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PACKETCABLE™ 2.0 AND TISPAN – CONVERGING ON IMS FOR A COMMON QOS ENABLED APPLICATION CORE

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The Next-Generation Network Goal

Next-Generation Networks (NGN) are envisioned as enabling a common set of applications to be delivered to subscribers with the requisite quality of service (QoS) in an on-demand environment, across any access architecture to any device.

A number of organizations are defining NGN standards for the various access architectures including cable, wireless and wireline. CableLabs® is defining the PacketCable 2.0 standard for the cable architecture, for the wireless architecture it is the 3GPP IP Multimedia Subsytem (IMS) and for the wireline architecture it is the ETSI TISPAN.

All of these architectures use a layered network approach that separates service logic from the transport. The three layers that are typically referenced are the application, control and transport layers. This layered approach enables applications to be created independent of network technology, leveraging a unified control layer to mediate between applications and underlying transport technology.

The ultimate goal of the access architectures is to create a converged environment that enables the same applications to be seamlessly accessed by both fixed and mobile users – the fixed/mobile convergence (FMC) vision.

By creating a universal control layer, the creation and deployment of applications is greatly simplified and time and cost are reduced. The control layer is able to abstract complex network functions into simplified application requests that can be executed on-demand to dynamically condition the network based on the per session application requirements. The diagram below (see Figure 1) outlines the evolution of the network from a "stovepiped" architecture where each service is vertically integrated to a fully horizontal architecture where applications leverage common resources for successful delivery.

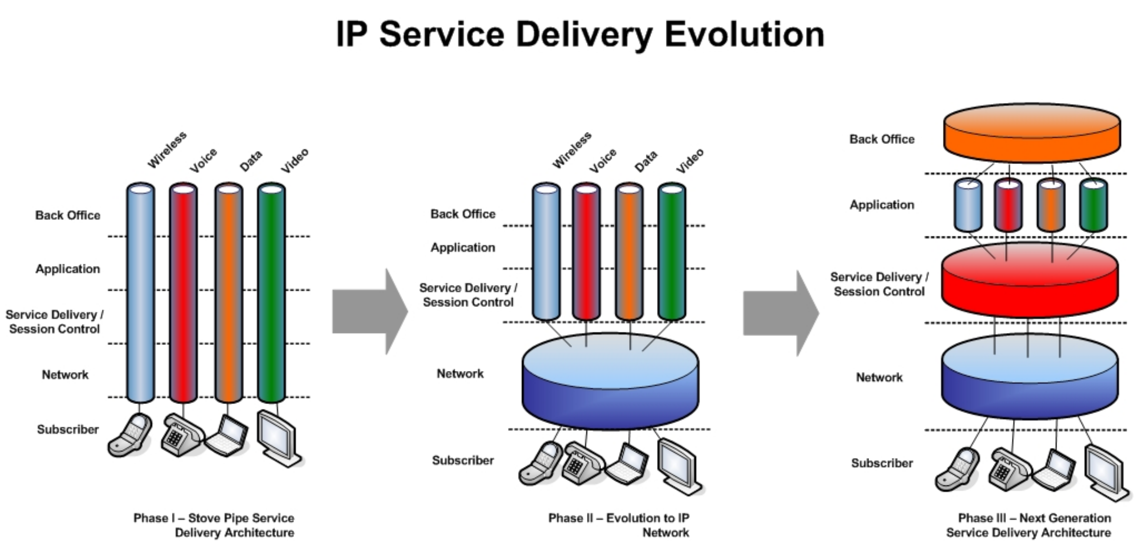

Figure 1: NGN Architecture Evolution

The one area where true convergence is occurring today is in the area of SIP-based service delivery. All three of these architectures (IMS, PacketCable 2.0, TISPAN) have standardized on what is being referred to as the "IMS core". What this means is that the service layer for SIP-based services will become universal across cable, wireless and wireline network architectures.

This is the first step towards a true FMC environment that enables a common set of services to be delivered across any access architecture, to any device.

The Application Layer

The application layer is responsible for handling the initial application request and maintaining state of the application session. Within IMS, the applications are all SIP-based voice, video and multimedia sessions. This approach has enabled IMS to create a converged application layer that provides universal support for SIP-based applications.

More over, IMS has made provisions to enable legacy voice services to be converted into SIP-based IMS services through the use of application servers and other components that mediate between the legacy circuit-switched world and the SIP-based packet-switched world.

The IMS approach, with its well defined interfaces and signaling path, can also be leveraged to support other non-SIP applications such Web 2.0 and IPTV services. However, these are currently outside the scope of existing standards and, therefore, are not a focal point for this paper.

The Control Layer

The control layer is responsible for handling session requests from the application layer (and transport layer in some cases) and negotiating for bearer resources or bandwidth on the transport layer in order to support the requested application session.

The control layer is primarily concerned with bandwidth and quality of service (QoS) characteristics for the session. However, another major component of the control layer is charging, whether it is simply accounting for sessions or dynamically managing the charging parameters of sessions with variable billing characteristics.

In addition, the control layer must be able to communicate with subscriber repositories to gain insight into service profile information in order to validate or authorize a subscriber’s session request.

Standards architectures are converging on control layers that provide bearer control, session security and session accounting/charging capabilities. The control layer is the next component of the NGN architecture that needs to converge in order to enable seamless mobility of services and subscribers.

The Transport Layer

The transport layer is unique to each to access architecture – cable, wireless, and wireline. The transport layer is responsible for providing bearer resources to facilitate application sessions. The transport layer is currently being tightly integrated with the control layer via well defined interfaces and function commands to provide per session resource guarantees and fine grain accounting of sessions.

With the increased demands for QoS-enabled sessions to support rich-media applications, the transport layer has become a critical component in the service delivery equation. The transport layer is also, however, the point of contention. Since there are often times when requests for bearer resources outweigh available bearer resources, the dynamic interaction between the control and transport layer is becoming increasingly important.

The End Game – Fixed/Mobile Convergence

The ultimate goal for the NGN architecture is to enable subscriber and application mobility. The concept is to create a network architecture that will support the delivery of any application, to any device, over any network at any time.

In order to accomplish this, the application and control layers must become universal across all access architectures. This will enable applications to be created once, communicate with a common control layer and not have to have any knowledge of the underlying transport architecture.

The control layer will mediate between the application layer, receiving the session request and negotiating for bearer resources with the transport layer, as well as define the charging rules for the session. When all is accepted, it will signal to the application layer to proceed with the session, or if the session cannot be supported by the transport network, signal to the application layer to reject the session.

With a unified set of applications communicating with a unified control layer, the ability to deliver a common set of applications to a highly mobile subscriber base across any access architecture will finally be realized.

This paper will look at how PacketCable 2.0 and TISPAN are leveraging IMS to deliver QoS-assured, SIP-based services over an IP network. This is the first step towards a true FMC capable service delivery environment.

The IP Multimedia Sub-system

The IMS architecture was defined by 3GPP for the delivery of real-time voice, video and multimedia services using Session Initiated Protocol (SIP) signaling over packet-switched networks with a focus on mobile wireless access networks. However, as other standards organizations began to evaluate how they would either introduce or migrate traditional voice services onto an IP architecture, the IMS became a common focal point.

This led many organizations including CableLabs and ETSI to work with 3GPP to ensure that future releases of the IMS specifications accommodated the unique requirements of the cable and wireline access networks, in addition to the wireless environment.

The "Core IMS" Foundation

As a result of the interest and participation of external standards bodies in the IMS specification, 3GPP ultimately created what is referred to as the "Common IMS". The common IMS consists of the "Core IMS" plus select additional IMS-related interfaces and functional entities to support the interconnection of the core IMS with other leading standards and access architectures.

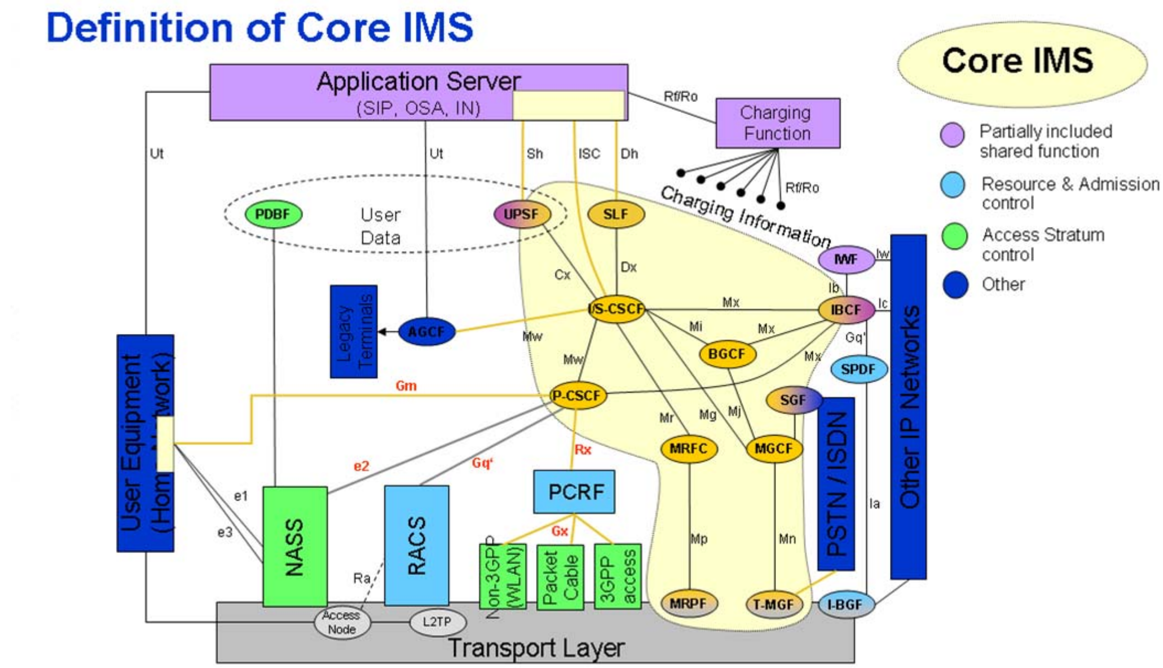

Figure 2: Common IMS Architecture

The critical components within the core IMS are:

Call Session Control Functions (CSCF) – the Interrogating, Proxy and Serving (I/P/S) CSCFs provide SIP message handling, address management, security associations, call routing and many other critical functions for successful session processing

Media Processing Resources – the Media Resource Function Controller (MRFC) converts SIP messages requesting media resources into H.248 for controlling the Multimedia Resource Function Processor (MRFP). Collectively the MRCF and MRFP source, mix, transcode and provide other types of media processing capabilities in the IMS architecture.

Breakout Gateway Control Function (BGCF) – the BGCF is responsible for routing calls to a circuit-switched networks (i.e. the PSTN). It determines the routing based on information in the SIP INVITE, administrative information, and/or routing databases such as ENUM.

Subscriber Location Function (SLF) – the SLF is a simple database that maps subscribers to an HSS. Small networks with a single HSS do not require a SLF. Networks with two or more HSSs require SLF to map subscribers to an HSS.

The core IMS also leverages a set of standardized, external interfaces, which in turn define the common IMS. Some of the critical interfaces connect to:

Policy and Charging Rules Function (PCRF) – the PCRF is responsible for policy, charging control and event reporting for service data flows. It receives service level policy requests from the P-CSCF (Rx Interface) and translates them into IP QoS parameters (Gx interface) for the Policy Enforcement Function (PEF) in the Gateway GPRS Support Node (GGSN).

User Profile Server Function (UPSF) – the UPSF is a database that contains user information and is very similar to the HSS. The UPSF still includes the IMS configuration and user authentication data.

Resource and Admission Control Subsystem (RACS) – the RACS provides a generic set of QoS services (gate control, policy enforcement, and admission control) for access and interconnected networks. It also includes support for Border Gateway Services including NAT. It can support both session-based and non-session-based applications.

Network Attachment Subsystem – the NASS provides UE initialization and access registration by providing subscriber authentication, IP address management and IP address to geographic location functions.

The core IMS essentially creates a converged SIP-based application control framework that enables universal access to a common set of service capabilities for all access network architectures. This in turn enhances the business case for multi-network operators investing in a core IMS framework. By accelerating the timeline to FMC, the subscriber population for application consumption is greatly expanded and, therefore, the revenue potential of a single application for an operator is expanded as well.

Leveraging "Common IMS" within PacketCable 2.0 and ETSI TISPAN

The core IMS provides the foundation for extending the delivery of SIP-based voice and multimedia services to other access networks. This is the direct result of the joint effort between 3GPP, CableLabs and ETSI TISPAN to extend IMS to all access networks. The common IMS architecture defines interfaces and functionality for cable and fixed line access networks to interconnect with the core IMS to leverage the same SIP applications across any network access architecture.

By creating a well-defined framework for interconnection and interworking between these entities and the access networks, they represent the baseline for the converged application layer that is created. The next step in the process is to unite the application layer with a unified control layer that can then mediate the application requests onto the various transport networks in real-time.

The interconnection point between the IMS and each of these access network architectures is the control layer. Each of these standards-based architectures (IMS, PacketCable, TISPAN) has defined a policy-driven control layer that enables the IMS to intelligently request network resources (bandwidth and QoS characteristics) on a per-session basis. Moreover, this control layer also provides per-session accounting and can be used to define charging characteristics for the session.

To accomplish this, the control layer provides subscriber, application and network awareness. This enables the control layer to understand who the subscriber is, what they are entitled to, what network resources are required by the application and what resources are available from the network at that given time.

The ability to dynamically evaluate and accept or deny application requests in an automated manner increases the efficiency of network resource utilization and ensures that network resources are not over extended. It also ensures that subscribers and other entities cannot take advantage of the network to provide increased quality of service without proper authorization and charging when applicable.

The ability of the control layer to understand the capabilities of the underlying transport layer has led both CableLabs and ETSI to define architectures that leverage a policy-driven control layer.

Each of these architectures provides interfaces from the control layer to the core IMS as well as to the transport equipment with which the control layer will need to communicate.

The next sections will discuss how CableLabs PacketCable 2.0 and ETSI TISPAN are leveraging control layers to mediate between core IMS and the underlying transport networks to ensure per-session quality of service, security and accounting.

PacketCable 2.0

PacketCable 2.0 is an architecture defined by CableLabs for the delivery of real-time voice, video and multimedia services using SIP and other standards-based protocols to initiate and control service delivery over packet-switched networks for cable access networks.

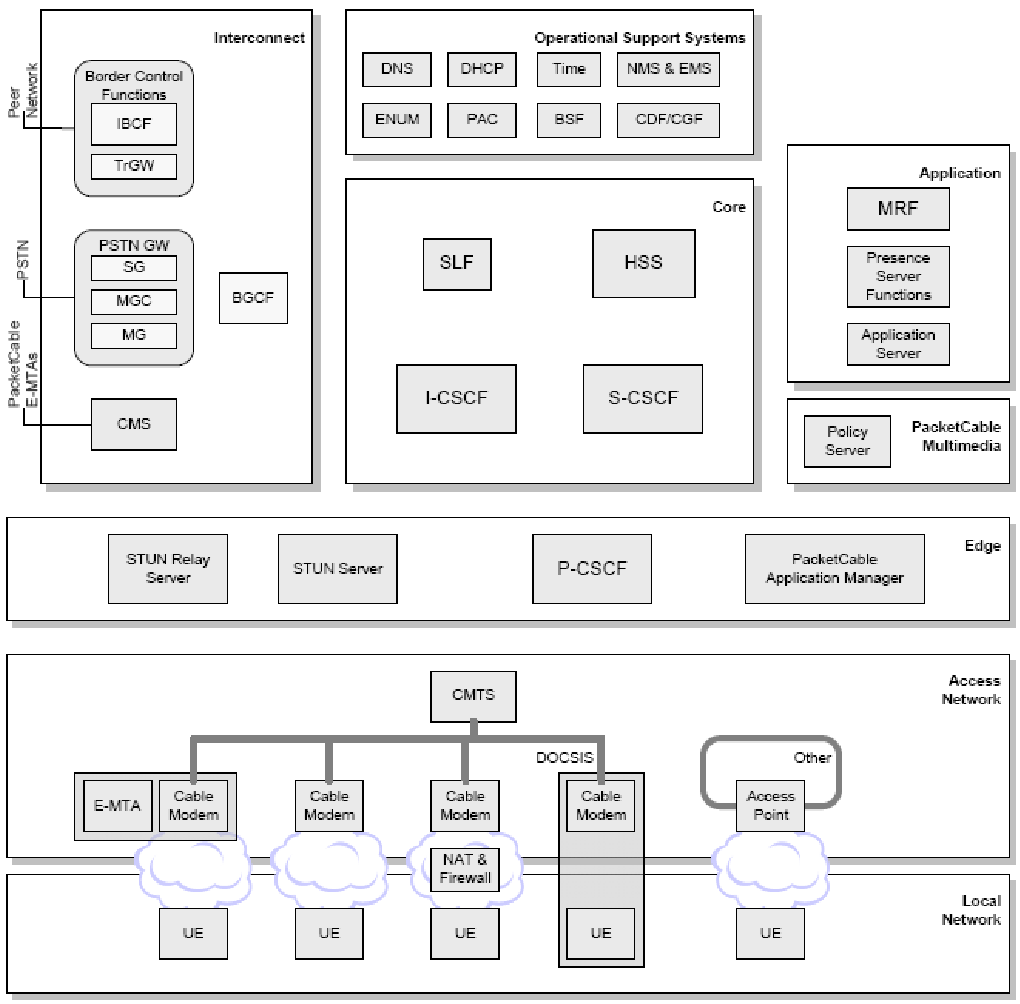

Figure 3: PacketCable 2.0 Architecture

Within PacketCable 2.0, it is the PacketCable Multimedia (PCMM) component that contains the Policy Server (PS). The PS acts as an intermediary between Application Manager(s) and CMTS(s) for QoS session management – the control layer.

The PS is the interconnection point for the IMS. In this context, the Proxy Call Session Control Function (P-CSCF) acts as an Application Manager (AM), signaling the PS for per-session admission control decisions based on subscriber entitlements and available network resources.

Delivering SIP-based voice services with PacketCable 2.0

By leveraging the PS as the interconnection between the core IMS application framework and the PacketCable 2.0 access network, CableLabs is able to deliver SIP-based voice, video and multimedia applications with existing DOCSIS® (Data over Cable Service Interface Specification-based transport networks.

This enables cable operators to maintain all of the existing QoS, subscriber and network security and accounting capabilities, while delivering next-generation SIP-based services to subscribers. This also simplifies the evolution to FMC for cable operators who choose to integrate existing DOCSIS access network assets with future wireless network assets.

Integrating PacketCable 2.0 Control layer with the “IMS Core”

With PacketCable 2.0, CableLabs has integrated some of the native IMS interfaces into its architecture, namely the Rx interface. The Rx interface is the interconnection point between the IMS application framework and the PCMM control layer.

The interface interconnects the P-CSCF and the PacketCable Application Manager (PAM), which typically will reside within the PS for IMS-based applications, effectively creating the PCRF as defined within the IMS architecture.

The Rx interface enables IMS applications to request admission control decisions on a per-session basis based on established business and network level policies. These policies typically review the subscriber’s entitlements as well as the available network resources. If the request is within the defined parameters, the session will be accepted and the call will proceed. The PS will reserve the required resources on the CMTS and the IMS will process the session request. If one or more of the policies is outside of the allowed parameters, the session will be rejected and the IMS will be instructed to terminate the session.

By integrating the PacketCable 2.0 control layer with the IMS core, CableLabs is enabling cable operators to accelerate the introduction of SIP-based services via existing infrastructure. This extends the lifecycle of the existing DOCSIS plant, while allowing cable operators to offer compelling next-generation services to subscribers.

The PacketCable 2.0 Transport Architecture

The DOCSIS access architecture is designed to enable per-session bearer reservations or gate sets. This ability is becoming increasingly important as more quality sensitive services migrate to the packet network.

The two critical components in this transport architecture are the Cable Modem Termination System (CMTS) and Cable Modem (CM). This combination provides enhanced security and the ability to define per-flow session characteristics.

When paired with the PS, this robust access architecture is able to dynamically respond to application requests and evaluate the availability of resources in order to accommodate the application request. This enables latency sensitive and bandwidth intensive applications to be provided with assured resources when available, or rejected when not available. The result is an enhanced subscriber experience and optimized utilization of network resources.

TISPAN

TISPAN Release 1 is an architecture defined by ETSI for the delivery of real-time voice, video and multimedia services using SIP and other standards-based protocols to initiate and control service delivery over packet-switched networks with a focus on wireline access networks.

Within the TISPAN architecture, it is the Resource and Admission Control Subsystem (RACS) that provides the Service Policy Decision Function and the Access-Resource Admission Control Function (A-RACF).

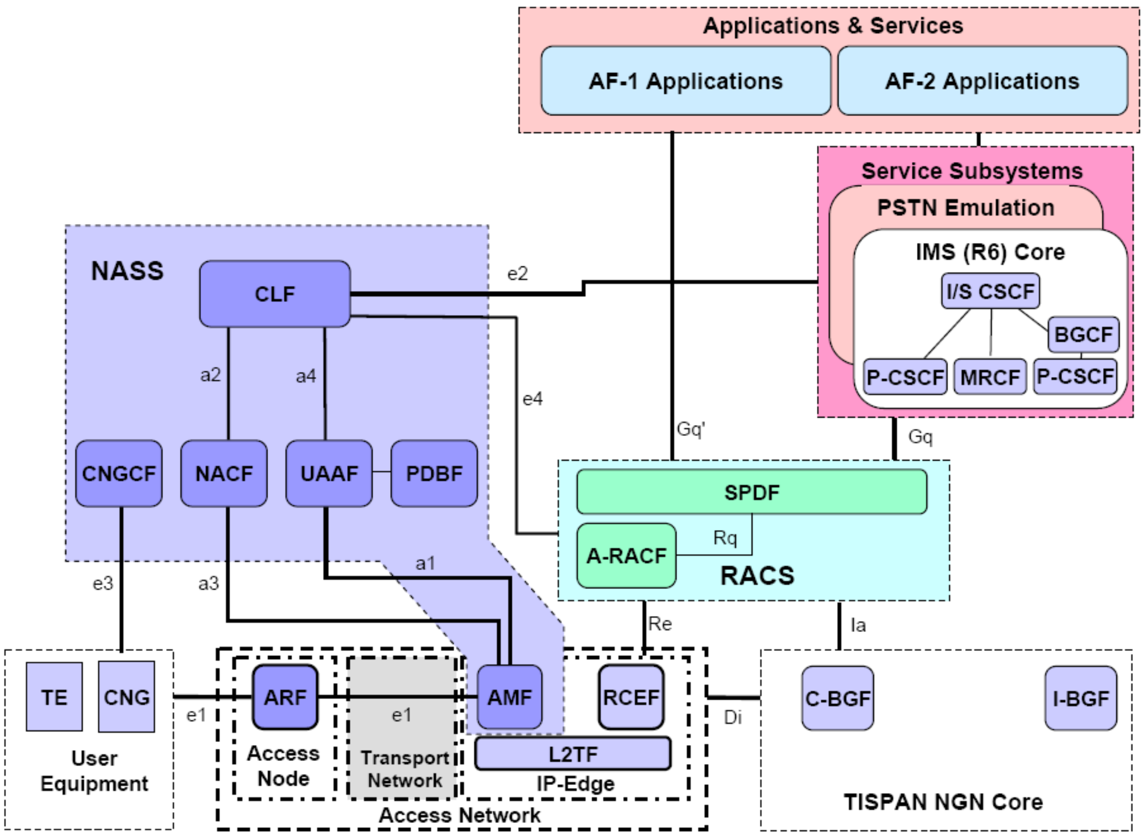

Figure 4: TISPAN Architecture

Delivering SIP-based voice services with TISPAN

By leveraging the RACS as the interconnection between the core IMS application framework and the TISPAN access network, ETSI is able to leverage SIP-based voice, video and multimedia applications with existing xDSL or Fiber based transport networks.

This enables wireline operators to maintain all of the existing QoS, subscriber and network security and accounting capabilities, while delivering next-generation SIP-based services to subscribers. This also simplifies the evolution to FMC for fixed-line operators who choose to integrate existing xDSL or fiber-based access network assets with future wireless network assets.

Integrating TISPAN Control layer with the "IMS Core"

With TISPAN, ETSI has integrated some of the native IMS interfaces into its architecture, namely the Gq' interface. The Gq' interface is the interconnection point between the IMS application framework and the RACS control layer.

The interface interconnects the P-CSCF and the RACS, which provides effectively the same capabilities as the PCRF as defined within the IMS architecture.

The Gq' interface enables IMS applications to request admission control decisions on a per-session basis based on established business and network level policies. These policies typically review the subscriber's entitlements as well as the available network resources. If the request is within the defined parameters, the session will be accepted and the call will proceed. The RACS will reserve the required resources on the Policy Control Enforcement Point (PCEF) and the IMS will process the session request. If one or more of the policies is outside of the allowed parameters the session will be rejected and the IMS will be instructed to terminate the session.

By integrating the TISPAN control layer with the IMS core, ETSI is enabling wireline operators to accelerate the introduction of SIP-based services via existing access infrastructure. This extends the lifecycle of the existing xDSL and fiber plant, while allowing fixed line operators to offer compelling next-generation services to subscribers.

The TISPAN Transport Architecture

The TISPAN access architecture is designed to enable per-session bearer reservations or gate sets. This ability is becoming increasingly important as more quality-sensitive services migrate to the packet network.

The two critical components in this transport architecture are the IP Edge device, which is typically a Broadband Remote Access Server (BRAS) and the Access Node, which is typically a Digital Subscriber Line Access Multiplexer (DSLAM). This combination provides enhanced security and the ability to define per-flow characteristics.

When paired with the RACS, this robust access architecture is able to dynamically respond to application requests and evaluate the availability of resources in order to accommodate the application request .This enables latency sensitive and bandwidth intensive applications to be provided with assured resources when available, or rejected when not available. The result is an enhanced subscriber experience and optimized utilization of network resources.

Summary

The core IMS is simplifying the process of delivering quality-assured, rich-media services over a packet-based network. For this reason CableLabs and ETSI have adopted the core IMS as the service delivery subsystem for SIP-based voice, video and multimedia services.

By engaging in the development of the common IMS, 3GPP, CableLabs, ETSI and all other participants are accelerating the path to true application mobility, or FMC. While each of these access architectures has provisions for non-IMS services, the common denominator has become the core IMS and SIP-based services.

Each standards body has defined a control layer that bridges the gap between the application and transport layers. This critical component provides per-session resource reservations, QoS, security, charging and accounting capabilities. As application mobility becomes a reality, the role of this control layer will grow and become paramount to service delivery success. It is the control layer that enables operators to harmonize transport architectures to enable successful service delivery and a common application experience for subscribers across all transport architectures.

On the road to FMC, the control layer is the next focal point for convergence. This intelligent command and control layer provides the intelligence to understand what type of network the subscriber is attached to, what the capabilities of the network are, what the subscriber is entitled to and what charging/billing arrangements are required for the session. Without this level of real-time intelligence in the network, applications would be forced to be built per access network and the goal of FMC would be lost.

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About the Author

Richard Cardone is responsible for executing Camiant's marketing vision. As vice president, marketing programs, Mr. Cardone is responsible for delivering Camiant's marketing message and working with customers and business partners to advance the market.

Richard Cardone brings to Camiant more than 16 years of marketing and business development experience with leading telecommunications, networking and video technology companies. Mr. Cardone joined Camiant in 2008 from Acme Packet where he was responsible for product marketing. Prior to Acme Packet he was the Director of Marketing at TAZZ Networks. As an early team member at TAZZ, he spent six years evangelizing next-generation service delivery solutions that bring intelligent controls and predictable performance to IP networks.

Mr. Cardone worked with leading service providers, network equipment vendors, and standards bodies to understand their market requirements and help shape their vision of next-generation network services. Mr. Cardone has held positions in marketing and business development at HydraWeb Technologies, Promptus Communications, PictureTel and Nynex.

Mr. Cardone holds a Master's of Business Administration and a Bachelor of Science in Engineering from Northeastern University.

Abbreviations and Acronyms

3GPP	3^{rd} Generation Partnership Project
AGCF	Analog Gateway Control Function
AM	Application Manager
AMF	Access Management Function
A-RACF	Access-Resource Admission Control Function
ARF	Access Relay Function
BGCF	Breakout Gateway Control Function
BGF	Border Gateway Function
BRAS	Broadband Remote Access Server
BSF	Bootstrapping Server Function
C-BGF	Core Border Gateway Function
CDF	Charging Data Function
CGF	Charging Gateway Function
CLF	Connectivity Session Location and Repository Function
CM	Cable Modem
CMS	Call Management Server
CMTS	Cable Modem Termination System
CNG	Customer Network Gateway
CNGCF	CNG Configuration Function
CSCF	Call Session Control Function
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
DOCSIS	Data over Cable Service Interface Specification

DSLAM	Digital Subscriber Line Access Multiplexer
EMS	Element Management System
EMTA	Embedded Multimedia Terminal Adaptor
ENUM	Electronic Number Mapping
ETSI	European Telecommunications Standards Institute
FMC	Fixed Mobile Convergence
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio Service
GSM	Global System for Mobile
GW	Gateway
HFC	Hybrid Fiber Coax
HLR	Home Location Register
HSS	Home Subscriber Server
IBCF	Interconnect Border Control Function
IBGF	Interconnect Border Gateway Function
I-CSCF	Interrogating Call Session Control Function
IMS	IP Multimedia Subsystem
IP-CAN	IP Connectivity Access Network
IPTV	Internet Protocol Television
IWF	Inter-working Function
L2TF	Layer 2 Termination Function
L2TP	Layer 2 Tunneling Protocol
LRF	Location Retrieval Function
MG	Media Gateway
MGC	Media Gateway Controller
MGCF	Media Gateway Control Function
MMTEL	IMS Multimedia Telephony Service
MRF	Multimedia Resource Function
MRFC	Multimedia Resource Function Controller
MRFP	Multimedia Resource Function Processor
NACF	Network Access Configuration Function
NASS	Network Attachment Subsystem
NGN	Next-Generation Network
NMS	Network Management System
OMA	Open Mobile Alliance
OSA	Open Service Access
OSS	Operational Support System
PAC	Provisioning, Activation and Configuration
PAM	PacketCable Application Manager
PCMM	PacketCable Multimedia
PCRF	Policy and Charging Rules Function
P-CSCF	Proxy Call Session Control Function
PDBF	Profile Database Function
PDP	Policy Decision Point
PEF	Policy Enforcement Function
PES	PSTN/ISDN Emulation Sub-system
PS	Policy Server
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RACS	Resource and Admission Control Subsystem
RAN	Radio Access Network
RCEF	Resource Control Enforcement Function
S-CSCF	Serving Call Session Control Function
SG	Signaling Gateway
SGF	Signaling Gateway Function
SGSN	Serving GPRS Support Node

SIP	Session Initiation Protocol
SLF	Subscriber Locator Function
SPDF	Service Policy Decision Function
TE	Terminal Equipment
TISPAN	Telecoms & Internet converged Services & Protocols for Advanced Networks
T-MGF	Trunking Media Gateway Function
TrGW	Translation Gateway
UAAF	User Access Authorization Function
UE	User Equipment
UPSF	User Profile Server Function
xDSL	any variant of the Digital Subscriber Line technology (i.e. ADSL, VDSL, etc.)