication Services span the whole operator network, from the network–network interface (NNI) to the user–network interface (UNI). Third-party applications will be connected through APIs built on Communication Services.

Some form of interconnect is required to ensure a wide range of non-standardized services can be successfully deployed. An example of such a non-standardized service is a multiplayer poker game, where the communication part of the game is handled by a standardized service (messaging). To ensure the interconnect agreements between different operators work well, a few parameters need to agreed, including: media characteristics; service unawareness of interconnect agreements; management of SIP fraud; and charging for transport of non-standardized services. As shown in Figure 2, this means that instead of establishing separate interconnect agreements per service, the operators can agree on a small set of basic agreements. In this way, the process of agreeing Service Layer Agreements (SLAs) and settlement rules for each new service is avoided.

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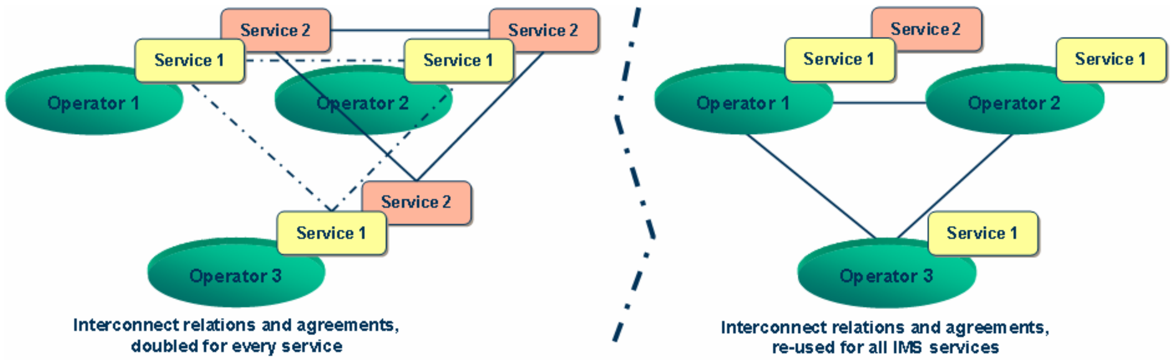

Figure 2. The difference in service interconnect between a non-IMS network and IMS-enabled operators.

In addition, it is vital that new IP services interwork successfully with the wide range of existing services in PSTN and PLMN networks. This is to avoid churn, encourage the uptake of new services and leverage existing investments. One advantage of IMS is that it has been developed to interwork with existing networks. The level of interworking between legacy services and IMS-based services will of course vary, according to the actual services supported in different domains and devices. Any interworking must have end-user experience as its key focus.

3.3.1 Open IMS standards necessary for interworking

To ensure mass-market acceptance, IMS services need to work across different networks, devices and access technologies. This is enabled through standards-compliant IMS products, verified in an end-to-end environment through interoperability testing between device and infrastructure vendors.

The IMS standard (illustrated in Figure 3) defines a generic architecture to offer multimedia services, including Multimedia Telephony. It is an international, recognized standard, first specified by the 3GPP/3GPP2 and now being embraced by other standards bodies such as ETSI/TISPAN, CableLabs, JCP, OMA and WiMAX Forum.

The IMS standard supports multiple access types, including GSM, WCDMA, CDMA2000, cable, wireline broadband access, WLAN/WiFi and WiMAX.

IMS takes the concept of layered architecture one step further by defining a horizontal architecture, where service enablers and common functions can be reused for multiple applications. The horizontal architecture of IMS enables operators to move away from traditional vertical ‘stovepipe’ implementations of new services – eliminating the costly and complex traditional network structure of overlapping functionality for charging, routing and provisioning. Standardization makes it work end to end and enables an attractive, convenient user experience.

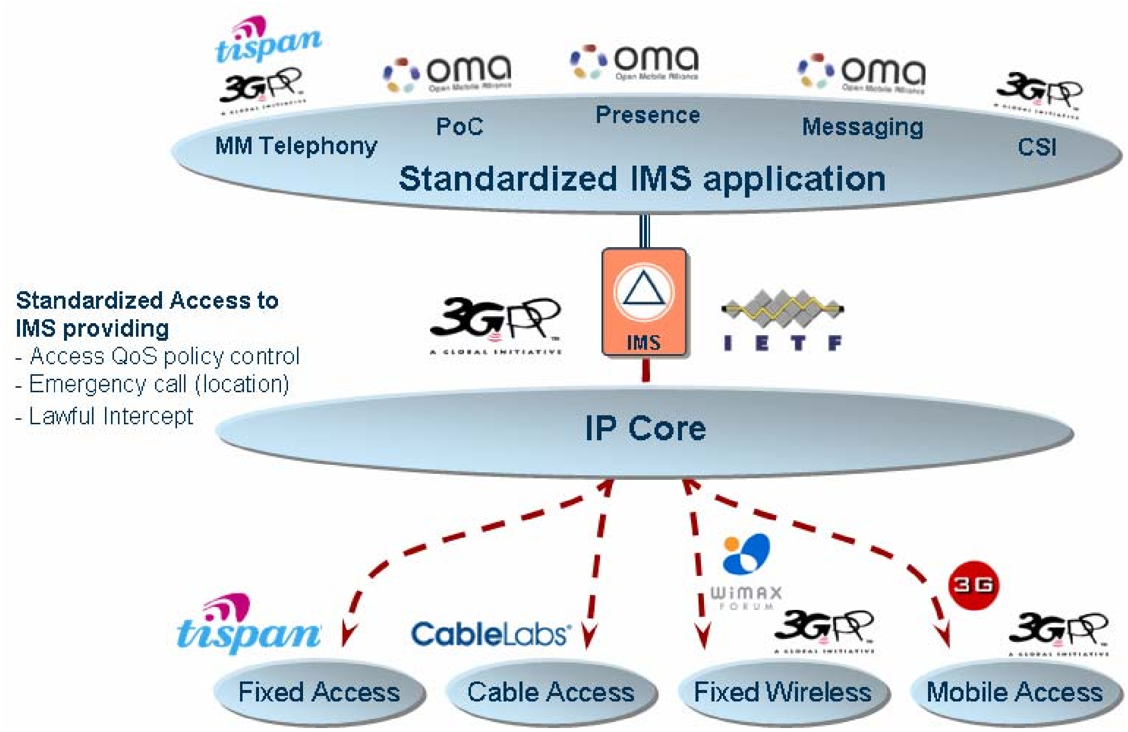

Figure 3. IMS standardization.

4 How IMS is structured

The previous chapter outlined the major motivations for IMS. This chapter describes the overall IMS architecture and key protocols.

4.1 IP multimedia core network

When broken down to its bare essentials, the role of IMS is to provide a secure and reliable means for terminals and applications to reach, negotiate and communicate with each other. This facilitates for the operator to provide multiple services to the user and maximizing equipment re-use through horizontalization. The horizontalization provides common; supervision and control of services in the IMS network, management and routing of sessions, as well as supporting the authorization and manipulation of media in the network. The IMS core is access independent which means that same services can be delivered over different types of access technologies. In the IMS specification the “core” of IMS comprises two main nodes: the Call Session Control Function (CSCF) and the Home Subscriber Server (HSS). In the IMS architecture overview (figure 4 below) the General Switched Telephony Network (GSTN) interworking functions Media Gateway Control Function (MGCF) and Media Gateway (MGW) have been depicted beside the IMS Core

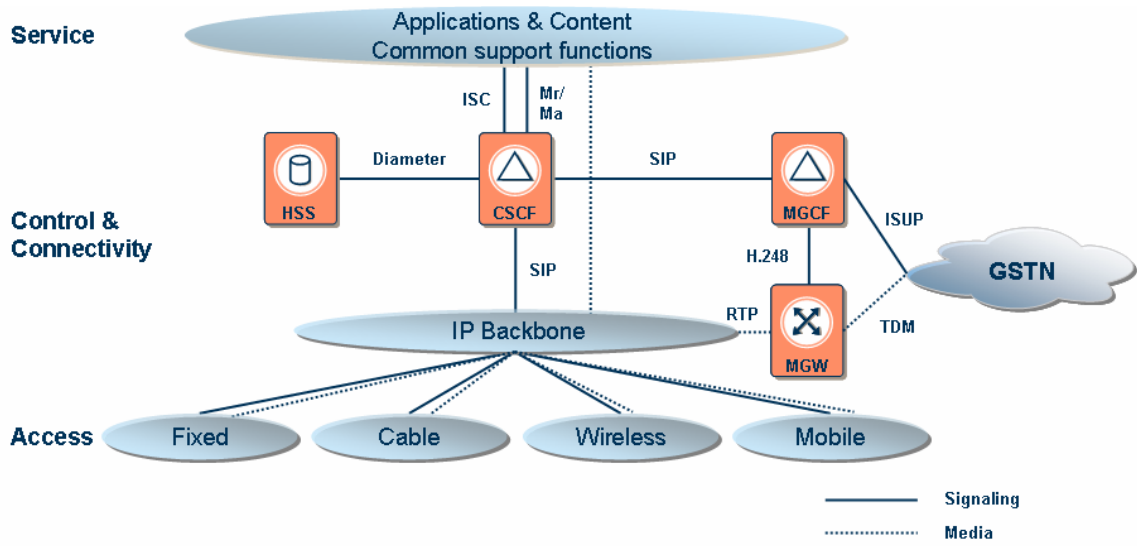

Figure 4. IMS architecture overview.

4.1.1 The role of Call Session Control Function

The Call Session Control function (CSCF) is the heart of the IMS architecture and is used to process SIP signaling. The main function of the CSCF is to provide session control for terminals and applications using the IMS network. Session control includes the secure routing of the SIP messages, subsequent monitoring of the SIP sessions and communicating with the policy architecture to support media authorization. It has also the responsibility for interacting with the HSS. As shown in Figure 5 CSCF can play three different roles: Serving-, Interrogating and Proxy- Call Session Control Function (S-, I- and P-CSCF).

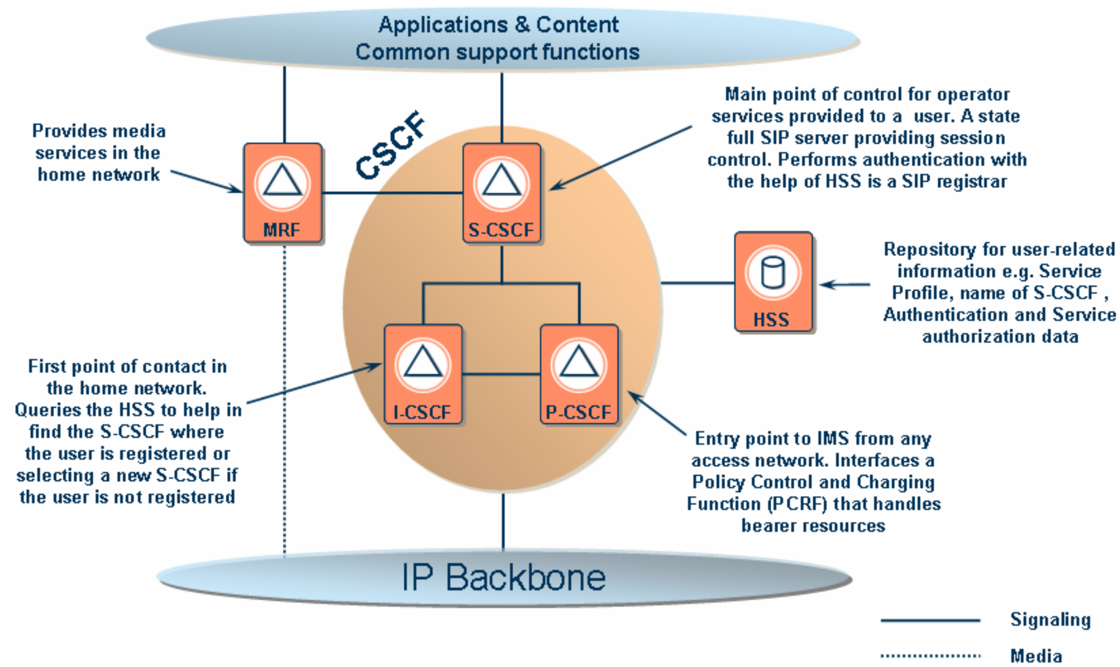

Figure 5. Common IMS core overview

Serving Call Session Control

The Serving Call Session Control Function (S-CSCF) is the central node for the provision of the SIP signaling and the heart of the IMS system. Besides passing information to the endpoints involved in a session, through their associated P-CSCFs, the S-CSCF is also responsible for routing and translation, maintenance of the sessions, interaction with other services and charging. It uses Diameter Cx and Dx interfaces to the HSS to assist in authenticating the user upon registration and retrieve the users' service profile.

Interrogating Call Session Control

The Interrogating Call Session Control Function (I-CSCF) is the home networks first point of contact for peer IMS networks. It queries the HSS using Diameter Cx and Dx interfaces to help in finding the S-CSCF where the user is registered or selecting a new S-CSCF if the user is not registered. The I-CSCF then routes the SIP request to its assigned S-CSCF.

Proxy Call Session Control

The Proxy Call Session Control Function (P-CSCF) is a SIP proxy that is the first point of contact that the IMS domain presents to the user terminals. The main functions of P-CSCF is to provide secure transmission of the SIP signaling with the terminal (integrity protection); interface towards the Policy Control architecture for the authorization of the media, and support compression of the SIP signaling where required. In doing so as the I-CSCF forwards SIP messages to Serving Call Session Control Function (S-CSCF) or Interrogating Call Session Control Function (I-CSCF) received by the user terminal.

The P-CSCF also plays a role in the detection of IMS Emergency services.

4.1.2 Home Subscriber Server

The Home Subscriber Server (HSS) is the master database that contains user and subscriber information to support the network entities handling calls and sessions. It provides the following functions: identification handling, access authorization, authentication, mobility management (keeping track of which session control entity is serving the user), session establishment support, service provisioning support, and service authorization support. When a user registers in the IMS domain, the user profile (relevant information related to the services to be provided to the user) is downloaded from the HSS to the CSCF. For session establishment, HSS provides information on which CSCF currently serves the user.

When more than one HSS is deployed in the network, a Subscriber Location Function (SLF) is needed to locate the HSS that holds the subscription data for a given user. Both the HSS and SLF use Diameter (Cx and Dx interfaces) (as shown in Figure 6).

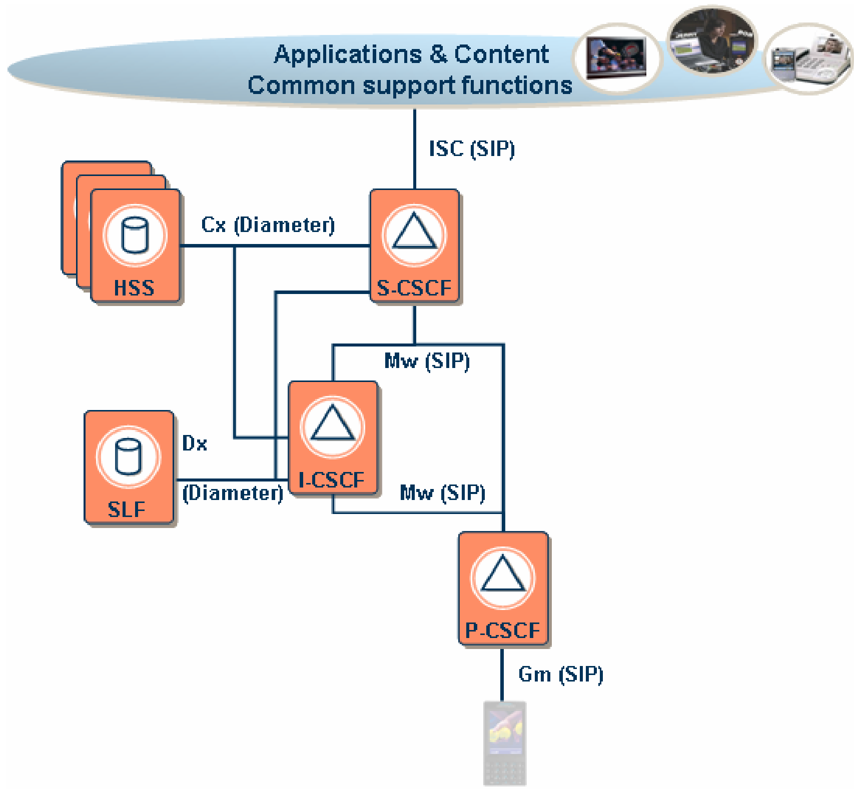

Figure 6. The Diameter interface between HSS, SLF and CSCFs and the SIP interfaces between CSCFs.

4.1.3 SIP application server

All the applications and services in IMS are executed in SIP application servers. One SIP application server can be dedicated to a single service or host several services. In IMS, it is also possible to combine services from several different SIP application servers to create one unified user experience for the end-user. For instance, a user can from a single terminal application, simultaneously combine the services of presence and video calling although the services themselves are located on different SIP application servers. The main benefits of SIP application server technology are ease of application development, rapid network and centralization. By centralizing business logic on an individual or small number of SIP application servers, updates and upgrades to the application for all users can be guaranteed. There is no risk of old versions of the application accessing or manipulating data in an older, incompatible manner.

4.1.4 Breakout Gateway Control Function

The Breakout Gateway Control Function (BGCF) is responsible for selecting break out operator and/or site for outbound sessions to the GSTN. It is the logical entity within the IMS network that decides how to route the Telephony sessions initiated in the IMS network and destined for a circuit switched network (GSTN). The circuit switched networks can be any legacy network, PSTN or other wireless networks. If breakout occurs in the IMS network, then the BGCF routes the session to a Media Gateway Control Function that then allocates a Media Gateway or the BGCF routes the session to a BGCF in another operators network as illustrated in Figure 7).

4.1.5 Media Resource Function

The Media Resource Function (MRF) provides media services in the home network and implements functionality to manage and process media streams such as voice, video, text-to-speech, and real-time transcoding of multimedia data. An MRF is normally only involved when an IMS application requires to provide a media service from the network such as playing announcements or mixing media streams in a multiparty conference and is normally only involved for the duration of the media service. Each MRF in the network can be further divided into a Media Resource Function Controller (MRFC) – a signaling plane node that acts as a SIP User Agent to the S-CSCF - and a Media Resource Function Processor (MRFP) – a media plane node that provides the essentially transcoding and content adaptation functionalities. H.248 is used between the MRFC and MRFP in order to set up a suitable IP support and to support the mixed streams.

4.1.6 Session Border Controller (SBC)

Session Border Controllers (SBC), which are referred to as boarder control functions in the IMS specifications, are IP to IP gateways deployed at the border between an operator's IMS network and other networks (Network to network interface, NNI). For a broadband access, the P-CSCF and the policy enforcement functionality can be implemented as a SBC supporting the User to Network interface, UNI. It manages IMS sessions (correlating signaling and media) to ensure Security, QoS, SLAs, NAT/FW traversal and other critical functions for real time IP streams where applicable. The session boarder gateway functionality can also be used to provide address translation; either between private and public IPv4 addresses, or between IPv4 and IPv6 address.

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4.1.7 Media Gateway Control Function (MGCF)

The Media Gateway Control Function (MGCF) is the central node of the PSTN gateway. The MGCF is responsible for controlling the media resources used when traffic needs to flow between networks using different media, typically between a Time Division Multiplexing (TDM) network and an IP-based network. It interacts with: the call and session control functions using SIP; the control plane of the GSTN using ISUP; and with the Media Gateway using the H.248 protocol (as illustrated in Figure 7).

4.1.8 Media Gateway (MGW)

The Media Gateway (MGW), controlled by the MGCF using H.248, is responsible for providing the interworking of media flows between different networks. It provides interworking between the different media transport formats, RTP/UDP/IP and TDM, as well as media transcoding of voice and video, if required.

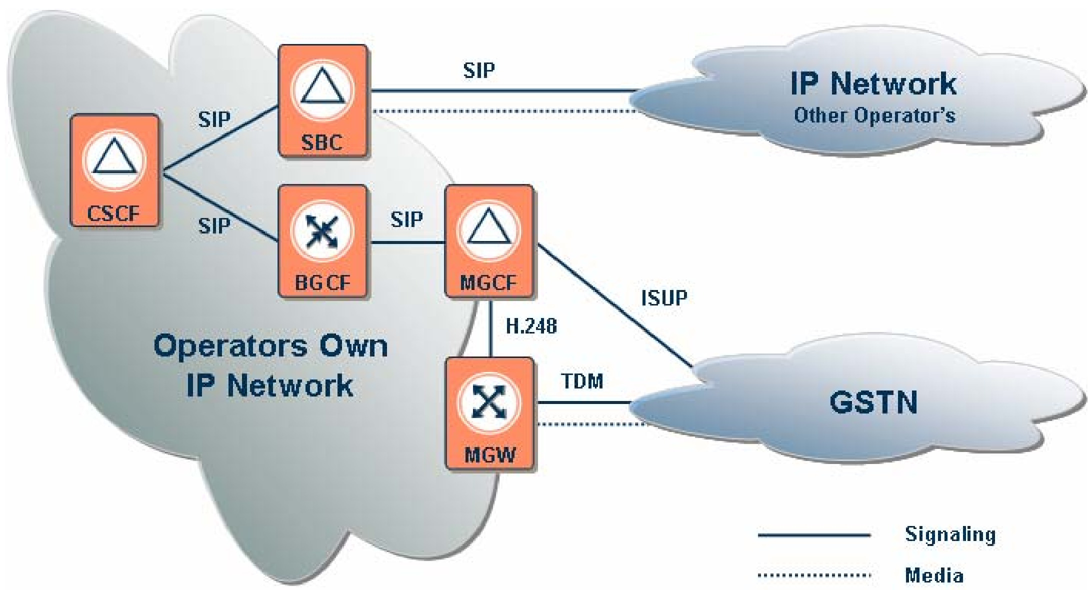

Figure 7. The IMS – IP Network/GSTN interface.

4.2 Additional Functionality

4.2.1 Transit functionality

While not allocated to a specific functional entity, the IMS provides the support of transit functionality. The transit functionality provides the ability to detect transit sessions, which are incoming calls that are destined for users in another network, and provides means to route and forward the sessions for transit session.

4.2.2 Support of Regulatory Services

In addition to providing end-user services, the IMS has the ability to provide the support for important regulatory services such as emergency services. Emergency services are handled largely in the network where the user is located, where the IMS supports the ability to connect to an emergency center with the use of an Emergency CSCF.

4.2.3 Support of IMS communication services and applications

In order to support the use of multiple applications, while maximizing the re-use of the network elements, the IMS provides the support of IMS communication services. IMS communication services are types of communication available to the end-user and applications.

4.3 Key protocols used in the IMS network

4.3.1 Session Initiation Protocol (SIP)

SIP is the main signaling protocol used in IMS networks. It was developed by the IETF and was selected by 3GPP as a standard for IMS in Release 5. The function of SIP is to establish, modify and terminate multimedia sessions – with medias such as voice, video and chat – over IP networks, where the media delivery part is handled separately.

In SIP there is just one single protocol, which works end-to-end and supports the establishment and termination of user location, user availability, user capability, session set-up and session management. SIP is also designed to enable additional multimedia sessions and participants to be dynamically added or removed from a session. These are the major reasons SIP has been selected in IMS; it is also considered to be flexible and secure.

4.3.2 Diameter – the Authentication, Authorization, and Accounting protocol

Diameter, a development of the current RADIUS protocol, was chosen as the policy support and Accounting, Authentication, Authorization (AAA) protocol for IMS. Diameter is used by the S-CSCF, I-CSCF and the SIP application servers in the Service Layer, and in their exchanges with the HSS containing the user and subscriber information. Compared with RADIUS, Diameter has improved transport – it uses Transmission Control Protocol (TCP) or Stream Control Transmission Protocol (SCTP), and not UDP, as transport – improved proxy, enhanced session control and higher security.

4.3.3 H.248 media control protocols

H.248 is a control protocol used between media control functions and media resources. Examples of nodes with media control functions are the Media Gateway Control Function (MGCF) and Media Resource Function Controller (MRFC). Typical media resources are the Media Gateway and Media Resource Function Processor (MRFP).

4.3.4 IPv6

Internet Protocol version 6 (IPv6) is a network-layer IP standard used by devices to exchange data across a packet-switched network. It follows IPv4 as the second version of the Internet Protocol to be formally adopted for general use. Originally, IMS was specified to use IPv6; however, with 3GPP Release 6, IMS does provide support for IPv4 and private address scheme. This means that even though IMS is expected to drive the adoption of IPv6, it is not dependent on IPv6 availability in order to be successfully launched.

5 Conclusion

As we started by stating, '*Why IMS?*' is the most interesting question. The key to the answer lies in what is happening all around us: a new communication culture is emerging, driven by community interaction over the Internet. Communication increasingly revolves around the sharing of everyday life experiences – anywhere, anytime and on any device.

IMS is the natural choice to address this transformation. It delivers multimedia services across fixed and mobile access. It is the only open standardized way to deliver convenient IP-based consumer and enterprise services to fixed, mobile and cable communities, enabled by one common core and control for all types of networks.

IMS has the tools and functions necessary to handle numerous of non-standardized services in a standardized way: interoperability; access-awareness; policy support; security; quality of service; interworking with existing networks; the properties necessary to meet ever-increasing consumer demand for attractive and convenient offerings.

Above all, IMS combines the quality and interoperability of telecom with the quick and innovative development of the Internet – making the unique values of the telecom industry readily available to the application development community.

6 Abbreviation

3GPP	Third Generation Partnership Project
3GPP2	Third Generation Partnership Project 2
AAA	Access, Authorization and Accounting
BGCF	Breakout Gateway Control Function
CDMA2000	Code Division Multiple Access
CSCF	Call Session Control Function
CSI	Combination of Circuit Switched and IMS Services
ETSI	European Telecommunications Standards Institute
FMC	Fixed–Mobile Convergence
FW	Fire Wall
GSM	Global System for Mobile communications
GSTN	General Switched Telephony Network
HSS	Home Subscriber Server
I-CSCF	Interrogating-CSCF
IETF	Internet Engineering Task Force
IMS	IP Multimedia Subsystem
IP	Internet Protocol
ISC	IMS Service Control
ISUP	ISDN User Part
JCP	Java Community Process
MGCF	Media Gateway Control Function
MGW	Media Gateway
MRF	Media Resource Function
MRFC	Media Resource Function Controller

MRFP	Media Resource Function Processor
NAT	Network Address Translation
NNI	Network-Network Interface
O&M	Operation and Maintenance
OMA	Open Mobile Alliance
P-CSCF	Proxy-CSCF
PoC	Push to talk over Cellular
PLMN	Public Land Mobile Network
PSTN	Public Switched Telephony Network
QoS	Quality of Service
RTP	Real-time Transport Protocol
S-CSCF	Serving-CSCF
SCTP	Stream Control Transmission Protocol
SIP	Session Initiation Protocol
SLA	Service Level Agreement
SLF	Subscriber Location Function
TCP	Transmission Control Protocol
TISPAN	Technical committee within ETSI for Next Generation Networks
TDM	Time Division Multiplexing
TLS	Transport Layer Security
UDP	User Datagram Protocol
UNI	User-Network Interface
VoIP	Voice over IP
WCDMA	Wideband Code Division Multiple Access
WiFi	Wireless Fidelity
WiMAX	Worldwide interoperability for Microwave Access
WLAN	Wireless Local Area Network

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