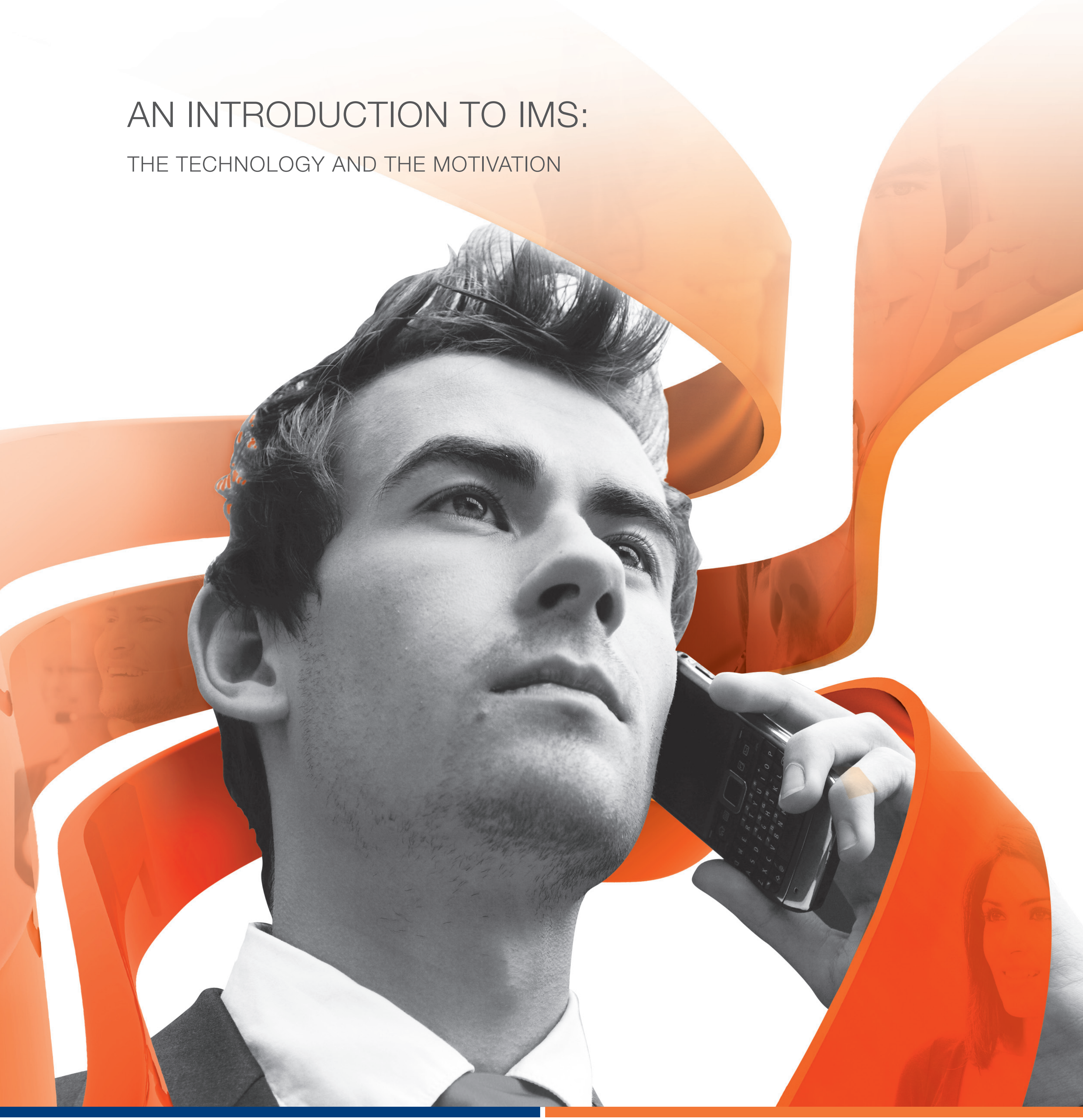
AN INTRODUCTION TO IMS:

THE TECHNOLOGY AND THE MOTIVATION



Metaswitch Networks

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EXECUTIVE SUMMARY

THIS PAPER IS AN INTRODUCTION TO IMS, DESIGNED FOR CARRIERS INTERESTED IN THE MUCH DISCUSSED PROMISES OF IMS AND SEEKING TO UNDERSTAND ITS BENEFITS AND TECHNOLOGIES BETTER. WE EXPLORE SOME OF THE MANY DIFFERENT REASONS THAT CARRIERS MAY BE MOTIVATED TO MOVE TO IMS, AS WELL AS INTRODUCING THE KEY COMPONENTS OF THE IMS ARCHITECTURE TO GIVE A TECHNOLOGICAL OVERVIEW TO SUPPLEMENT THE BUSINESS CASE.

Long a buzzword within the industry, evidence now shows compelling reasons to move to an IMS architecture. Carriers may be motivated by many different reasons:

- The architectural advantage of being able to provide one single common platform for delivering voice and multimedia services to both fixed and mobile endpoints.
- A long term strategic desire to reduce network operational costs through managing just a single infrastructure.
- The prospect of a platform capable of rapid innovative service deployment, in a manner that would never be financially viable in other architectures.

Any introduction to IMS though cannot look at the motivators for it without first exploring the technology and the architecture. With that background the capabilities and advantages of IMS are much easier to understand. This paper introduces the following key concepts:

- The IMS architecture, interfaces and associated benefits
- The principles behind the architectural design
- How IMS technology can be blended with pre-IMS technology

MetaSwitch is in a strong leading position in the IMS industry, and has a broad range of products covering many of the IMS components. This paper is intended to give a product-neutral background understanding of IMS. For information covering in more detail how MetaSwitch's products can bring revenue generating features to your IMS network today or provide an open path to IMS migration tomorrow, please visit metaswitch.com, or contact your account manager.

INTRODUCTION

'IMS' – THE IP MULTIMEDIA SUBSYSTEM – HAS BEEN A BUZZWORD IN THE TELECOM INDUSTRY FOR MUCH OF THE LAST DECADE, SUPPOSEDLY OFFERING THE THE PROMISE OF BRINGING WIRELINE AND WIRELESS VOICE TOGETHER INTO A MODERN, MODULAR ARCHITECTURE. YET UNTIL NOW IMS HAS REMAINED A PIPE DREAM – A VISION OF A STANDARDIZED, UNIFIED NETWORK ARCHITECTURE THAT TECHNOLOGY, COST AND PRAGMATISM HAS PREVENTED FROM MATERIALIZING IN ANY MEANINGFUL WAY.

However, perhaps now more than ever the IP Multimedia Subsystem (IMS) is truly being seen as the definitive architectural direction for future voice networks. While IMS may not be the right direction for every carrier, it is clear that it will have a profound impact on the entire global industry. It is certainly the richest and most comprehensive set of standards yet published for creating interoperable packet networks that support all kinds of multimedia services (including, of course, voice) and all kinds of access, both fixed and mobile. Every carrier must consider and understand it, in order to weigh the risks and rewards of this architecture which has promised so much for so long, but is only now beginning to deliver.

In this paper we look at introducing the technology concepts within IMS, assuming a good background knowledge of telecoms, but no prior experience of IMS. With that background we introduce the technology and architecture of IMS and address the many reasons why voice service providers should consider deploying IMS in their networks. It is worth noting that the complete set of specifications for IMS run to tens of thousands of pages, and there are many many reasons why a service provider may look to IMS for the future. In this introduction to IMS we attempt to boil down the complex ideas of IMS into relatively straightforward basic principles, and to look at some of the most common reasons for adopting IMS.

STANDARDS AND SPECIFICATIONS

The main body that is driving the development and evolution of IMS standards is the 3rd Generation Partnership Project (3GPP). This organization is an industry consortium that was originally formed to define standards for 3G mobile networks based on GSM technology, but its charter has been progressively expanded to include standards for IP-based voice and multimedia in mobile networks, and evolution to 4G mobile networks. 3GPP is now recognized by various national standards bodies, including ATIS and ETSI, as the chief authority for IMS specifications.

Although the focus of 3GPP is primarily on mobile networks, IMS has been defined from the very beginning to provide a solution for IP-based voice and multimedia services that is essentially independent of the means by which access is provided. Both vendors and service providers recognized the value of developing an architecture that would support the creation of converged networks in which a common set of core functions could deliver a wide range of services to subscribers with either mobile access, fixed access, or both – and with the ability to roam between the two.

At a very early stage in the development of IMS, the 3GPP decided to adopt SIP as the protocol for voice and multimedia session control. Over time, the 3GPP has determined that certain extensions are needed to SIP to meet various requirements that have emerged during the definition of IMS. Rather than defining these extensions itself, 3GPP worked with the IETF to create RFCs for this purpose. The IETF continues to be active in this area, and there are currently a number of Internet Drafts under development that are driven by IMS requirements and that will eventually turn into RFCs.

The 3GPP has limited the scope of its work on IMS endpoints to terminals that support SIP natively, and has not directly addressed the question of how legacy terminals such as analog telephones may be served by an IMS network. The TISPAN group within ETSI has been working for some years on the conjunction between legacy access networks and next-generation VoIP core networks, and has aligned this work with 3GPP specifications for the IMS core. The combination of 3GPP and TISPAN specifications now provides a solution that effectively enables legacy local exchanges or Class 5 switches to be replaced by an IMS-based network, transparently to the subscribers served by those local exchanges.

The 3GPP specifications for IMS can be found here: http://www.3gpp.org/specification-numbering. Note that this site also includes numerous non-IMS specifications, since it also addresses radio access technologies, 3G circuit-switched voice etc. 3GPP works with various other standards bodies on aspects of IMS specifications, most notably the IETF, ETSI and TISPAN.

GENERAL PRINCIPLES OF IMS

THIS SECTION PROVIDES A BRIEF INTRODUCTION TO IMS TECHNOLOGY, AND IS INTENDED TO PROVIDE SOME CONTEXT FOR THE BUSINESS REASONS AND MOTIVATION TO ADOPT IMS. IF YOU'RE MORE INTERESTED IN THE WHY THAN THE HOW, YOU MAY WISH TO SKIP AHEAD TO SECTION 6.

4.1 Scope of IMS

IMS is concerned with addressing the following aspects of voice and multimedia services over IP networks:

- Procedures for SIP terminals (either mobile or fixed) to register with an IMS network and to establish voice or multimedia sessions.
- Core network infrastructure that facilitates the establishment and routing of voice or multimedia sessions between SIP endpoints, and the invocation of services associated with those sessions.
- Standardized repositories of data about subscribers, and the services to which they are subscribed.
- Support for originating, terminating or mid-call services in voice or multimedia sessions.
- Definition of certain generic services that may be delivered over an IMS infrastructure.
- Interconnection of IMS networks and between IMS and the legacy PSTN.
- Procedures for roaming, so as to permit subscribers on one IMS network to access their services via another IMS network.
- Collection of billing information about sessions and usage of call services.

In general, IMS itself is not particularly concerned with the details of physical access; what matters is that IMS endpoints can communicate with the IMS core network over IP – and this communication can take place over a wireless or a fixed broadband network. Having said this, IMS does define certain kinds of interaction with the access network, primarily concerned with the enforcement of policy regarding usage of access network resources, and with the availability of those resources. But we won't address that topic further in this paper.

IMS defines a functional architecture with standardized interfaces between each pair of intercommunicating functions. However IMS does not mandate that each function must be implemented as a separate device. There are several areas of IMS where it may make sense to combine two or more functions into a single device. This may have the effect of reducing overall box count and simplifying deployment.

Let's look at each of the various aspects of IMS in turn.

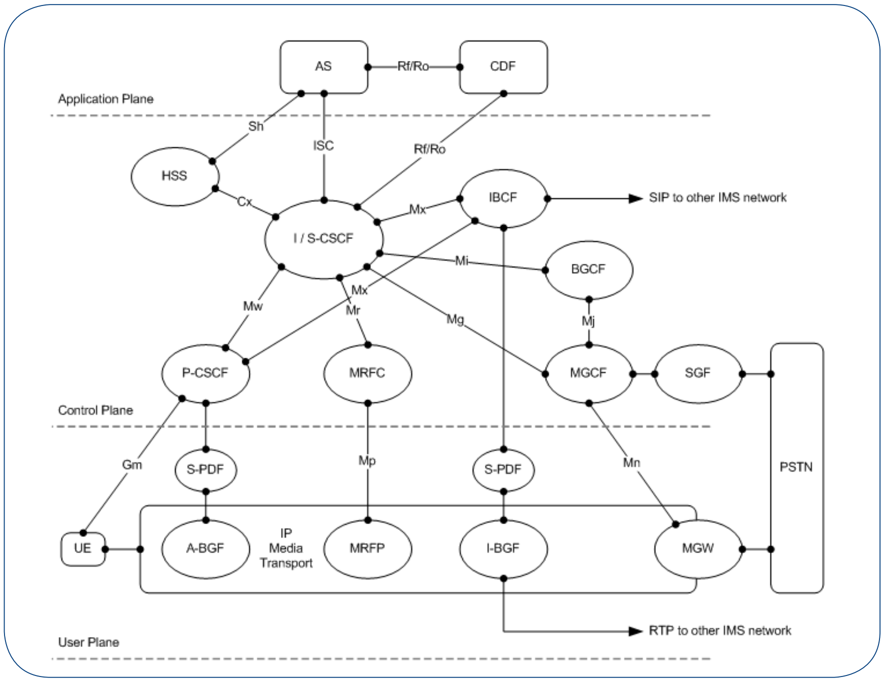


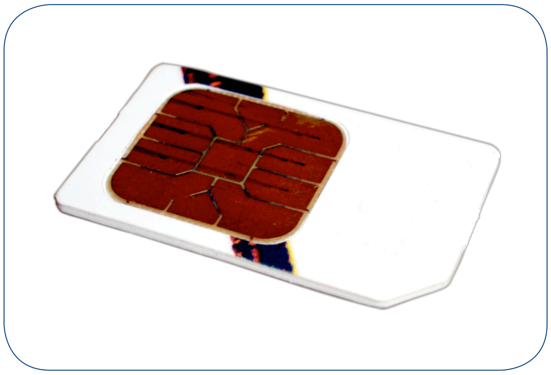
Figure 1 IMS Architecture

4.2 The User to Network Interface

Just like any conventional SIP endpoint, IMS endpoints register with the network and, once successfully registered, are able to participate in both outbound and inbound session establishment. The registration process is concerned with identifying to the network that a particular endpoint is ready to make and receive session requests, and binding a user identity (i.e. a phone number) to a particular network address.

IMS demands a high degree of security on the user-to-network interface. All SIP signaling is transmitted securely using IPSec, and all attempts by an IMS endpoint to register are challenged so as to securely authenticate the endpoint.

An IMS endpoint identifies itself by a combination of “private” and “public” user identities. The private user identity typically identifies a device, and in a mobile IMS terminal it is stored on the “ISIM” which is the IMS equivalent of the SIM card familiar to users of GSM phones. A private user identity is associated with at least one public user identity, which is effectively a phone number or a SIP addresses at which the subscriber can be reached. In the simple case, an IMS endpoint would have just one public identity, its phone number, but IMS allows for an endpoint to have multiple public identities.



The ISIM Application Runs on the same UICC Smart Cards as GMS/UMTS SIM

Once an IMS endpoint is registered, it may engage in any of the standard SIP procedures for establishing and manipulating voice or multimedia sessions.

The network side of the user-to-network interface is implemented in a function known as the Proxy Call Session Control Function (P-CSCF). All SIP messages to and from IMS endpoints must pass through a P-CSCF. Before an IMS endpoint can register, it must discover the IP address of a suitable P-CSCF – which may be accomplished via DHCP at the point when the IMS endpoint first establishes IP connectivity.

The P-CSCF function acts as the secure edge of the IMS network for access. It maintains an awareness of all IMS endpoints that are currently registered with the network, and performs various manipulations on the SIP signaling messages that are arriving from and being sent to the endpoints. For example, it adds the “P-Asserted- Identity” header to inbound SIP INVITE messages to ensure that the Caller ID associated with the session establishment request is the correct one for this endpoint, thereby preventing Caller ID spoofing.

4.3 The IMS Core and Session Routing

The IMS core network comprises three different kinds of Call Session Control Function (CSCF) together with the Home Subscriber Server (HSS). The IMS core processes registration requests and routes signaling requests and responses from IMS endpoints via application servers to other IMS endpoints.

We have already described the Proxy Call Session Control Function (P- CSCF) as the secure edge of the network for user access.

The Serving Call Session Control Function (S-CSCF) can be regarded as the central hub of the IMS core network. Each endpoint is associated at registration time with a specific S-CSCF instance, which processes all originating and terminating requests and responses associated with that endpoint, invoking any call services that may be required by sending SIP signaling to Application Servers, and then routing the signaling towards its destination. So a call attempt by user A addressed to user B will take the following route:

- User A
- P-CSCF associated with user A
- S-CSCF associated with user A
- Application Server(s) supporting A’s originating calling services
- S-CSCF associated with user A
- I-CSCF
- S-CSCF associated with user B
- Application Server(s) supporting B’s terminating calling services
- S-CSCF associated with user B
- P-CSCF associated with user B
- User B

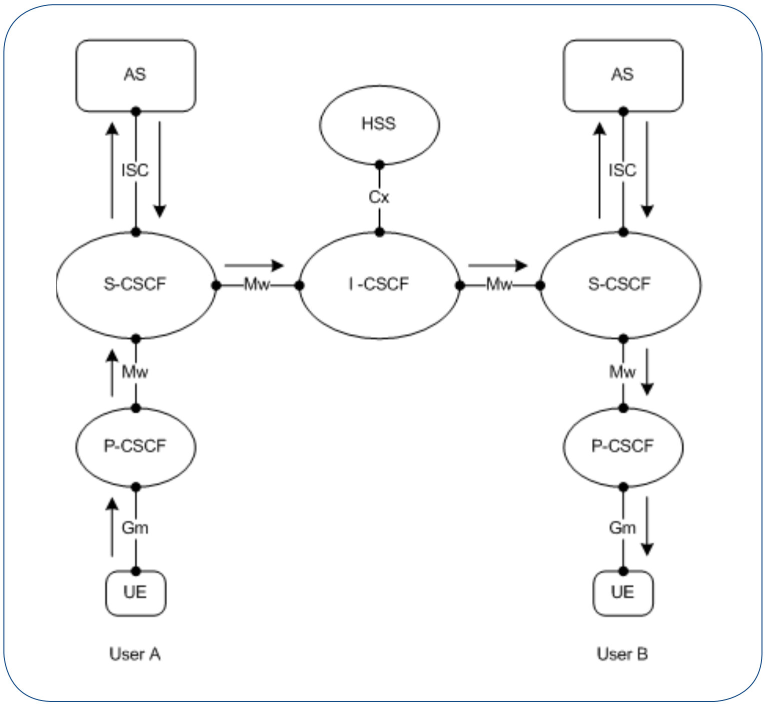


Figure 2 On-net call flow

At each step along the way, each IMS function needs to know where to send the signaling next. This is accomplished as follows:

- User A discovers the P-CSCF to which it must send all signaling using DHCP or possibly some fixed local configuration.
- The P-CSCF observes the registration signaling for User A, takes note of the identity of the S-CSCF instance assigned to User A during the registration process, and stores this information.
- At the point where the S-CSCF instance is assigned to User A (during registration), the S-CSCF obtains information from the Home Subscriber Server (HSS) that identifies which Application Server(s) need to be invoked when User A makes a session origination request.
- Once the S-CSCF for User A has received signaling back from User A's originating Application Server(s), it sends the session setup request on to the Interrogating Call Session Control Function (I-CSCF). There is only a single logical I-CSCF function in the network to which all such requests are sent.
- The I-CSCF queries the HSS to learn the identity of the S-CSCF assigned to User B.
- At the point where the S-CSCF instance is assigned to User B (during registration), the S-CSCF obtains information from the Home Subscriber Server (HSS) that identifies which Application Server(s) need to be invoked when a session request is received for User B, to provide B's terminating services.
- The S-CSCF assigned to User B takes note of the identity of the P-CSCF associated with User B at registration time.
- The P-CSCF associated with User B maintains knowledge of User B from observation of the User B's original registration request.

From the discussion above, it is obvious that the HSS is a critical link in the whole process. It provides each S-CSCF instance (at registration time) with details about which Application Servers to apply to originating and terminating calls for each registered endpoint, and it also answers queries about which S-CSCF is currently serving a given endpoint. We'll say more about the HSS in the next section.

The Interrogating Call Session Control Function (I-CSCF), as well as acting to pass on session setup requests from the originating user's S-CSCF to the terminating user's S-CSCF, is the point of entry to an IMS network for SIP session requests originating outside the network. The I-CSCF also controls the process for assigning an S-CSCF instance to an IMS endpoint at registration time.

4.4 Repository of Subscriber Data

In describing the basic call flow above, we've already touched on some of the functions performed by the Home Subscriber Server. The HSS serves as a central repository of all the per-subscriber data needed by the IMS network to deliver voice and multimedia services.

All IMS functions that need to communicate with the HSS do so using a protocol called "Diameter". Diameter is a client-server transactional protocol originally based on the widely used authentication and accounting protocol RADIUS.

The HSS supports a number of important procedures during the registration process for an IMS endpoint:

- The registration request from an IMS endpoint is passed via the P-CSCF to the I- CSCF, which queries the HSS to determine whether the endpoint is already registered, and if so, which S-CSCF instance the endpoint is associated with. If not, the I-CSCF chooses a S-CSCF instance to which this endpoint will be assigned, and sends the registration request to that S-CSCF.
- The S-CSCF queries the HSS to perform authentication of the registration request.
- Once registration is complete, the HSS pushes "User Profile" information to the S-CSCF for the endpoint; this includes the rules that the S-CSCF needs to apply to determine when to invoke the services that are hosted in Application Servers for any given signaling request.

The HSS stores the identity of the S-CSCF assigned to each registered IMS endpoint. This main consumer of this information is the I-CSCF function, which is invoked for all session setup requests to on-net destinations, to obtain the identity of the S-CSCF associated with the destination endpoint.

The HSS may also be used to store subscriber-related service configuration and state data on behalf of Application Servers. Such data is known as "Transparent Data" because its content and syntax is not defined by IMS specifications, but is specific to the applications that use it. It is not a requirement that Application Servers store anything in the HSS; the HSS function is defined as supporting the storage of Transparent Data, but Application Servers do not have to take advantage of this.

4.5 Applications and Services

In the IMS architecture, all services beyond the simple establishment of a voice or multimedia session between two endpoints are implemented with logic hosted in Application Servers. The IMS core network is responsible for routing all session-related signaling via the Application Server(s) that are required to support a given subscriber's services.

> ***All services beyond the simple establishment of a voice or multimedia session… are implemented with logic hosted in Application Servers.***

The S-CSCF routes signaling messages to Application Servers based on the rules in the subscriber's user profile that is downloaded from the HSS to the S-CSCF at registration time. These rules take the form of "Initial Filter Criteria" (iFC). The iFC define trigger points for services to be invoked, which comprise logical conditions based on the type of session setup request (originating or terminating) and the content of the SIP messages, together with the identity of the Application Server to which the request should be sent if the logical conditions are matched.

For example a simple terminating service that is applied to all calls would require the presence of an iFC entry that matches on session case "terminating" and SIP method "INVITE", and identifies the Application Server that provides this terminating service. This iFC entry would cause the S-CSCF to send all INVITE requests addressed to the subscriber in question to be routed to the specified Application Server.

Application Servers contain logic for processing SIP signaling so as to apply services. An Application Server is permitted to manipulate SIP signaling in any appropriate way to provide the required service behavior, as in the following examples of terminating services:

- Anonymous Call Rejection – the AS rejects an INVITE message with a 403 Forbidden response if the caller ID is identified as "anonymous".
- Unconditional Call Forwarding – the AS changes the Request URI and To header in an INVITE message to that of the forwarding destination, and sends the INVITE back to the S-CSCF.
- Simultaneous Ring – the AS acts on an INVITE message by generating one or more additional INVITE messages to the configured destinations, sending all of these to the S-CSCF, and subsequently monitoring the responses to each of these INVITE requests so as to connect the call to the first destination that answers.

A user profile may contain several iFC entries, and the effect of these may be to require the S-CSCF to send the same request to more than one Application Server in sequence. In this case, the iFC entries have a priority indication that tells the S-CSCF about the order in which the Application Servers should be invoked, and the S-CSCF keeps track of which AS has already handled the request by inspection of the Route headers in the SIP message, which are manipulated by each AS in turn.

Some Application Servers (for example, Voicemail) may behave like endpoints on an IMS network, in that session setup requests may be addressed directly to them. Such Application Servers are addressed by a configured “Public Service Identity”, as opposed to a normal registered endpoint address.

Certain applications require announcements and / or digit collection to be applied to calls, for example to present a voicemail collection menu or an auto- attendant. In these cases, the Application Server may send the call to a Media Resource Function Controller (MRFC) to perform these actions.

4.6 Generic Service Definitions

Although the specification work on IMS to date has been primarily concerned with defining an architecture over which any arbitrary voice or multimedia service could be delivered, the 3GPP has now turned its attention to standardization of certain basic supplementary services such as Caller Identity Presentation and Restriction, Communication Diversion, Explicit Communication Transfer and Three-Party Call. The draft IMS specifications for these services define SIP call flows and the configuration model for each service.

4.7 IMS Network Interconnection

The IMS specifications define how IMS networks may be connected to other IMS networks and to the legacy PSTN.

IMS networks can be connected to each other so as to support hand-off of SIP signaling and RTP media directly between network operators. For reasons of security and policy control, the edge of the IMS network is protected at this interconnection point by the Interconnection Border Control Function (IBCF), which provides session border control on the SIP signaling path, and the Interconnect Border Gateway Function (I-BGF) function which applies policy-driven control to the RTP media path.

IMS networks can be connected to legacy PSTN networks by means of a Media Gateway Control Function (MGCF), a Media Gateway (MGW) and a Signaling Gateway Function (SGF). These functions may provide support for any of the legacy TDM trunk types, e.g. ISUP, ISDN PRI and MF.

The routing of signaling requests to other networks is performed by the Breakout Gateway Control Function (BGCF). During the processing of an originating call, the IMS network analyzes the called party ID to determine whether it corresponds to an on-net or off-net destination. This processing may be carried out by the S-CSCF, using ENUM (if the called party ID is in the form of an E.164 telephone number), or by an originating Application Server (if the called party ID is in the context of a private dialing plan). If the destination is determined to be off-net, then the originating S-CSCF routes the signaling to the BGCF. The BGCF then applies configured routing logic to determine whether to send the call to an IBCF (because the destination is in another peer IMS network) or to an MGCF (because the destination can only be reached via the PSTN), and determines which particular IBCF or MGCF instance to send the call to.

4.8 Roaming

IMS is designed to meet the needs of both fixed and mobile networks, and roaming is clearly a vital function for mobile networks.

There are a couple of different models for roaming in IMS networks, depending on whether the IMS endpoint accesses the IMS core via a P-CSCF in the visited network or a P-CSCF in the home network. But in both cases the principle is the same: an IMS endpoint is always assigned to a S-CSCF in its home network, and makes use of its usual Application Servers in the home network. This ensures that, no matter what visited network an IMS endpoint is roaming on, it always has access to the full set of services to which it is subscribed. Note that, in this respect, IMS offers superior behavior to circuit-switched mobile networks, where the services that are available when roaming may be restricted by the capabilities of the visited Mobile Switching Center.

IMS enables subscribers to roam on other carriers’ networks, while using services delivered by the home carrier’s network

4.9 Billing and Charging

IMS defines methods for collecting information needed for billing, and supports both post-paid and pre-paid charging models. IMS functions that are involved in session control and call services (e.g. S-CSCF and Application Servers) report significant events to a Charging Data Function (CDF), by means of the Diameter protocol. These events typically include the start and the end of voice or multimedia sessions, and the invocation of chargeable services provided by Application Servers. The event details may then be correlated and turned into call detail records for billing purposes.

IMS AND LEGACY ENDPOINTS

IMS IS DEFINED AS AN END-TO-END SOLUTION THAT SPECIFIES THE DETAILED BEHAVIOR OF ALL COMPONENTS OF THE NETWORK INCLUDING THE ENDPOINTS (OR "USER EQUIPMENT" IN IMS PARLANCE). A "NATIVE" IMS ENDPOINT IS A MOBILE OR FIXED VOIP PHONE THAT SUPPORTS SIP SIGNALING ACCORDING TO THE IMS SPECIFICATIONS, BUT CURRENTLY FEW SUCH DEVICES EXIST IN THE MARKET – IF ANY. IN THIS SECTION, WE DISCUSS THE OPTIONS FOR SUPPORTING IMS WITH EXISTING ACCESS AND ENDPOINT DEVICE TECHNOLOGIES.

5.1 Mobile handsets

Many current mobile handsets are able to support IP-based communications with sufficient performance to handle IMS voice and even video, typically by leveraging 3G data access technologies such as HSPA or EV-DO. Such handsets could support IMS with the addition of suitable software that implements a SIP client in accordance with IMS specifications. This approach is expected to be used for the earliest deployments of IMS to support mobile services. But because the service coverage of high-speed wireless IP access is not as good as that for circuit-switched voice access, these early IMS implementations are likely to support roaming and hand-off between IMS-based voice and circuit-switched voice, which will require special convergence gateways in the network.

An alternative means of connecting mobile handsets to an IMS network would be to retain circuit-switched voice as the access method for all calls to and from the handset, but to arrange things such that all calls are routed through the IMS network and connected into the circuit-switched mobile domain by a convergence gateway. For mobile-originated calls, this would require the use of Intelligent Network techniques (WIN or CAMEL) to force all calls to be routed via the convergence gateway into the IMS network. The complexity and cost of implementing this solution is likely to make it an uneconomical proposition. This means that deployments of IMS in mobile networks will rely initially on 3G mobile handsets with SIP client software, with the takeup of IMS in mobile networks accelerating as high-speed 3G services such as HSPA become ubiquitous, and 4G mobile handsets start to become available.

5.2 Fixed IP phones

IP phones, Analog Telephone Adapters (ATAs) and Integrated Access Devices (IADs) are increasingly being used to support both business and residential telephony. Almost all of these devices use SIP signaling, although none of the currently available devices are directly compatible with the IMS standards because they don't implement all of the signaling procedures in the manner required by IMS.

Having said this, it is relatively straightforward to translate the SIP signalling from all of these kinds of devices so as to interoperate with an IMS core network. This translation function may be carried out by a Session Border Controller (SBC) device which could also integrate the P-CSCF function.

5.3 Legacy PSTN access

The vast majority of fixed telephony endpoints today are TDM-based, including POTS phones and PBXs connected via ISDN PRI or T1 CAS. The solution for connecting such endpoints to an IMS network is being defined by the ETSI TISPAN working group, under the title "PSTN Emulation Subsystem".

The PSTN Emulation Subsystem comprises three components that work together around an IMS core network. The Access Gateway (AGW) supports physical connectivity to TDM-based legacy access technologies such as GR-303, TR-008, ISDN PRI and T1 CAS. The Access Gateway Control Function (AGCF) controls the AG and supports SIP signaling towards the IMS core. The combination of AGCF and AG looks to the IMS core network like a P-CSCF with a collection of IMS endpoints behind it. And finally, the PSTN Feature Server is an IMS Application Server that delivers the complete set of traditional PSTN calling services to POTS phones and other legacy endpoints, including Call Waiting, various types of Call Forwarding, Anonymous Call Rejection and so on.

A combination of IMS network and PSTN Emulation Subsystem should provide a complete solution for Class 5 switch replacement, enabling expensive TDM infrastructure to be retired while migrating the access network into a new IP-based IMS core.

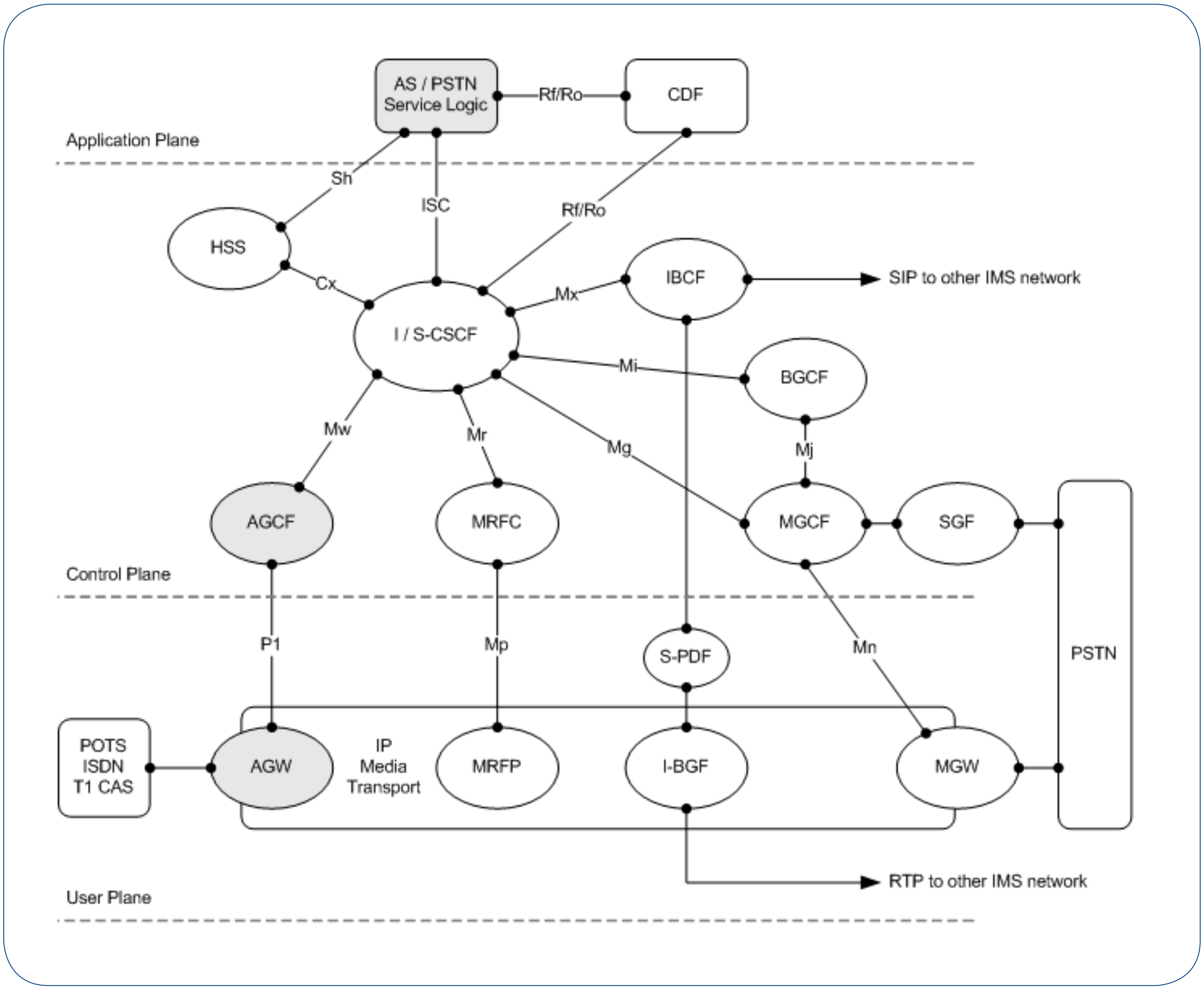


Figure 3 IMS PSTN Emulation Subsystem Architecture

WHY DEPLOY IMS?

VOICE NETWORK TRANSFORMATION FROM TDM TO IP HAS BEEN PROCEEDING FOR SEVERAL YEARS NOW, AND THE PACE OF THIS TRANSFORMATION CONTINUES TO QUICKEN. BUT THERE IS VERY LITTLE IMS YET DEPLOYED – THE VAST MAJORITY OF THE NETWORK TRANSFORMATION INITIATIVES TO DATE USE SOFTSWITCH-BASED ARCHITECTURES.

Given this, why deploy IMS? Why not just continue to evolve the network using softswitching combined with SIP application servers? Having examined the technology already, in this section we examine some of the key motivators to deploy IMS.

6.1 Converged platform for fixed and mobile services

One of the most compelling reasons to deploy IMS is that it can provide a common platform for delivering voice and multimedia services to a mix of fixed and mobile endpoints. Service providers who today offer both mobile and fixed line services may use a common shared transport infrastructure, but are typically not able to achieve convergence at the services layer. Class 5 switches deliver services to fixed lines, while Mobile Switching Centers deliver services to mobile phones, and these are completely separate network elements. Enhanced services may be provided by Intelligent Network techniques, but fixed and mobile networks use different and incompatible IN protocols (AIN, WIN and CAMEL) and so cannot share the same enhanced services platform either. It is possible to develop services that bridge both worlds, but such solutions are expensive to develop since they need to talk two sets of protocols.

IMS represents a kind of grand unification of fixed and mobile voice and multimedia services. There are obviously important differences in the physical access network technologies that are used by fixed and mobile endpoints, but IMS itself is essentially independent of the type of network access used.

IMS is 100% IP, with all signaling based on SIP, and this means that a common set of infrastructure components including HSS and Application Servers can serve any mix of fixed and mobile endpoints.

With IMS, it is possible to deploy rich, high-value services such as hosted business voice to both fixed endpoints and mobile endpoints without having to make any service-related distinction between them. Furthermore, IMS allows us to take advantage of some special capabilities of SIP such as forking, so that a user can have a fixed phone and mobile phone that have the same phone number without having to do anything special to support this in the network. Also, SIP signaling in the IMS network could provide a means to converge SMS and Instant Messaging services with the integration of presence information across any mix of fixed and mobile phones.

This is clearly an exciting vision of the future, but there are only certain kinds of service providers who can usefully benefit from IMS in this way – those who own spectrum and can deploy a wireless broadband voice access network, or possibly those who are in a position to negotiate favorable terms to use a third party broadband wireless network for voice access to their own IMS networks.

6.2 Unified approach to network modernization

Many fixed line operators are engaged in modernizing their voice networks with overlay VoIP services for business and/or residential customers, and with softswitch-based replacements for Class 4 or Class 5 switches that have reached end-of-life. However, these developments tend to take place in “silos” without a clear vision of how the voice network will eventually evolve to replace all legacy telephony services.

IMS can provide a unifying architecture that supports all of the different strands of VoIP-based network modernization with a single, consistent approach. The HSS provides a single repository of data about all subscribers, so there is just one place in the network to go to add new subscribers and to define what services a subscriber gets. The BGCF enables all data about routing calls to off-net destinations to be maintained in a single network-wide view for all services. And the IMS infrastructure should provide a single common framework for managing the delivery and the quality of all types of services.

The tangible benefits of deploying IMS for all kinds of network modernization arise from the reduction in cost of integrating provisioning and management functions with back-office systems, and from the reduced operational costs of managing a single consistent end-to-end infrastructure for all the multimedia services.

It should be noted, however, that IMS does not mandate a consistent approach to the per-subscriber configuration of services in Application Servers, so any savings expected in the area of provisioning integration may depend on how the Application Server vendors approach this aspect of their solutions.

Building a business case for IMS based on these kinds of savings is not, of course, easy. The challenge is that, for any given new deployment of a voice application, the initial cost of deploying IMS cannot be justified. The savings only accrue across multiple voice applications in the network. The decision to deploy IMS as the basis of a unified approach to network modernization therefore has to be based on a medium to long term strategic view.

6.3 Platform for rapid service innovation

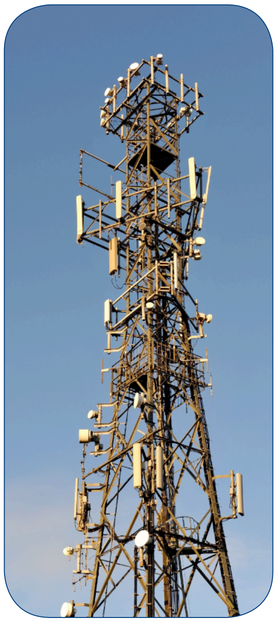
Service providers are constantly looking for ways to increase the average revenue per user, and one way to do this is to launch new services that attract incremental subscriptions.

Historically, the problem with service innovation has been its high cost. Developing and deploying a new service has been so expensive that only services of very broad and general interest, with the potential to attract a significant proportion of the subscriber base, had any chance of meeting the necessary business case criteria. If the cost of deploying new services falls dramatically, then it becomes economical to launch services that have much narrower appeal. While each new service may generate only limited incremental revenue, the impact of launching a number of such services may have a very significant effect on the top line.

One of the key objectives of IMS has always been to make it easier to deploy new services, and from a technology and architecture point of view at least, it's hard to disagree that IMS achieves that. A new service requires only a new Application Server (or some new software on an existing Application Server), and it can then be made available to all subscribers served by the IMS infrastructure. The new service can take advantage of all of the common infrastructure provided by IMS: charging and billing, subscriber data repository, service management capabilities etc, and therefore the development effort need only concern itself with service functionality that is genuinely new. Furthermore, the technology environment in which such services are typically developed – service delivery platforms with standard APIs such as SIP Servlet and built-in support for Web Services – make it much easier to carry out the required development than traditional approaches based on AIN technology and Service Control Points.

However, while IMS may take the pain out of the technology aspects of new service development and deployment, it obviously does not address the costs of marketing, promotion and training associated with a new service. Service providers who believe in the value of IMS to support rapid service innovation need to pay close attention to these issues if they are to realize the full value of their investment in IMS.

6.4 Voice services in 4G wireless networks



The roll-out of 3G wireless networks around the world is very far from complete, so some may wonder whether it is too early to be talking about 4G. But we're already beginning to see the first "4G" wireless networks being deployed (based on Mobile WiMax), and several major operators have announced plans to deploy LTE (Long Term Evolution) – the natural successor to the GSM and CDMA mobile technologies of today – as early as 2010. In May 2009 Verizon Wireless President and CEO Lowell McAdam stated in a conference call that its LTE network would launch commercially in around 20 to 30 US markets during the second half of 2010, with a nationwide buildout complete by late 2013 to early 2014. In the US, the major deployments of LTE will use 700 MHz spectrum that was auctioned by the FCC in March 2008.

3G mobile networks support both circuit-switched voice and packet-switched data. It might well be argued that 3G circuit-switched voice isn't broken, so why fix it? But 4G mobile networks are one hundred percent IP – they don't support circuit-switched voice. So voice in a mobile 4G world is going to be over IP, and that will need either IMS or some alternative proprietary solution in the network core.

IMS provides a very comprehensive blueprint for voice and multimedia telephony in 4G mobile networks, addressing all of the key issues such as roaming and the management of Quality of Service and bandwidth allocation in the access network. It's hard to imagine a mobile operator deploying a 4G network with the intention of supporting voice services and choosing not to deploy IMS. It seems certain that IMS will be the preferred platform for 4G voice and multimedia services.

CONCLUSION AND FURTHER READING

THE DEVELOPMENT OF IMS HAS TAKEN MANY YEARS, AND THE RATE OF ITS TAKE-UP HAS PERHAPS BEEN SLOWER THAN ITS PROPONENTS HAD FIRST ENVISIONED. HOWEVER, IN RECENT YEARS IT HAS BECOME CLEAR THAT IMS REALLY WILL MAKE A SIGNIFICANT IMPACT ON THE INDUSTRY. IN A WORLD LOOKING TOWARDS WIDESPREAD LTE '4G' COVERAGE AND DECLINING TRADITIONAL WIRELINE USAGE, A NETWORK ARCHITECTURE THAT FOCUSES ON SERVICES, NOT ACCESS, IS SOMETHING ALL CARRIERS SHOULD BE INTERESTED IN.

The promise of IMS to converge fixed and mobile networks onto an IMS core supporting a common set of services has to be attractive to those who currently face the operational costs of running two separate networks in parallel. From a long term view IMS offers not only reduced network operational costs, but also lower barriers to entry for innovative services to be deployed rapidly. In a 4G world with declining traditional wireline usage, a network architecture that focuses on services, not access, has to be an attractive solution.

For traditional wireline carriers, although IMS formally only defines a method for native SIP endpoints within a network, there has been much work to address how to incorporate legacy endpoints into the architecture, while minimizing the cost and impact of the transition.

To understand the IMS architecture in more detail, MetaSwitch recommends the book 'The 3G IP Multimedia Subsystem' by Camarillo and Garcia-Martin, alongside the 3GPP and TISPAN technical specifications.

MetaSwitch is an innovative force within the IMS industry, and has a broad product portfolio that can be deployed today to enhance an existing IMS network, or can be deployed to manage a seamless phased migration from the existing network toward an IMS future. For more information on how MetaSwitch can help you realize the potential of IMS today, or pave the path toward it in the future, please contact your account manager.

APPENDIX A: ABBREVIATIONS

3G	Generic name for third generation cellular network technology, supporting circuit-switched voice and high speed data.
3GPP	Third Generation Partnership Project, the industry consortium that owns the standards for GSM, IMS and LTE.
4G	Generic name for fourth generation cellular network technology, supporting broadband wireless. 4G networks are all IP and don’t support TDM or circuit switching.
A-BGF	Access Border Gateway Function. The network function in IMS that enforces policy on the access media path.
AGCF	Access Gateway Control Function. The network function in the IMS PSTN Emulation Subsystem that emulates a P-CSCF and that controls network-based and residential Access Gateways.
AGW	Access Gateway. The network function in the IMS PSTN Emulation Subsystem that connects legacy access technologies such as POTS, ISDN and T1 CAS into the IMS network.
AIN	Advanced Intelligent Network. Traditional technique for layering enhanced voice services over a Class 5 switch infrastructure.
AS	Application Server. The network function in IMS that provides voice and multimedia services over and above basic session setup.
ATA	Analog Telephone Adapter. A form of Access Gateway that is deployed in customer premises.
ATIS	Alliance for Telecommunications Industry Solutions. A standards body accredited by the American National Standards Institute.
BGCF	Breakout Gateway Control Function. The IMS function responsible for routing calls to off-network destinations.
BLC	Broadband Loop Carrier. A network-based access device that provides both Access Gateway function for POTS and broadband services via DSL.
CAMEL	Customised Applications for Mobile networks Enhanced Logic. A version of AIN used for layering enhanced voice services over a GSM-based mobile switching infrastructure.
CAS	Channel-Associated Signaling. A method of signaling used for connecting legacy PBXs over T1 lines.
CDF	Charging Data Function. The IMS function responsible for collecting and correlating chargeable event details for billing and charging purposes.
CDMA	Code Division Multiple Access. A cellular networking technology widely used in 2G and 3G networks in North America, as an alternative to GSM.
DHCP	Dynamic Host Configuration Protocol. An protocol used in IP networks that enables systems to obtain basic configuration, including a dynamically assigned IP address, when they start up.
DSL	Digital Subscriber Line. The generic name for technologies that deliver high-speed data services over copper pairs to customer premises.
EDGE	Enhanced Data rates for GSM Evolution. The most-widely deployed technology for supporting high speed data in 3G GSM networks.
ENUM	Telephone Number Mapping. A protocol that makes use of the Domain Name System (DNS) to support the mapping of telephone numbers into domain names.
ETSI	European Telecommunications Standards Institute.
EV-DO	Evolution Data Optimized. The most-widely deployed technology for supporting high speed data in 3G CDMA networks.
FCC	Federal Communications Commission.

APPENDIX A: ABBREVIATIONS

FTTX	Fiber To The X. Generic name for optical fiber in the access network, terminating at the home, the office or at the roadside curb.
GSM	Global System for Mobile communications. The most widely used technology for 2G and 3G cellular networks.
HSS	Home Subscriber Server. The IMS function responsible for storage of various kinds of subscriber-related data, including authentication credentials, details of services subscribed, and identity of currently assigned S-CSCF.
I-BGF	Interconnect Border Gateway Function. The IMS function that enforces policy on the interconnection media path with other IMS networks.
I-CSCF	Interrogating Call Session Control Function. The IMS function responsible for querying the HSS to obtain the identity of the S-CSCF to which signaling requests addressed to particular destination should be sent.
IAD	Integrated Access Device. A form of Access Gateway deployed on customer premises that also supports data services.
IBCF	Interconnect Border Controller Function. The IMS function responsible for session border control at the point of signaling interconnection with other IMS networks.
IETF	Internet Engineering Task Force.
IFC	Initial Filter Criteria. A set of structured data held in the HSS for each IMS endpoint that identifies which Application Servers are to be invoked on signaling requests to or from the endpoint.
IMS	IP Multimedia Subsystem.
IP	Internet Protocol.
ISDN	Integrated Services Digital Network.
ISIM	IP Multimedia Services Identity Module. The IMS equivalent to the Subscriber Identity Module (SIM) used in GSM handsets.
ISUP	ISDN User Part. The signaling protocol used for call control in the PSTN.
LTE	Long Term Evolution. A broadband wireless technology that is expected to form the basis of most 4G networks.
MF	Multi Frequency. A legacy signaling protocol used on PSTN trunks.
MGCF	Media Gateway Control Function. The IMS function responsible for controlling Media Gateways used for interconnecting IMS networks with the PSTN.
MGCP	Media Gateway Control Protocol. A protocol used by some earlier generations of Access Gateways.
MRFC	Media Resource Function Controller. The IMS function responsible for controlling Media Resource Function Providers.
MRFP	Media Resource Function Provider. A media server function in the IMS network, used to provide tones and announcements and to support interactive voice response applications.
NCS	Network-based Call Signaling. A version of MGCP used by cable operators to support telephony services to residential gateway devices in PacketCable environments.
P-CSCF	Proxy Call Session Control Function. The IMS function responsible for providing a secure edge between the access network and the IMS core network.
PBX	Private Branch Exchange.
PES	PSTN Emulation Subsystem. A set of IMS functions that together enable an IMS network to provide a replacement for Class 5 switching systems.
POTS	Plain Old Telephone Service, based on analog transmission over copper loops.
PRI	Primary Rate Interface. A PSTN interface based on ISDN protocols running over a T1 transport facility.
PSTN	Public Switched Telephone Network.

APPENDIX A: ABBREVIATIONS

RFC	Request for Comments. The name used for standards documents published by the IETF.
RTP	Real-Time Protocol. The IP-based protocol for transport of voice and multimedia streams.
S-CSCF	Serving Call Session Control Function. The IMS function responsible for directing signaling requests to Application Servers so as to invoke services for subscribers on the network.
S-PDF	Serving Policy Decision Function. The access network function that accepts requests for media policy enforcement from P-CSCF and IBCF functions, and that controls the A-BGF and I-BGF functions which enforce the requested policy.
SBC	Session Border Controller. Generic name for a function that supports the secure interconnection of VoIP signaling protocols, and optionally VoIP media.
SGF	Signaling Gateway Function. The IMS function responsible for mapping legacy PSTN signaling protocols such as ISUP into an IP transport for processing by the MGCF.
SIP	Session Initiation Protocol. The protocol used for setting up and controlling voice and multimedia sessions in IMS networks.
TCF	Transit Control Function.
TDM	Time Division Multiplexing. Generic name for the technology that supports circuit-switched networks such as the PSTN.
TISPAN	Telecoms& Internet converged Services & Protocols for Advanced Networks. The group within ETSI responsible for defining the PSTN Emulation Subsystem.
UE	User Equipment. An IMS endpoint.
VOIP	Voice over Internet Protocol.
WIN	Wireless Intelligent Networking. A version of AIN used for layering enhanced voice services over a CDMA-based mobile switching infrastructure.