The Evolving IPTV Service Architecture

Service providers are expanding their offerings to include broadband triple-play bundles, unleashing exciting new revenue opportunities with new services such as broadcast and video on demand (VoD). These services are delivered over converged networks, along with other new multimedia applications that take advantage of fixed and mobile convergence (FMC). This transformation has led to the investigation of different approaches for creation and management of video and hybrid services. IP Multimedia Subsystem (IMS) has garnered intense interest as a method of managing converged services using a session-based approach. Equally important, however, are non-IMS options for managing services (such as peer-to-peer, instant messaging, video streaming, and business IP VPNs) that do not necessarily always involve the creation and management of sessions.

This paper examines the evolution of IPTV networking standards, including IMS, and explores how the Cisco® IP Next-Generation Network (IP NGN) architecture can easily adapt and scale to meet any large-scale deployment requirements that become important to service providers, including accommodating emerging IPTV standards as these mature.

Overview

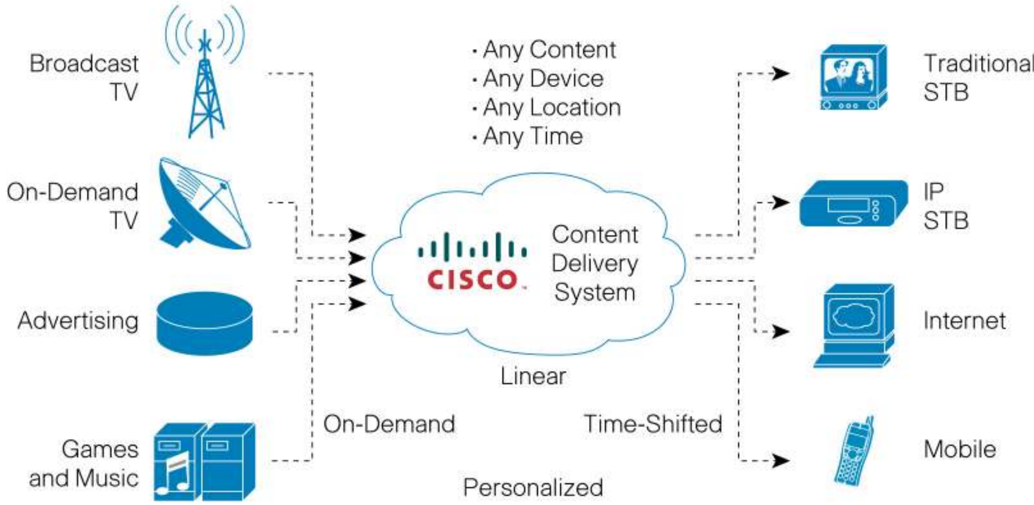
The service provider market is undergoing a major transition resulting from technology evolution and competitive pressures. Service providers realize that they need to transform their infrastructures, offerings, and business plans to compete effectively. They must also operate their networks more cost-efficiently by eliminating overlay networks, and many of them are now integrating networks and services over a next-generation IP infrastructure. This vertical convergence and integration strategy is critical to reduce network complexity, lower capital and operational expenses, and even more importantly enhance the network's ability to quickly and effectively provide new services and revenues.

Today's consumers want to choose between a range of service offerings available for a variety of different devices, from cell phones to PCs, MP3 players, TVs, and gaming consoles. Two services that wireline service providers are now deploying, high-speed broadband and IPTV, are seen as vital to the provider's ability to reduce customer turnover and reverse revenue declines from traditional services, particularly voice.

IPTV Service Requirements

With the introduction of IPTV, traditional wireline service providers and content providers are entering a new market delivering broadcast and VoD video services to consumers. The success of this endeavor is heavily dependent upon how fast service providers can roll out reliable IPTV services that give consumers the most convenience and flexibility before competing providers do the same thing. Network-addressable devices of many kinds, from PCs and phones to set-top boxes (STBs), Figure 1, must receive innovative IPTV services in the home and on the go. These services include different features that enable transmission of a wide variety of content either in real time, on demand, with the ability to stop and go, and with personalization options.

Figure 1. IP NGN: Delivering Any Service on Any Device

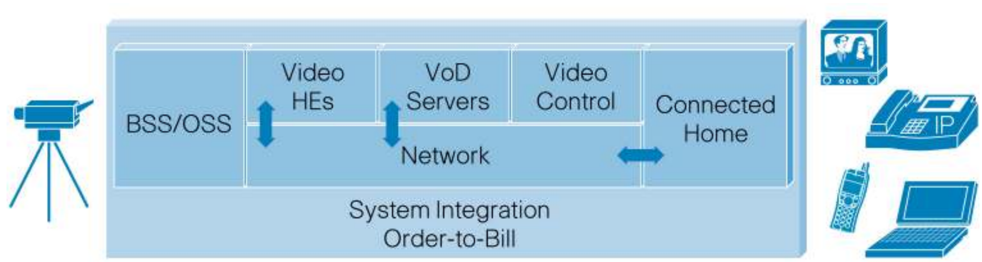


While all major service providers are planning to launch or have already launched IPTV services, the strategies that will lead to the long-term economic success of these services are still being debated. However, several factors during initial service introduction will heavily influence customer perception and thereby enable longer-term success:

- Quality of experience for the end user
- Attractiveness of content
- Ease of installation and operation
- Competitive pricing

A complex architecture is required to deliver competitive services, requiring close interoperability of all components involved in service delivery, including the business support system (BSS) and operations support system (OSS) and particularly the underlying network from the headend and VoD server to the home environment, Figure 2. Within the home, there are other considerations in order to allow interworking of the STB with the control software (or middleware) and the integration of the middleware with other components (such as the headend, VoD servers, Web portals, and electronic program guide [EPG]).

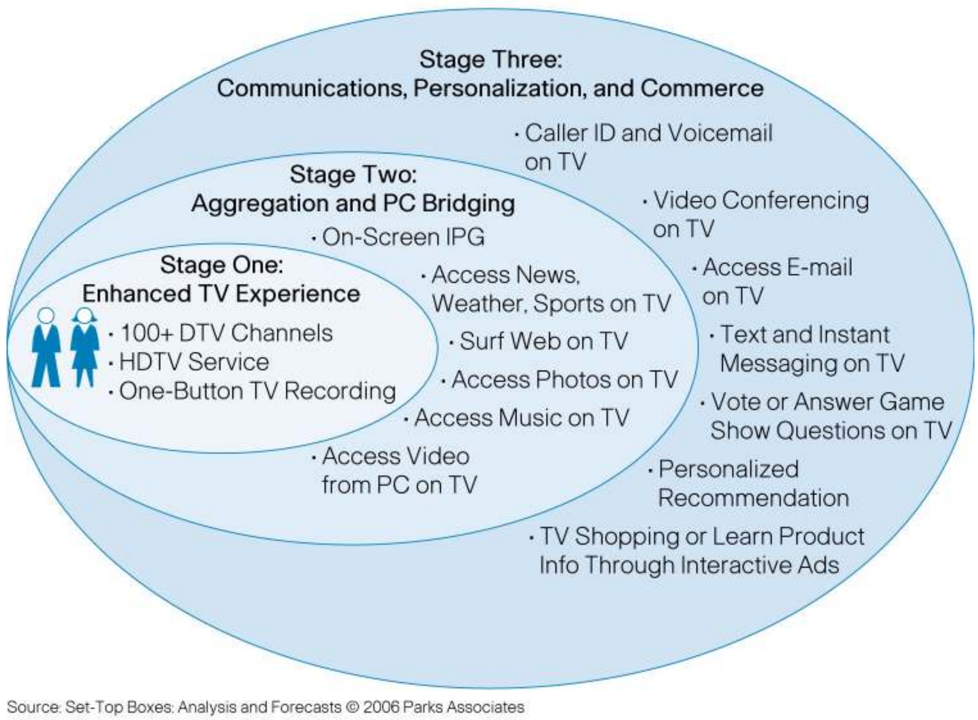
Figure 2. High-Level IPTV Architecture



While the underlying complexity is high, the initial services offered by wireline IPTV providers may be perceived as offering limited differentiation from competing services such as satellite TV. Important initial differentiators are sophisticated digital video recorder (DVR) and time-shifting capabilities (the ability to stop, pause, and rewind real-time programs) and a rich VoD environment. Therefore it is essential for a sustainable IPTV business to rapidly evolve the new offering toward an interactive experience that clearly differentiates IPTV from those TV offerings that subscribers can get and enjoy already.

Many service providers believe that a successful, competitive quad-play service (data, voice, IPTV, and mobility) depends upon the successful integration of the different services into unique, innovative applications. These include the ability to enjoy entertainment not just on a TV but also on mobile devices and at the same time to integrate communication services with entertainment services to make the IPTV services more interactive, as shown in Figure 3.

Figure 3. Potential Stages of IPTV Services Evolution



Migrating Other Services to Converged Networks Using IMS

Aside from offering IPTV services, service providers have begun migrating their traditional fixed and mobile voice and communication services to converged IP NGN networks. As circuit-switched technology is phased out, new VoIP and rich media communication services are being deployed in packet-switched environments through the use of SIP signalling. IP Multimedia Subsystem (IMS) is emerging as an effective, standards-based architecture defining SIP-based voice and rich media service delivery. IMS promises:

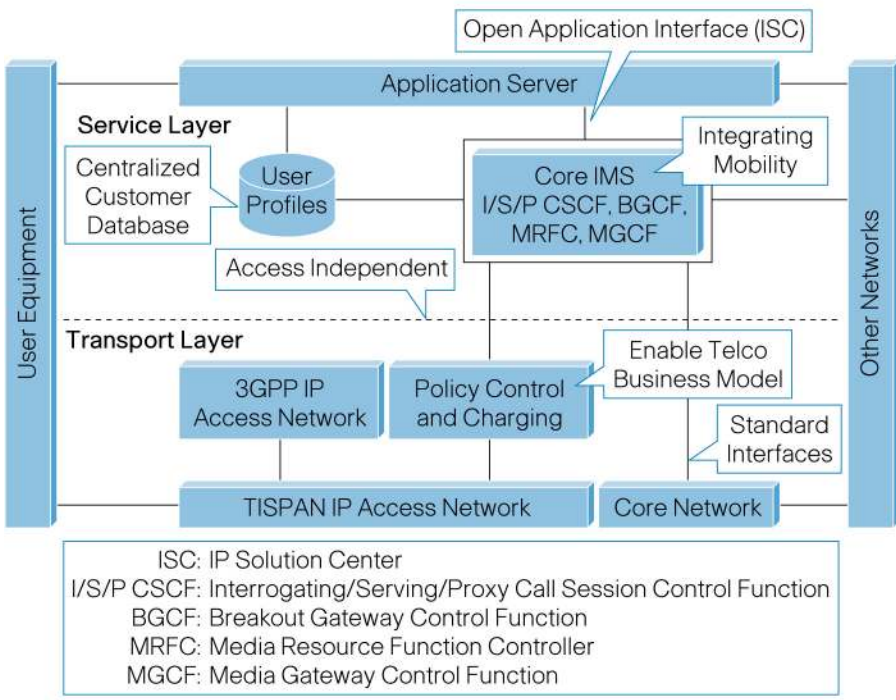
- Access-independent service delivery of a centralized subscriber database
- Open interfaces to application servers
- Per-session dynamic quality of service (QoS) for an optimized quality of experience
- A replacement for public switched telephone network (PSTN)

IMS was originally conceived by the 3rd Generation Partnership Project (3GPP) as an architecture that would allow mobile carriers to run voice and other real-time, SIP-based services over an all-IP network.

Today IMS is being promoted as the architecture of choice for multimedia communications services of all kinds. Organizations such as the ETSI and CableLabs® are creating standards to enable an IMS architecture to be supported on their specific access networks. Telecoms and Internet converged Services and Protocols for Advanced Networks (TISPAN) is the standards group within ETSI and ITU that has been charged with developing a more universal service delivery architecture that adapts the 3GPP-defined IMS standards to address the needs of wireline providers to build a policy- controlled IP transport network.

Current versions of the IMS standards are focused on SIP-based communication services and PSTN replacement. Standards are still a work in progress, with 3GPP at Release 7 and TISPAN working on the definition of an NGN Release 2. Figure 4 shows the TISPAN NGN architecture.

Figure 4. TISPAN NGN High-Level Architecture



Current initial trials and pilot IMS deployments are focused on supporting voice and rich media communication services. Service providers are investigating the implementation of IMS components in support of their vision for an IP NGN and to address the obsolescence of older circuit-switched technology. The open issue at this stage is how the vision of the tightly integrated quad-play solution can be delivered using IMS and IPTV architectures.

IMS alone does not address the full spectrum of applications that service providers are profitably delivering now and will continue to offer for years to come. Aside from IPTV, today's non-SIP-based applications include peer-to-peer streaming; business IP VPN; and messaging such as instant messaging, Short Message Service (SMS), and Multimedia Message Service (MMS). These applications continue to grow at a rapid pace. Some providers are not waiting for the IMS-based standards or their own IMS architectural capability to extend support to these non-SIP applications and are therefore looking for a means to quickly, efficiently, and profitably deliver both SIP and non-SIP-based applications. In such cases, the Cisco Service Exchange Framework addresses service providers' needs because it provides unique and comprehensive support for both SIP and non-SIP-based applications as providers evaluate and evolve their integrated IMS and non-IMS strategies.

Current IPTV Standardization Overview

Overview of IPTV Standardization

A number of organizations are working on specifications for the delivery of IPTV. The IETF has defined the fundamental mechanisms for support of IPTV such as the protocols for the control of video streaming and of multicast flows. These specifications have in turn been used by organizations such as the Digital Video Broadcasting Project (DVB Project), an industry consortium with more than 270 members, in the specification of IPTV systems. In addition to using the basic mechanisms defined by the IETF, the DVB Project has specified a protocol for service discovery and selection. More recently ETSI TISPAN, Alliance for Telecommunications Industry Solutions IPTV Interoperability Forum (ATIS IIF), and the ITU-T Focus Group on IPTV have begun work on IPTV, including the integration of IPTV within NGN architectures. Two approaches to the integration of IPTV in NGN are being studied. One is based on using IMS and the other uses a dedicated IPTV subsystem without use of IMS session control procedures. In addition, mobile IPTV is being studied in the Open Mobile Alliance (OMA) and 3GPP, and PacketCable™ and ITU-T Study Group 9 are studying IPTV for the cable networks.

Digital Video Broadcast

DVB specifications are published by ETSI. ETSI TR 102 033 describes an architectural framework for the delivery of DVB services over IP-based networks and includes descriptions of IPTV services. ETSI 102 034 specifies the transport of MPEG-2-based DVB services over IP-based networks and defines Real Time Streaming Protocol (RTSP) profiles for Live Media Broadcast (LMB), Media Broadcast with Trick Modes (MBwTM), and content on demand (CoD).

Some of the main guidelines in ETSI TS 102 034 include:

- The information for service discovery and selection services is assembled according to the Service Discovery and Selection (SD&S) protocol, which for multicast (push) services is transported in IP packets according to the DVB SD&S Transport Protocol (DVBSTP) and for unicast (pull) services is transported via HTTP. An SD&S entry point can be implemented using a Domain Name System (DNS) mechanism.
- RTSP is used to control the delivery of broadcast TV, radio, and on-demand delivery.
- The audio and video streams and the service information are multiplexed into an MPEG-2 transport stream. The resulting MPEG-2 packets are encapsulated using the Real-Time Transport Protocol (RTP), with differentiated services code point (DSCP) packet markings for QoS.

- Real-Time Transport Control Protocol (RTCP) is used, for example, to send information to receivers about transmission statistics, and Internet Group Management Protocol (IGMP) to join and leave multicast streams.
- The Dynamic Host Configuration Protocol (DHCP) is used to configure the Home Network End Device (HNED) with an IP address. Real-time clock services or accurate network time services are implemented using either the Simple Network Time Protocol (SNTP) or Network Time Protocol (NTP) respectively.
- RTSP profiles for LMB, MBwTM, and CoD are defined.

ETSI TISPAN 102 005 specifies the use of video and audio coding in DVB services delivered directly over Internet protocols (that is, not involving an MPEG2 transport stream).

IPTV and the Next-Generation Network

ETSI TISPAN, ATIS IIF, and the ITU-T Focus Group on IPTV have begun work on IPTV and that work includes integration of IPTV within NGN architectures. Two approaches to the integration of IPTV in the NGN are being studied. One is based on using IMS and one uses a dedicated IPTV subsystem without IMS, Figure 5.

Figure 5. ITU-T Focus Group Working Document on IPTV Converged Architecture

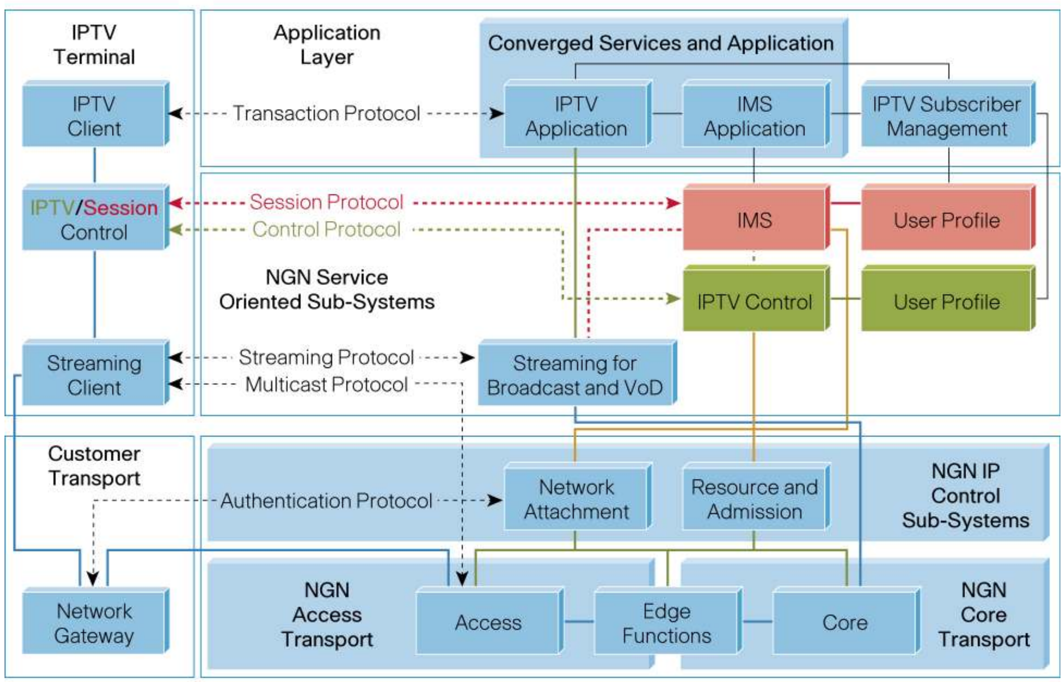


Figure 5 shows the high-level architecture for IPTV being developed in the ITU-T Focus Group on IPTV (Working Document FG IPTV-DOC-0056). The IMS-based and non-IMS-based approaches only differ in terms of the inclusion of the core IMS session control functions in the IMS-based IPTV solution. It is not yet clear whether the IPTV control and IMS control functional entities are alternatives because the detailed procedures have not yet been specified but in all likelihood IPTV control procedures will be required in both approaches. Thus, the IMS-based solution differs from the non-IMS based solution with the addition of IMS session control procedures. In both approaches common user profile and charging functions can be utilized. In addition, in both cases the NGN transport functions can be used, including network attachment and resource and admission control features, and NGN applications.

The IMS-based approach is most actively being pursued in ETSI TISPAN but the architecture is currently under discussion and has not yet been finalized so that work on protocol mechanisms can begin. Therefore, there is a degree of guesswork involved in envisioning the form that a thoroughly standardized IMS-based solution for IPTV will finally take. It will be necessary, for example, to decide upon how much of the current control procedures performed by RTSP and IGMP (such as channel change) will be taken over by IMS SIP procedures; how admission control and resource allocation will be performed if, as is most likely to be the case, an IPTV control protocol will be needed in addition to the use of SIP; and how IMS and IPTV control procedures are to interact (for example, in case of error or user commands such as pausing a video).

IPTV in Cisco IP NGN: compliant to emerging standards

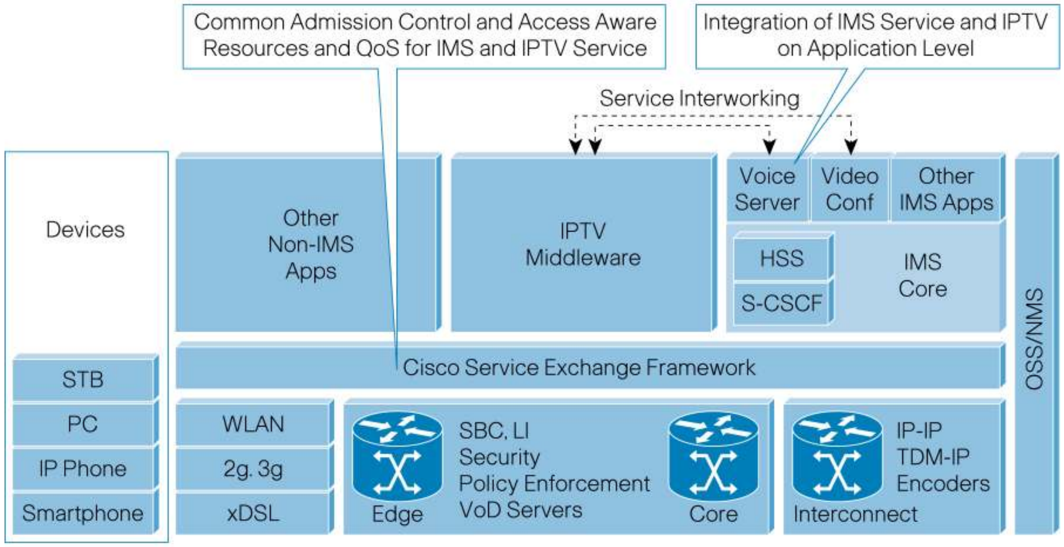
The Cisco Approach for Integrating IPTV and IMS

Cisco is the leader in enabling converged networks and the Cisco IP NGN architecture has been adopted by numerous cable, wireless, and wireline service providers for delivery of any-play services. Also, Cisco with Scientific Atlanta, a Cisco company, is the leader in the deployment of large-scale video systems (such as VoD and broadcast TV) over IP networks worldwide. Although the promise and potential of IMS and enhanced SIP-based services are attractive, Cisco also understands the revenue opportunities and customer demands that are encouraging service providers to enhance their non-SIP network resources and services today. A purely IMS-based IPTV solution is not feasible in the near future due to the immaturity of the IMS IPTV standards and the lack of standards resolution of issues among the IPTV architecture, IPTV components, and the IMS architecture.

The Cisco approach to IMS focuses on enabling IMS as a service-delivery subsystem that works in conjunction with existing SIP and non-SIP-based services and support infrastructures. The Cisco Service Exchange Framework provides standards-based interfaces to the IMS subsystem, allowing service providers to build out native IMS functions with Cisco products or by selecting best-of-class fully integrated products from the Cisco ecosystem of IMS system partners. The Cisco solution, applied through the Cisco Service Exchange Framework, is comprehensive and allows service providers to deliver a wide range of applications while supporting industry-leading scalability and resiliency. This flexible approach enables providers to adopt IMS and its related SIP services at a pace appropriate to their business and in a way that is financially viable.

Cisco believes that an integration of IPTV and IMS communication services will occur at an intelligent layer close to the network, providing common dynamic QoS control; authentication, authorization, and accounting (AAA); and resource management functions independent of service and access layers. An important application to enable a high quality of experience is admission control, a function that prevents oversubscription by determining which services can be guaranteed without exceeding traffic thresholds. The Cisco Service Exchange Framework, Figure 6, enables this capability.

Figure 6. Integration of IMS and IPTV Services through the Cisco Service Exchange Framework



With the Service Exchange Framework, a pragmatic integration of IMS, non-IMS, and IPTV service subsystems is possible, allowing services such as incoming call display on a TV (Figure 7) or DVR programming from cellular phones. The Cisco BTS 10200 Softswitch voice application server, in combination with an STB from Scientific Atlanta, a Cisco company, supports these capabilities today.

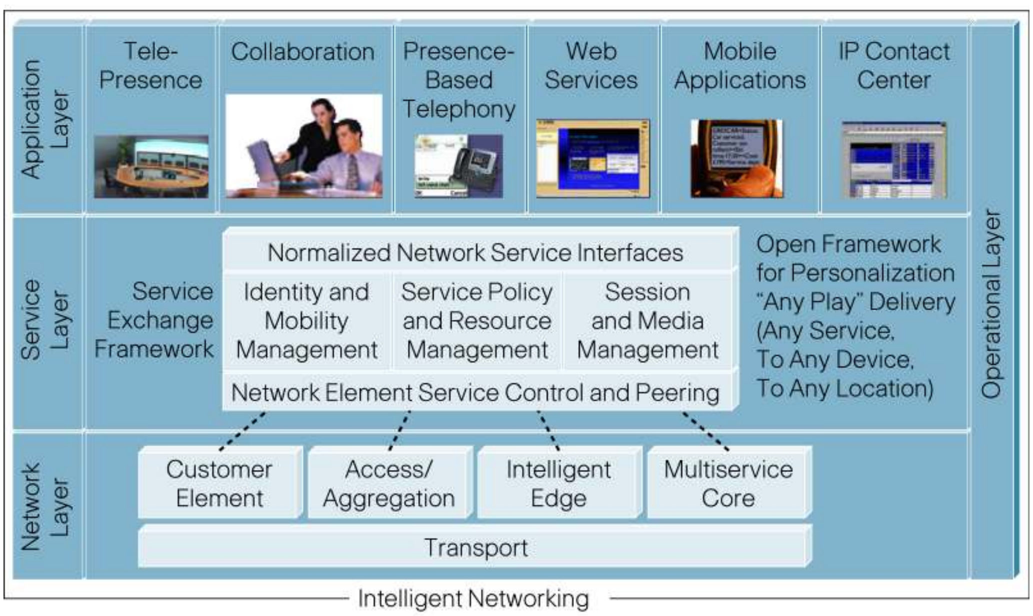
Figure 7. Incoming Phone Call Signaled on TV Screen

Cisco will initially not use IMS session control in its IPTV systems but will concentrate on making optimal use of common NGN components such as user profile databases accessed using standardized interfaces. The NGN transport stratum infrastructure will be adapted to efficiently support IPTV, and common interfaces to NGN applications will be supported to integrate NGN and IPTV user services. SIP session-control procedures may be integrated in the future if the IMS-based solution that is eventually standardized provides additional functional capabilities.

Cisco Service Exchange Framework

The initial integration of IPTV and communications services (both IMS and non IMS-based) is best accomplished with the service-enabling technologies of the Cisco Service Exchange Framework. The Service Exchange Framework is the layer tasked with mediation functions between users and applications within the Cisco IP NGN architecture, Figure 8. It allows service providers to separate and optimize application-specific traffic on a per-subscriber basis while adding mobility, presence, and a complete suite of subscriber-aware capabilities. The Service Exchange Framework enables IMS, non-IMS, and IPTV applications, using common network resource management and authentication mechanisms close to the network. It provides a range of interface options in the application layer, including IMS-compliant interfaces (such as Gq'), Web services, and more. The Service Exchange Framework supports IMS/TISPAN specifications for functions equivalent to the Resource Admission Control Subsystem (RACS), Network Attachment Subsystem (NASS), and policy function of IMS/TISPAN specifications. It makes these functions available to IPTV services, core IMS functions, and other IP-based services.

Figure 8. Cisco Service Exchange Framework



The comprehensive Service Exchange Framework provides a variety of service-enabling and management technologies that are essential for the success of IPTV deployment, including:

- **Intelligent service and policy control**: Cisco Broadband Policy Manager provides universal subscriber access and automates policy-control operations with business rules to deliver services. This open platform smoothly integrates Cisco products with OSS/BSS and multi-vendor networks.

- **Quality of experience:** Cisco Integrated Video Admission Control in Cisco 7600 Series Routers maintains a high-quality end-user experience in oversubscribed networks by dynamically determining when networkwide resources can support a video session.
- **Ability to detect and manage authorized and unauthorized third-party video content:** With packet flow optimization technology from Cisco and application classification enabled by the Cisco Service Control Engine, service providers can offer multi-tiered, application- and subscriber-aware services.
- **Content virtualization**: The Cisco Content Engine provides intelligent content and asset distribution across access-independent networks.

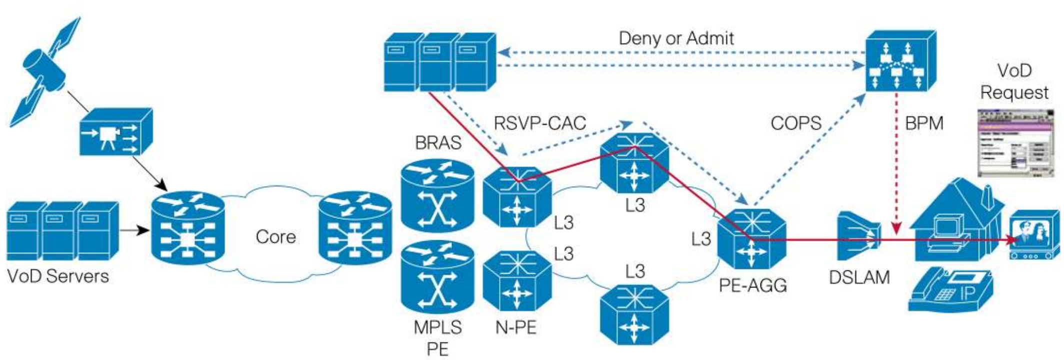
Cisco Integrated Video Admission Control

Protecting voice and video service from oversubscription by performing admission control for both on-demand and broadcast TV is an important capability that Cisco can provide to preserve a high quality of experience for subscribers.

The Cisco video admission control solution is able to take into account complex network topologies that have redundant and load-sharing paths in the transport network as well as access link utilization and business policies that may be enforcing other types of constraints on the subscriber's service. To do this, the network routers, in coordination with policy managers and on-demand servers, collectively perform an admission control function called Integrated Video Admission Control.

First, an in-path method performs admission control for the complex core and distribution network topologies found in service providers' next-generation network designs. The solution uses the Resource Reservation Protocol (RSVP) for in-path signaling, sent by the VoD server or a component on its behalf prior to starting the VoD session, Figure 9. Second, to prevent a video stream from being sent to a set-top box if the access link to a subscriber's home doesn't have enough capacity to carry the stream, the VoD server or a network component in the path mechanism will send a request to an off-path component, such as the Cisco Broadband Policy Manager (BPM), that is keeping track of the access network utilization.

Figure 9. Cisco VoD Integrated Video Admission Control with both Off-path and In-Path Functions



By coordinating with an STB, home access gateway, and other access equipment, the Cisco BPM can determine if the access link or home network has enough unused bandwidth and it can also check business policies that may or may not allow the stream to be supported.

Only using an off-path component, such as the Cisco BPM, to perform admission control for the core and distribution layers (where it is necessary to track any changes in the complex network topologies in real time) is a sub-optimal solution. The combination of both in-path admission control with an off-path policy server in the Cisco Integrated Video Admission Control solution is the most reliable and efficient way for an admission control solution to decide whether or not a new VoD stream should be allowed to reach a specific subscriber.

IPTV Architecture Evolution

Cisco is actively participating in a further integration of IMS and IPTV services through internal research and development and extensive involvement in the leading standards bodies. Cisco supports the TISPAN effort on development of an IPTV architecture and is helping to define requirements for network transport capabilities to support IPTV services. Additionally, Cisco is planning to make a SIP stack available on STBs to connect directly into the core IMS and appropriate application servers. Many hybrid TV scenarios are also in development as analog TV systems are disabled and subscribers in some countries are able to view digital off-air TV using DVB features. Other hybrid scenarios include TV reception on handsets using DVB-H specifications.

All of these approaches require a flexible IPTV architecture that can evolve to meet the needs of consumers, content developers, and device designers.

Conclusion

Service providers must expand their service offerings to include IPTV, along with integrated data, voice, and mobility services, to counter declining traditional voice revenues and compete with other types of providers. As standards bodies define architectures for converged, quad-play networks, IMS is evolving toward a leading solution for creation and management of many session-based services. IPTV, along with many other applications, is not session-based and has unique characteristics that are not yet addressed by IMS standards. The Cisco Service Exchange Framework, the service creation and management layer of the Cisco IP NGN, addresses both IMS and non-IMS services, including IPTV, to give service providers the broadest range of options as they provide services today and tomorrow.

Unique features and intelligence within the architecture, technologies, and products of the Cisco Service Exchange Framework include subscriber and application awareness for efficient and scalable enforcement of policies and Integrated Video Admission Control for per-subscriber control of broadcast and VoD traffic. With its comprehensive IPTV solution, Cisco gives service providers the tools to deliver a high quality of experience to their subscribers. The result: greater customer loyalty and a platform for the introduction of other types of services that can be integrated into IPTV for greater subscriber differentiation and new sources of revenue.

For More Information

White Paper: "Supporting the IP Multimedia Subsystem for Mobile, Wireline, and Cable Providers": www.cisco.com/en/US/netsol/ns549/networking_solutions_white_paper0900aecd80395cb0.shtml

White Paper: "Intelligent Service Convergence with the Cisco IP Next-Generation Network Service Exchange Framework": www.cisco.com/en/US/netsol/ns549/networking_solutions_white_paper0900aecd80592c03.shtml

White Paper: "Delivering Video Quality in Your IPTV Deployment" IP NGN solutions for wireline carriers: www.cisco.com/en/US/netsol/ns610/networking_solutions_white_paper0900aecd8057f290.shtml

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