Application Services in an IP Multimedia Subsystem (IMS) Network

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1 Introduction

1.1 Background

This is a time of fierce competition for network providers. They face a decrease in profit margins for the supply of the basic communications “bit-pipe” to businesses and consumers. The more forward-looking providers are investigating new services as a way to differentiate their offerings and to generate new revenue streams. It is crucial to these network providers that they can deploy new services in a timely and efficient fashion. This is where IP Multimedia Subsystem (IMS) comes in.

IMS defines a standard framework for the deployment of next generation IP-based application services. It defines how these services connect and communicate with the underlying telecommunications network(s) and how they integrate with the network provider’s back-end systems.

IMS was first introduced as a 3rd Generation Partnership Project (3GPP) initiative, but it gradually emerged as the de-facto standard for all next generation application services, encompassing both wireless and PSTN networks. It is now being formally adopted by the ETSI and Parlay standards bodies.

The driving force behind this convergence is that PSTN and mobile networks have a key requirement in common with the IP-based next generation networks – the need for a flexible and standard platform to simplify the development and deployment of new services. Most of the components of IMS are independent of the underlying telecommunications network and so, with the appropriate gateways in place, IMS can meet this general requirement, regardless of the type of access network.

IMS is a broad and evolving standard and some aspects of it will continue to evolve over the next few years. Fortunately, the specifications for how application services should fit into IMS are reasonably finalized. This means that companies like Data Connection are already able to develop products and services that are fully IMS-compliant.

1.2 About this document

This white paper gives an overview of IMS, and in particular the Applications Services Structure, and how an IMS-compliant application service needs to be architected. It then goes on to discuss how Data Connection's next generation application services, such as our MailNGen unified messaging product and our MeetingServer conferencing product, fit in to an IMS-enabled network.

The rest of this document is structured as follows.

Section 2, IMS Fundamentals, introduces the basic IMS architecture and describes how the components fit together.

Section 3, Application Service Structure, describes how application services operate within an IMS architecture.

Section 4, Example Services, gives some examples of next generation services (taking examples from Data Connection's development roadmap) and shows how they fit into an IMS network.

Section 5, IMS and Data Connection's Products, illustrates how specific unified messaging, conferencing and unified communications applications can be deployed in IMS using Data Connection's MailNGen, MeetingServer and UC-Portal products as examples.

Section 6, Conclusion, presents the conclusion of this white paper.

1.3 About Data Connection

Data Connection Limited (DCL) is a unique UK technology company. We have a very unusual structure that leads to phenomenal commercial success and people stability. Our technologies span

- messaging, collaboration and directory technologies for Service Providers
- IP, VoIP and ATM protocol technology for OEMs
- next generation class 5 switching through our MetaSwitch division.

Please see Appendix A of this document for some more information about Data Connection, including details of our technology, commercial success and staff retention.

2 IMS Fundamentals

2.1 Introduction

PSTN, mobile and VoIP networks all have one key requirement in common, which is the need for a flexible platform to support application services. IMS started out as a platform for deploying services over next generation networks, but it has become the platform of choice for deploying value-add services over all existing networks.

The key advantages of IMS, for network providers, are as follows.

- A broader choice of services

  IMS uses an open standard set of protocols between components, and therefore allows network providers to “pick and mix” the components in their IMS network. In particular, network providers can select the most appropriate application services from multiple vendors, based on their own specific requirements.

- Reduced time to market

  An IMS-enabled network provider is no longer tied to the timescales and functions of the services available from their primary equipment provider. Adoption of “killer apps” will be faster for those providers that have an IMS infrastructure already in-place.

- Consolidated operations

  IMS separates out core functions, such as service billing and management. This means that back-end systems need only be integrated with the IMS infrastructure and not with individual services. New services can be deployed without having to train personnel on the provisioning, billing and management aspects of the new service.

- Fixed-mobile convergence

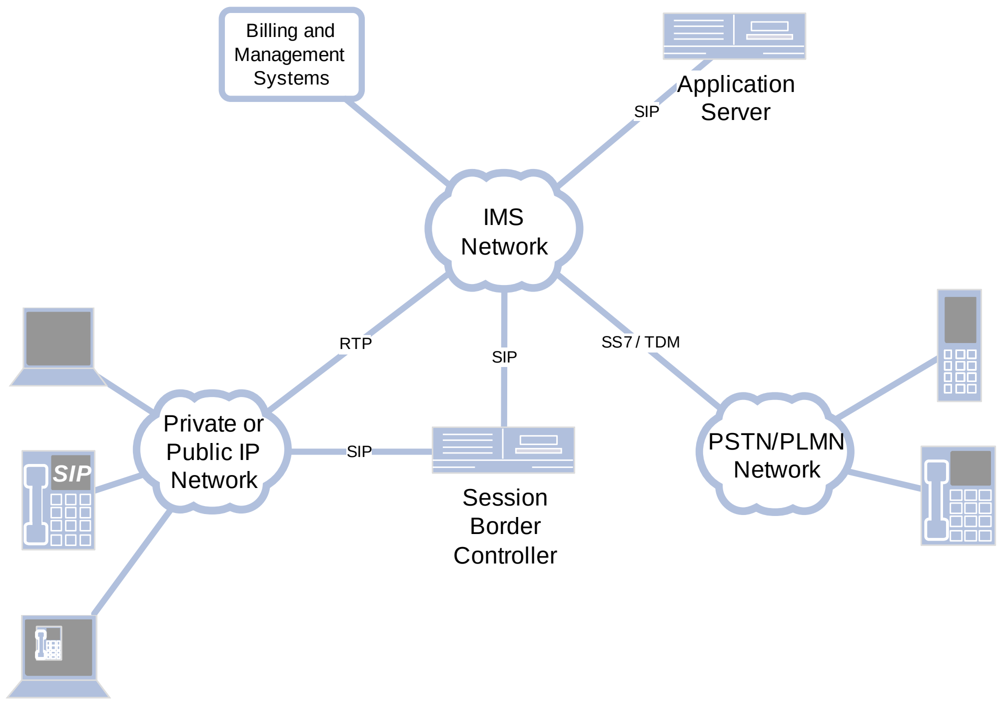
  IMS is independent of the underlying media transport. IMS-based application services can span both fixed-line and mobile networks, as well as VoIP, although the level of end-user function delivered may vary depending on the capabilities of the endpoint. As the telecoms industry becomes more consolidated, there is an increasing need for this application service convergence.

Deploying IMS-enabled solutions will result in a broader set of services for the end-user, which in turn frees the network provider from competing on a commodity “bit-pipe” basis.

2.2 The IMS Architecture

As with any network, IMS exists to provide a platform for communicating between terminals. In next generation networks these terminals range from plain old telephones through mobile phones and PDAs all the way to desktop PCs.

The following diagram shows how IMS interacts with endpoints and services at the highest level.

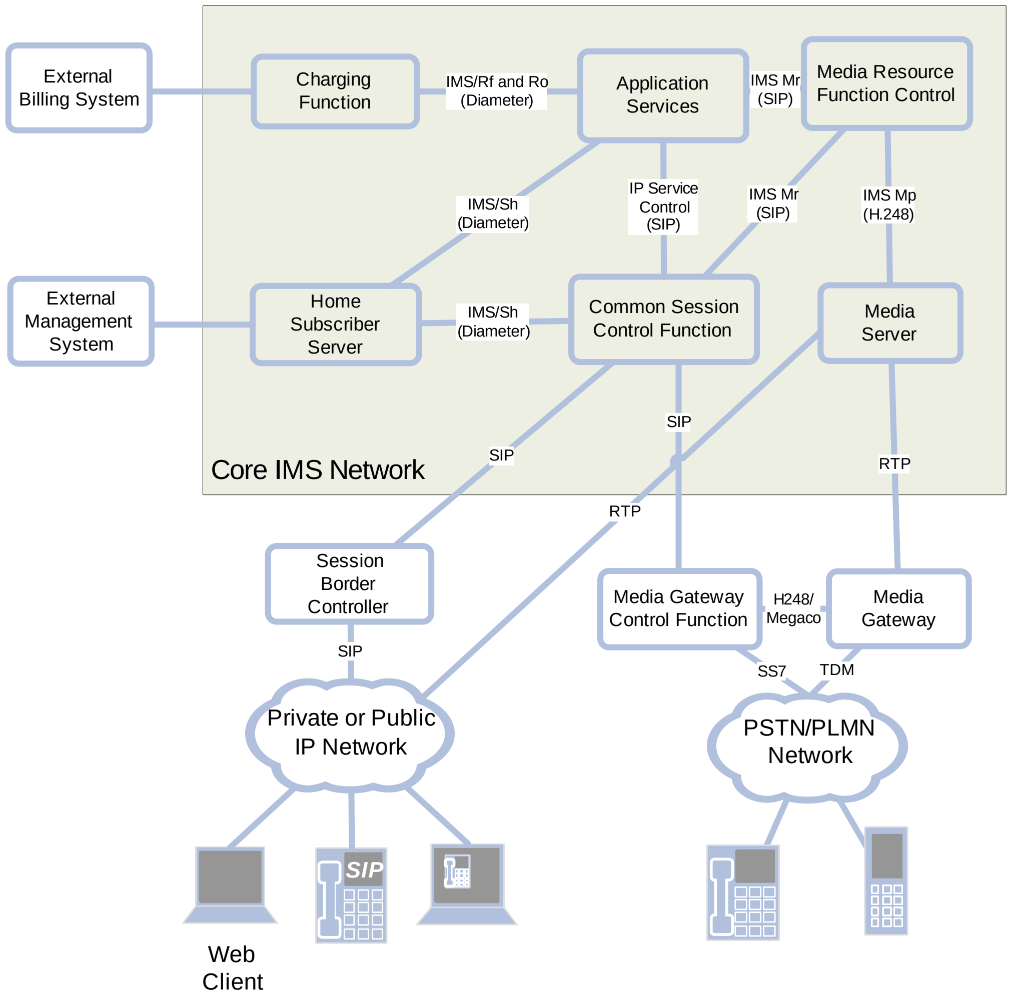


The IMS standard includes specifications for interfaces with both IP networks and “legacy” fixed line and wireless networks.

For IP networks, IMS supports SIP calls from endpoints across either public or private networks. Calls across the public network use a Session Border Controller to provide the control needed to route IP calls through the provider’s firewall.

Calls from legacy networks enter the IMS network through the normal SS7/TDM channels. Inside the IMS cloud these calls are mapped down the common SIP/RTP protocols that are the underlying signaling and transport mechanisms of the core IMS network.

This is expanded in the diagram below.



As you can see, once the legacy signaling has passed through the media gateway, all calls are handled as SIP/RTP traffic. This is fundamental to the IMS standard.

Apart from specifying that the media is transported by RTP, IMS is not concerned with the media itself. The negotiation of media encoding, for example, is left to the endpoints and gateways. RTP streams are routed directly between media servers, media gateways and endpoints.

IMS is closely involved in the call signaling. The Common Session Control Function is a core component that intercepts the call signaling and passes it over the IMS Service Control interface to the application services for them to handle.

The final result of the signaling can vary depending on the decisions made by each service that is offered the call. For example, the results of a call can depend on

- the called party's presence
- the called party's current preferences (barring, do not disturb, unwanted callers, busy, straight to voicemail…)
- the caller's preferences (no divert to voicemail, no video please…)
- the current time/date
- the caller and called party's current terminal capabilities (PC/PDA/plain old phone…)
- the caller and called party's current credit
- and so on.

The following sections give an overview of the key components of the IP Multimedia Subsystem.

2.2.1 Home Subscriber Server (HSS)

IMS defines a central repository for subscriber information, the Home Subscriber Server (HSS).   The HSS includes all the subscriber information required for establishing sessions between users and for providing them with services.

The HSS includes information about

- the subscriber registration (name, address, what services they use…)
- the subscriber's preferences (how they want the services to behave, in what order they should operate…)
- the subscriber's location (where they are now, for roaming-related services)
- service-specific information for each subscriber (their personal contact list…).

IMS defines a standard interface to the HSS which is called Sh. The Sh interface is built upon the existing DIAMETER standard for accessing subscriber information (which is itself an extension of the RADIUS standard).

Sh defines both the protocol for communicating with the HSS and the data stored in the HSS. As well as defining the core data stored for a subscriber it also defines an XML-based mechanism for storing a subscriber's service-specific data (such as their contact list) in the HSS.

We also need to consider existing, deployed subscriber directories and how the HSS fits with those. The HSS should be viewed as a server that provides a consolidated interface to multiple sources of information. The subscriber directory is one such source. The mobile network's Home Location Repository is another data source that is integrated through the HSS.

The HSS is a way of pulling this data together under one interface, rather than replacing the repositories for that information. Switching to an IP Multimedia Subsystem, to support next-generation services, should not require replacing existing directories.

2.2.2 Common Session Control Function (CSCF)

CSCF is the session routing point in an IMS network. It acts as a "service broker", handing incoming call events over the IP Multimedia Service Control (ISC) interface to the application services.

The ISC interface defines a series of filters that can be set for each subscriber. These filters are obtained from the Home Subscriber Server and compared to the SIP message to determine which application services should be invoked and in what sequence.

As well as call routing, the CSCF handles initial subscriber authentication. An application service that receives a message from the CSCF knows that the subscriber has been provisioned to receive that service. All it has to do is perform any additional application-specific checks on the subscriber,

CSCF uses standard SIP messages to pass events over the ISC interface. In fact, the event that is passed to the service is simply the SIP message itself (REGISTER, INVITE etc) with some additional header information to allow the CSCF to remain in control of the call.

When it receives a SIP message, an application service may choose either to

- handle the message itself, in which case it will inform the CSCF, and the CSCF will take no further action to route the message
- return the message to the CSCF, which will inspect the ISC filters to check which is the next service in the chain and pass the message on (or reject it if there are no more recipients in the list).

IMS recognizes that existing application services may be written to a Parlay interface and it includes the option of inserting a Parlay gateway between the CSCF and these legacy application services to translate the signaling.

The CSCF plays a major role in providing independence between application services. By defining an ISC interface with standard filters and SIP behaviour, it is possible for services to be deployed alongside each other with no cross-dependencies.

2.2.3 Media Resource Function Control (MRFC)

There are three types of application service.

- Some services simply redirect calls and never get involved in the media stream. One such example is a “sim-ring” service that can ring multiple phones and route the call to the first one that answers.
- Other services that need proprietary hardware to generate the media streams. For example, a special purpose media streaming server for delivering video on-demand.
- The majority of services require media processing that can be delivered by a standard media server. These general purpose servers are able to play audio prompts, convert text to speech and handle audio mixing for conference calls and are usually driven by a Voice XML (VXML) application.

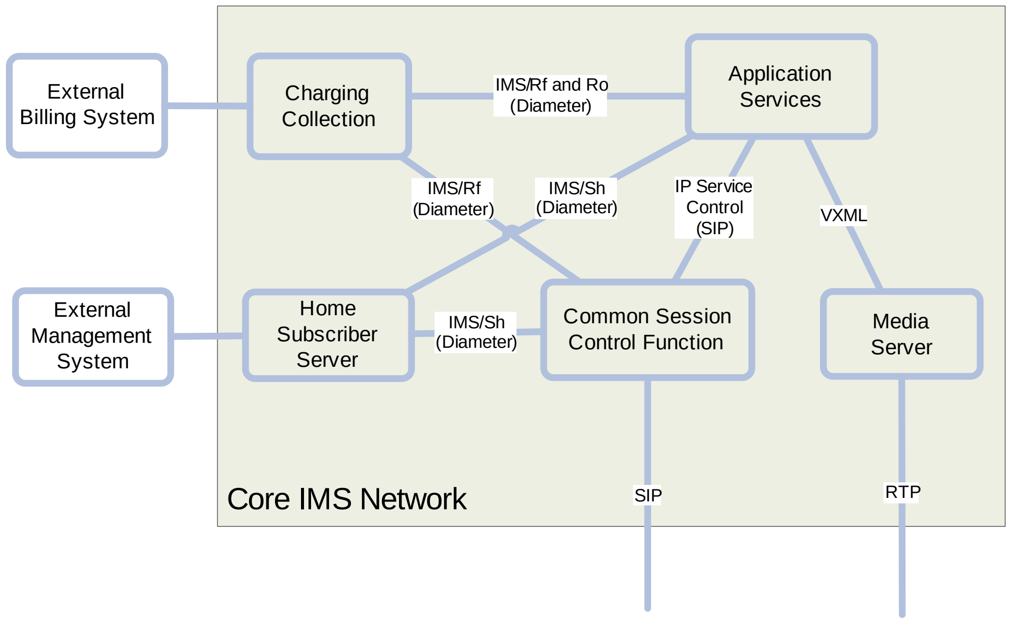
For the last type of service, IMS identifies a network component called Media Resource Function Control, to run alongside the media server. The MRFC accepts instructions from an application service and directs the media server to handle the media stream. The MRFC controls the media server using the standard H.248/Megaco protocol.

This separation of the media server resource control function from the media server is an IMS standard that is currently under debate. IMS had taken the view that the media server function will be delivered by the same hardware as the media gateway, in which case H.248 is the logical choice for controlling both the server and the gateway. However, we are seeing the media server and media gateways emerge as separate entities, with a richer set of protocols than H.248 being defined for controlling media servers.

Apart from media server control, the MRFC has responsibility for

- charging and conference control, which are functions that can be performed by the application services themselves
- control of subscriber roaming, which is also a CSCF function.

Given all this, it is likely that future IMS standards will recognize the evolution of the media server and retire the MRFC component. As you can see from the diagram below, this change will have little impact on the IMS system architecture.



In this diagram the MRFC has been removed and the application service, which already had most of the responsibility for service charging, has taken over the media server's charging functions as well. Apart from that, the picture remains the same.

2.2.4 Media Gateway Control Function (MGCF)

IMS recognises that many calls will originate or terminate in PSTN or mobile networks. It includes a specification for a Media Gateway Control Function, which interacts with the media gateway using the Mn interface. Mn specifies that H.248/MEGACO be used for controlling media gateways in an IMS network.

Media gateways are already widely deployed to bridge the TDM->VOIP domains. The Cisco AS5850 and the Nortel Media Gateway 15000 are deployed examples.

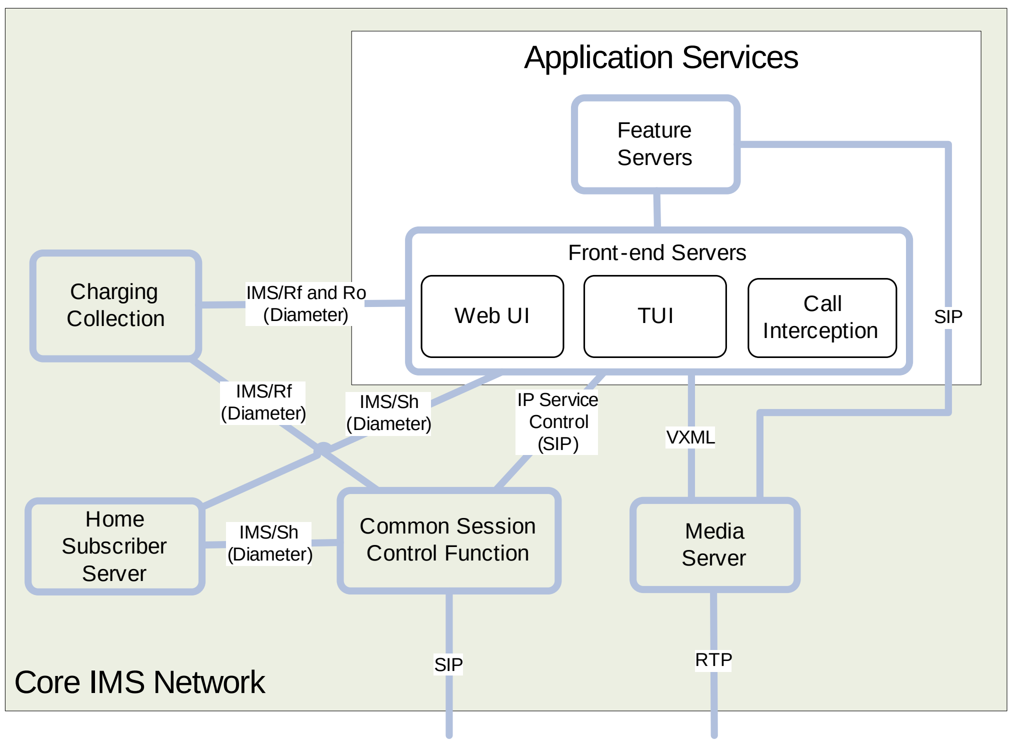
2.2.5 Charging

IMS includes a definition of the interfaces an application service must use for charging. These allow for the presence of one or both of an offline charging entity (Rf) and an online charging entity (Ro). Both these interfaces use a common format of Diameter message, the Accounting Request.

The intention here is to adopt a flexible structure for the call data, to keep integration with existing back-end systems simple, and also to support migration from the traditional batch mode of billing to a real-time model that is more appropriate for advanced services and mobile network integration.

3 Application Service Structure

This section looks inside the application services themselves. The following diagram shows the core IMS network, but now we have expanded the application service to show the breakdown of the service components. Looking inside the application service in this way, we are going beyond the defined scope of IMS, but it is important for an understanding of the overall picture.



The application service is delivered by a combination of

- Front-end Servers, which handle incoming requests from SIP endpoints and web endpoints
- Feature Servers, which provide the more complex service-specific functions, such as voicemail or conferencing.

The front-end servers have three primary roles.

- Web UI

  The majority of services provide some form of web access for functions such as subscriber self-care, or a UI to access the service itself (webmail, for example).

- TUI

  The TUIs provide phone access to the services. They handle SIP signalling and instruct a media server to commence a VXML dialog with the endpoint.

  Modelled on the HTML approach to delivering web pages, VXML is a good protocol for developing flexible TUIs through a media server.

- Call Interception

  The front-end will receive a SIP request for one of two reasons.

  - SIP clients dial in to the front-end directly to access to a service. These requests are handled by the TUI function in the front-end.

  - The CSCF intercepting a SIP request from an endpoint originating or terminating a call and routing it to the application service as a result of a match on an ISC filter. These are handled by the Call Interception function in the front-end.

  In both cases the front-end needs to decide if it can handle the call or it needs to pass it on to a Feature Server. While this split of front-end server from Feature Server is not an IMS requirement, it does bring benefits in deployment of hardware to ensure that processing intensive applications such as voicemail and conferencing are offloaded from the front-end servers.

- Feature Servers

  Simpler application services, such as simultaneous ringing, can be provided directly by the Front-end Servers in the Application Service routing the call based on subscriber preferences obtained from the HSS.

  For the more complex application services, such as messaging and conferencing, the system includes feature servers to provide the actual service function.

3.1 A model for front-end development

The Web UI and the TUI support different access protocols (one is handling HTTP requests and the other is handling SIP) but they also have much in common. Many services have functions that are accessible both through the Web UI and the TUI. For example, a subscriber might want to be able to view all their call history on screen but dial in and have the TUI read out missed calls.

It is good practice for the application service to reflect this commonality, so that as many functions as possible are accessible through both Web or TUI.

A good choice is to use Java servlets to implement both types of UI, using

- HTTP servlets for the Web UI
- SIP Servlets for the TUI and Call Interception.

SIP Servlets are a new JAIN standard (JSR116) that defines a model for handling SIP endpoints which closely resembles the HTTP servlet model for handling HTTP endpoints.

By using servlets for both types of UI, the page content, whether HTML or VXML, can be generated through Java Server pages calling common Java Beans to acquire the data. This allows for a good degree of commonality between the code running on the Web servers and on the TUI servers.

The Call Interception functions can also trigger Web UI and TUI interactions and , here again, it makes sense to use a common SIP Servlet approach to the implementation.

4 Example Services

IMS is just a means to an end. The real objective is to be able to deploy new services quickly. As IMS becomes more widely deployed, the industry will see the rapid development of some innovative and possibly "killer" applications. Below is a list of application services that are currently under development (some of which are offered by Data Connection).

The key benefit that IMS brings for all these services is that they can be slotted into a well-defined infrastructure for

- signaling control
- delivery of media resources
- TUI and GUI presentation
- directory management (subscriber records, preferences etc)
- billing and provisioning.

4.1 Email and voicemail

These traditional messaging services are not the most exciting of services, but they top the list in terms of the functions that are currently driving the adoption of next-generation networks, simply because of

- the cost benefits of using commodity hardware to replace expensive hardware solutions
- the pain of migrating from the current legacy systems really brings home the benefits of a flexible and extensible platform for deploying new services.

Section 5, IMS and Data Connection's Products, gives more details of Data Connections Unified Messaging system and how it fits into an IMS network.

4.2 Conferencing

IMS can be used to provide flexible conferencing services including voice, video, and data conferencing using commodity media servers. The per-port costs are significantly lower and you are no longer tied to a specific bridge manufacturer because of a dependence on proprietary integration interfaces.

There are other, seemingly small, benefits that could have a big impact on a service provider's bottom line. For example, having a single well-known access number for all services, with including conferencing links off the main TUI, can increase the uptake of a high per-minute revenue-generating audio conferencing service. Again, section 5 gives more detail on how Data Connection's conferencing products can be used to provide such a service.

4.3 Presence and instant messaging

Few people doubt that presence and instant messaging will develop to span the internet and telephony domains. Presence is generally regarded as a service in its own right, but we will increasingly see presence awareness being integrated with other services, such as click-dial or push-to-talk.

Using IMS simplifies the consolidation of presence information through the notification interface to the HSS. The HSS does not become a presence server in its own right, but it does provide a common interface to presence information for the application services.

4.4 Push to talk

Some people regard push-to-talk as the next "killer" application. Emulating the traditional walkie-talkie, push to talk associates a call with the push of a key thus enabling a conversational voice service without an underlying permanent connection. Killer or not, it could certainly revolutionize mobile phone usage, *provided the current barriers between providers can be removed*.

The challenge of deploying a push-to-talk solution is in handling the different session creation and service billing model, particularly when the session is cross-provider. IMS does not provide all the answers here, but what it does bring is a common infrastructure that will help with the development of a cross-provider application service.

4.5 Network integration

The telecoms industry is in a phase of consolidation. The biggest challenge facing this consolidation is that of integrating all the different network technologies. Taking the IMS approach, of using an IP backbone to link the networks together, means that many of the integration issues can be solved with standard network elements, with the added benefit that the resulting network is ready for the deployment of next-generation application services.

4.6 Content sharing

An application service could provide a content sharing function, along the lines of a personal web log, including the storage of audio, text, video and photos. The richness of the content that could be delivered would obviously depend on the capabilities of the terminal used to access the data.

Imagine the problems with deployment and take-up of a non-IMS version of this service, where you have non-standard provisioning, billing, management and self-care interfaces to be integrated, plus a separate access number which requires advertising. It would be difficult to make a business case to cover the substantial deployment costs for this service.

With an IMS version of the service, deployment is quicker/smoother and you can configure a one-off prompt to let subscribers "discover" the new service. The revenue ramp surpasses the deployment costs much sooner.

4.7 Legacy switch enhancement

It is not nearly as exciting as some of the new applications listed above, but legacy switch enhancement is a key driving force for IMS adoption. The idea of legacy enhancement is that, rather than switching their entire customer base to next generation switches, a network provider can enhance their existing switches by routing selected calls out to the IMS network.

For example, if a subscriber on a legacy switch wants to subscribe to an advanced find-me/follow-me service, then any calls to their number can simply be routed into the IMS network to provide the service (and then routed based on the new destination number, possibly back through the legacy switch).

This avoids the need to completely re-provision the subscriber on a next-generation switch if they request a next-generation service.

4.8 Emerging services

New services are emerging at an increasingly rapid pace. For example, advanced messaging services will evolve from SMS, MMS and email/voicemail, to include functions such as real-time chat and messaging functions related to specific to business and consumer applications.

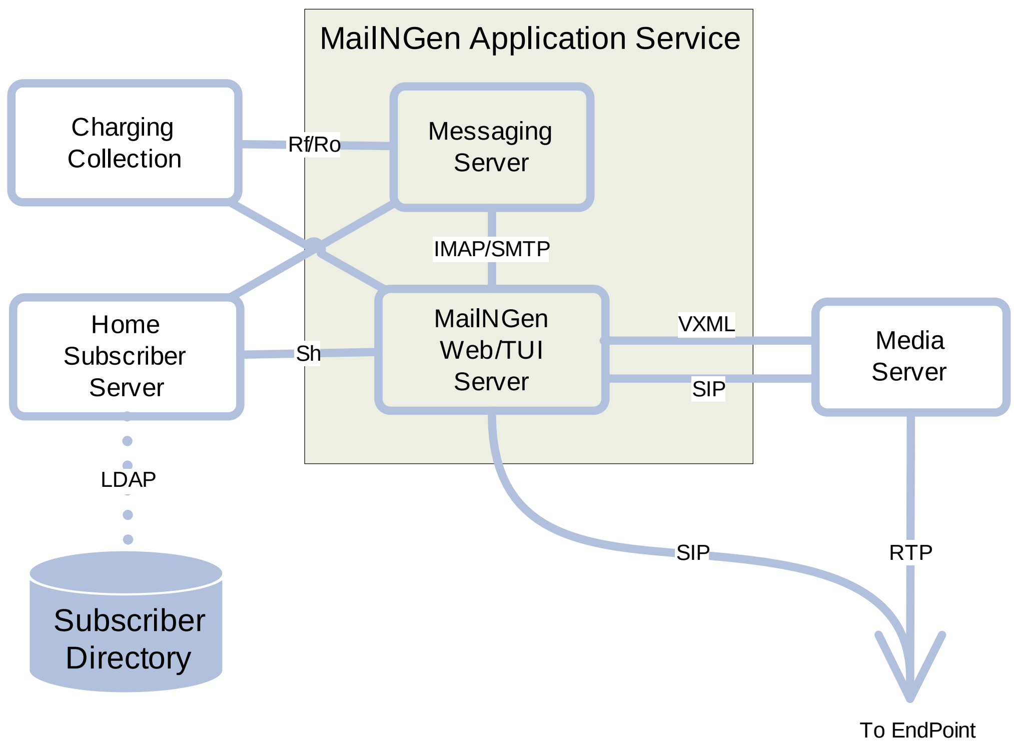
IMS is the enabler that allows rapid adoption of this kind of new service, as it emerges.

5 IMS and Data Connection's Products

The section looks at Data Connection's Unified Messaging, Conferencing and telephony application services to provide case studies of how real applications fit within an IMS network.

5.1 Unified Messaging

The following diagram illustrates how Data Connection's MailNGen Unified Messaging application service fits into an IMS network.



As the diagram shows, the application services uses the standard IMS SIP and Sh interfaces to communicate with external components.

The following points in this diagram are of particular interest.

- The front-end/back-end split in the service

  The service is split into the front-end Web and TUI servers and the back-end mail servers, communicating over the standard IMAP/SMTP mail protocols. This separation of function allows for other modes of access to the service, such as direct IMAP access from an installed mail client.

- The link between the HSS and the subscriber directory

  Most existing networks use a large LDAP directory to store subscriber information rather than already deploying an HSS.

  MailNGen can integrate with these environments by either

  - interfacing directly with the LDAP directory
  - running over an HSS migration layer that is built on top of the external LDAP directory.

  Data Connection's MailNGen product simplifies this integration by providing an IMS Sh interface for application services with various options for integrating this with the underlying data repositories.

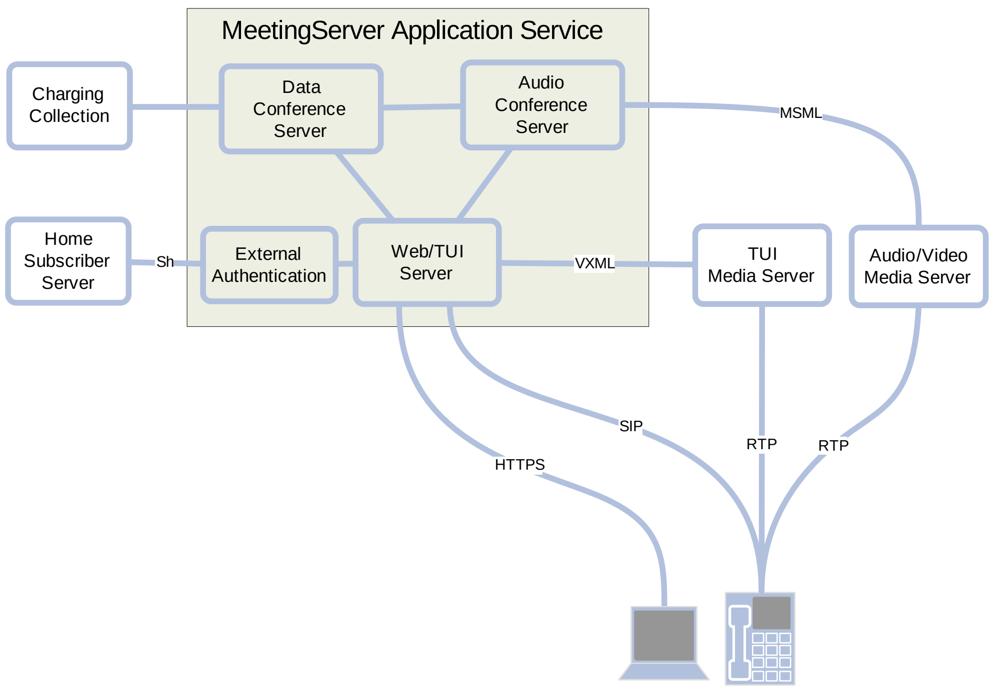
- Choice of media server

  MailNGen can run with any IMS-compliant media server that supports the VXML standard for TUI generation.

  Included with the MailNGen system is a VXML media server that is built specifically for use by MailNGen. It provides a tailored solution running on commodity server hardware to achieve a low per-port cost. This is not a full IMS compliant media server, and so it should be viewed as a part of the MailNGen application service. (As discussed in section 2.2.3, Media Resource Function Control (MRFC), it is perfectly acceptable for an application service to act as an endpoint itself.)

5.2 Conferencing

The following diagram shows how the Data Connection's MeetingServer application service fits in an IMS network.



Here again, you can see that the only interfaces to the application service are SIP/RTP, Sh to the HSS and regular HTTPS web traffic. The Web And TUI server communicate, in this case, to a pair of feature servers working together to provide audio/video and data conferencing.

MeetingServer is a slightly more complex application service than MailNGen because it is a hybrid web and telephony service. The audio/video is delivered over the VOIP network (possibly passing through a media gateway to the TDM domain) whereas the data conferencing and web video function is delivered over HTTPS.

Particular points of interest in this diagram are the two types of media server and the integration with external authentication mechanisms.

- The two types of media server.
  - The TUI server handles initial access requests through the TUI media server, driven with VXML scripts. MeetingServer includes custom media server software to handle this initial TUI interaction, since a software server is best suited for this kind of on-demand web-server access.
  - For handling audio/video conferences, the call is transferred to a specialized media server with the necessary audio encoding and mixing capabilities. The audio conference server controls this server directly, using MSML to set up the conferences and perform conference control functions.
- External authentication

  MeetingServer isolates user authentication into a single integration point, and, to fit in to an IMS network, this External Authentication component simply accesses the IMS HSS over the Sh interface.

  Those familiar with MeetingServer will recognise that the External Authentication component actually handles service configuration as well as authentication. This is consistent with IMS, where both authentication and configuration information is accessed from the HSS.

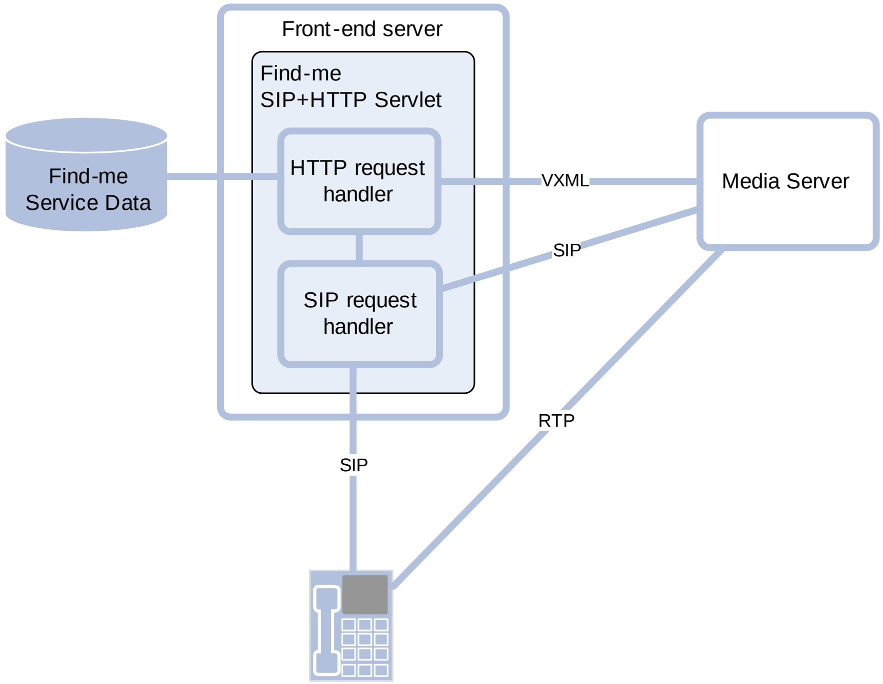
  Here again, MeetingServer can easily live within a hybrid IMS network, using SIP for signalling but LDAP for authentication. In this case the External Authentication simply executes against an LDAP API rather then the IMS Sh API.

5.3 Telephony Applications

Data Connection's Unified Communications Portal, UC-Portal, is a product that provides next-generation telephony services in an IMS environment.

UC-Portal is actually a suite of application services, each of which conforms to the diagram in section 3, Application Service Structure. They all use a SIP Servlet environment developed by Data Connection to provide for rapid service development and deployment.

Some of these application services require complex call signalling and routing, and for this we leverage the combined SIP/HTTP capabilities of the servlet container, as illustrated in the following diagram.



Find-me is an application service that can route calls based on a number of configuration parameters, including

- multiple phone numbers
- time and date
- current user settings (do not disturb).

The call signalling to achieve this goes beyond that provided in the VXML standard. Instead, the VXML to control the TUI is generated by an HTTP servlet working in concert with a SIP servlet that retains control for the incoming call.

This allows a much more flexible routing of the call than can be achieved with VXML alone, and yet places no special demands on the media server other than the support for standard VXML.

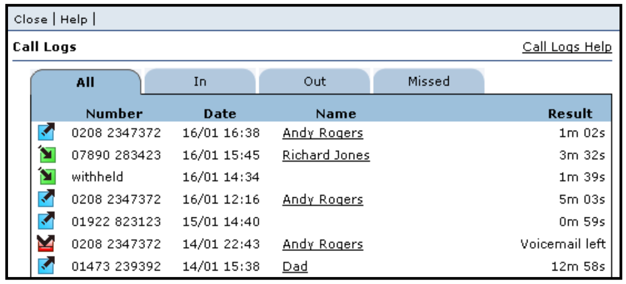
What is particularly exciting about UC-Portal is that the application service platform allows us to

- develop a much more flexible set of TUI and Web UIs
- deliver an advanced form of web access for real-time PC client notification of calls and call screening.

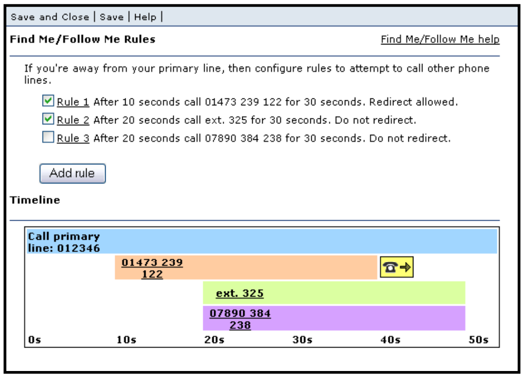
The next few sections give a brief overview of the sort of applications that UC-Portal provides on this infrastructure.

5.3.1 Call History

The Call History service provides users with a Web view of their all calls made, received and missed – providing real-time call information in an easily understandable form.



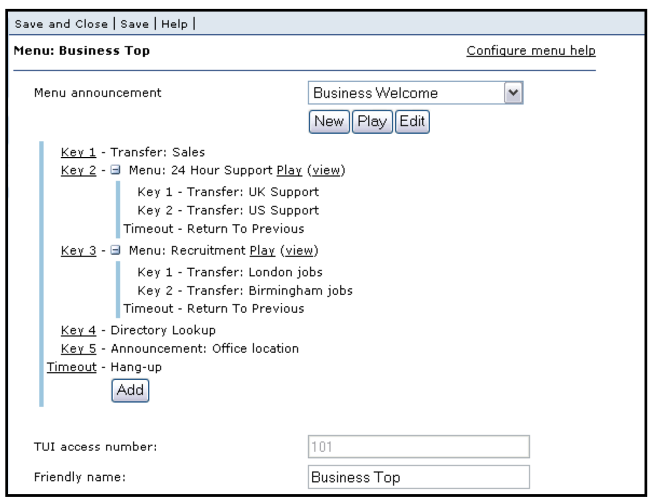
5.3.2 Find-me Follow-me



The take-up of traditional call redirect services has been limited by the complexity of the management interfaces. Today any web browser can present the information graphically, to make the UI for a user to set up their call redirect rules far more simple and intuitive.

5.3.3 Auto Attendant

Setting up an auto attendant can also be made simple and powerful enough for a user to do themselves using any Web browser.



5.3.4 PC Notification and Screening

Next-generation telephony really comes in to play when the user's phone and PC work together to provide them with call notification and handling.

Here again, the focus is on clear and simple function. A "toaster" fading in on the user's PC lets them know about the call, with just a single click to take the call, redirect it to voicemail or screen the call.

6 Conclusion

Anyone who has browsed the web for information on IMS will know how difficult it is to find a good starting point. This document provides an overview of the structure of IMS, with sufficient background information to help with future research.

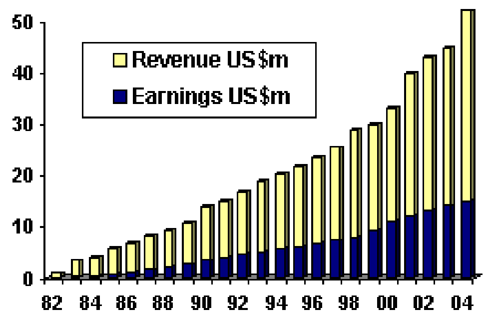
Furthermore, this paper introduces Data Connection's expertise and technology in this area. If you would like more information on any of the existing or future products described above, please contact us or visit our website at www.dataconnection.com.

A Background on Data Connection

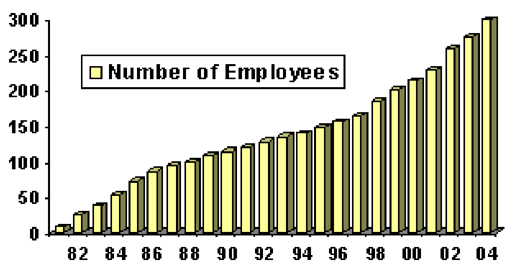
Data Connection (DCL) has a unique ownership structure that leads to enviable commercial stability and people retention, and most importantly, high quality products and services.

The company is 100% owned by the Data Connection Employee Benefit Trust, ensuring that the company's main priority is employee motivation. All profit is distributed to employees on an annual basis, and the culture is focused on building an exceptionally capable engineering team. This leads to employee dedication to the quality of our technology support provided.

- Data Connection has been continually profitable.
- 2004 revenue was $52m with profit of $15m.
- The vast majority of revenue is abroad.



This commercial stability means that Data Connection is the *most dependable* technology supplier and customers can have huge confidence in our long-term ability to support our products.



Data Connection enjoys phenomenal people retention with an average length of service of 8 years and a turnover rate of just 3%.

The vast majority of staff are recruited from the 3000+ applications which we receive each year from top university graduates. We then focus on continual training in good technology design, development, testing and support, resulting in incredibly consistent application of high quality development procedures.

The quality of our technology and services is best reflected through the customers that rely on us for major systems.

Please see www.dataconnection.com for more information on our service provider applications, network protocol technology for OEMs and MetaSwitch, our widely deployed class 5 replacement softswitch.