Alcatel·Lucent

TECHNOLOGY WHITE PAPER

Alcatel-Lucent Evolved Packet Core Solution:

Delivering technical innovation for the new LTE mobile core

This white paper provides an overview of Alcatel-Lucent's perspective on Evolved Packet Core and how Alcatel-Lucent is addressing radically new requirements imposed on data and control planes in LTE. With unprecedented amounts of bandwidth to be unleashed in the data plane for new services, LTE-focused architecture is needed to ensure end-to-end QoS, reliability and scalability, as well as to provide service awareness of data flows with per-service, per-subscriber, per-application QoS. Alcatel-Lucent's EPC solution is delivered through high-performance, purpose-built service-aware platforms that bring forward Alcatel-Lucent's vast experience and leadership in key areas of service-aware IP/MPLS routing, dynamic mobility management and dynamic policy management

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1. Executive summary

The Evolved Packet Core (EPC) is an integral part of Alcatel-Lucent's end-to-end Long Term Evolution (LTE) solution. Alcatel-Lucent envisages the EPC as the cornerstone of full and complete IP transformation in mobile networks and a key enabler of the evolved wireless broadband.

EPC is a new, all-IP mobile core network for the LTE, and a converged framework for packet-based real-time and non-real-time services. It is specified by 3GPP Release 8 standards (Q1 2009).

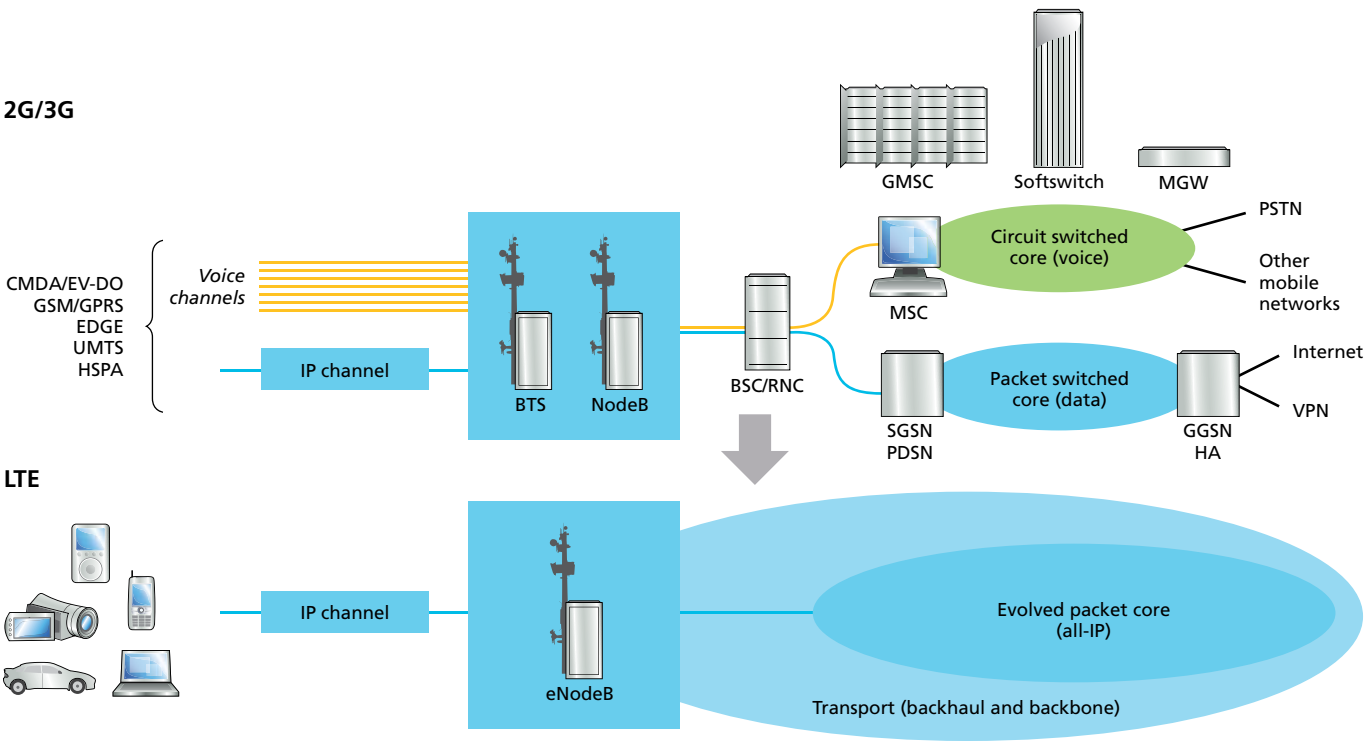
The EPC provides mobile core functionality that, in previous mobile generations (2G, 3G), has been realized through two separate sub-domains: circuit-switched (CS) for voice and packet-switched (PS) for data. As shown in Figure 1, in LTE, these two distinct mobile core sub-domains, used for separate processing and switching of mobile voice and data, are unified as a single IP domain. LTE is all-IP, end-to-end: from mobile handsets and other user end (UE) terminal devices with embedded IP capabilities, over IP-based Evolved NodeBs (LTE base stations), across the EPC and throughout the application domain (IMS and non-IMS).

EPC is essential for end-to-end IP service delivery across the LTE. As well, it is instrumental in allowing the introduction of new business models, such as partnering/revenue sharing with third-party content and application providers. EPC promotes the introduction of new innovative services and the enablement of new applications.

EPC IN THREE POINTS

- Evolved Packet Core is a new mobile core for LTE – all-IP, end-to-end
- EPC must address a radically new set of network requirements to deliver true wireless broadband Quality of Experience (QoE)
- EPC must enable new business models and rapid introduction of new services

Figure 1. LTE: Evolution from separate CS and PS core sub-domains (3GPP case shown) to one common IP core



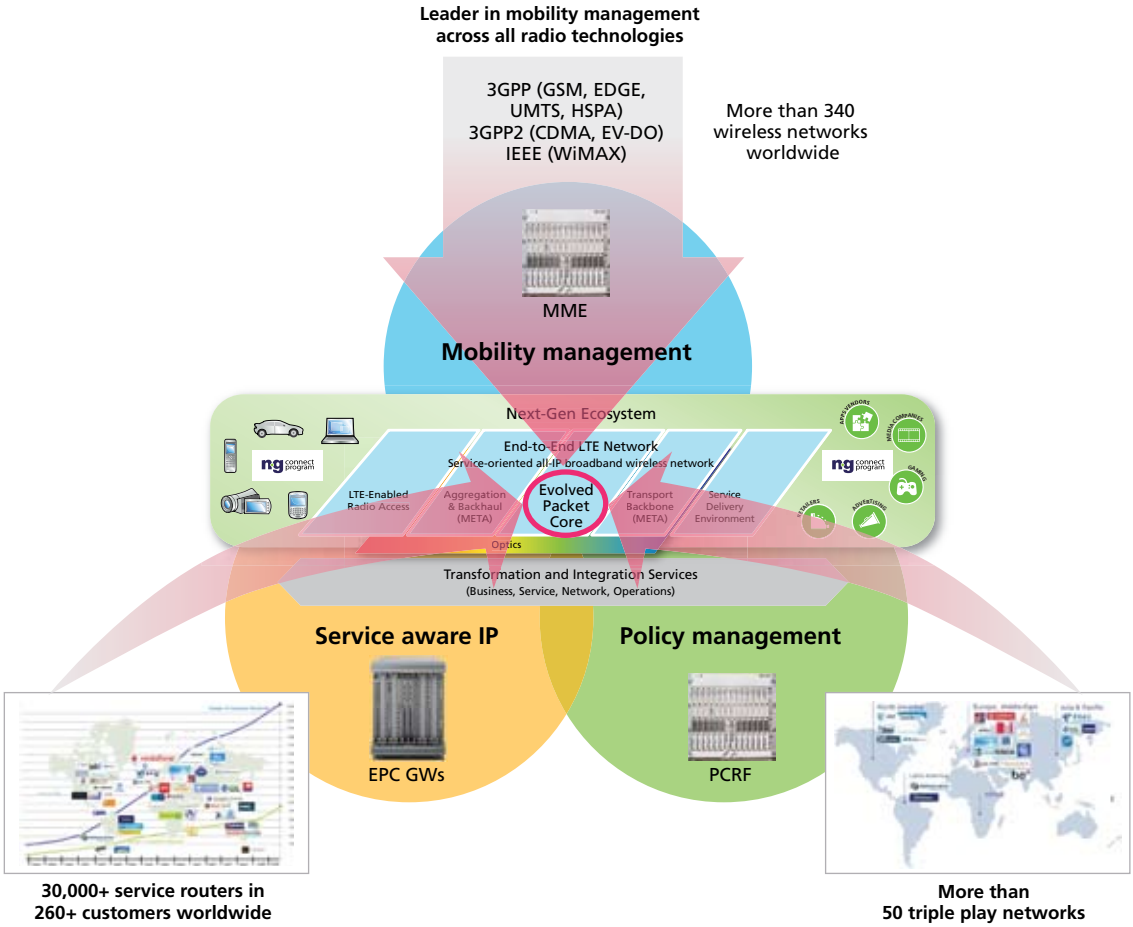
2. Alcatel-Lucent's EPC solution

The Alcatel-Lucent EPC solution is purpose-built service-aware EPC, developed in-house and optimized for the future of mobile broadband. It is based on Alcatel-Lucent's:

- Technical leadership in IP/MPLS and service routing (service-aware IP)
- Broad and long expertise in mobility management across all wireless technologies (3GPP, 3GPP2, IEEE)
- Expertise and a proven track record in large-scale, real-time dynamic policy management

These three key areas of Alcatel-Lucent's expertise and leadership are graphically represented in Figure 2.

Figure 2. Alcatel-Lucent's areas of expertise in delivering high-performance EPC



Alcatel-Lucent views the introduction of the EPC as a fundamental shift in mobile networks towards all-IP wireless broadband; a new core that is a foundation for wireless broadband for years to come. Alcatel-Lucent reduces the overall cost of LTE with forward-looking product architectures that minimize hardware upgrades. At the same time, its EPC solution has the capability to unleash new business models by allowing integration with third-party content providers, allowing managed and secure network openness (presence of new devices and applications), and rapidly enabling and activating new services.

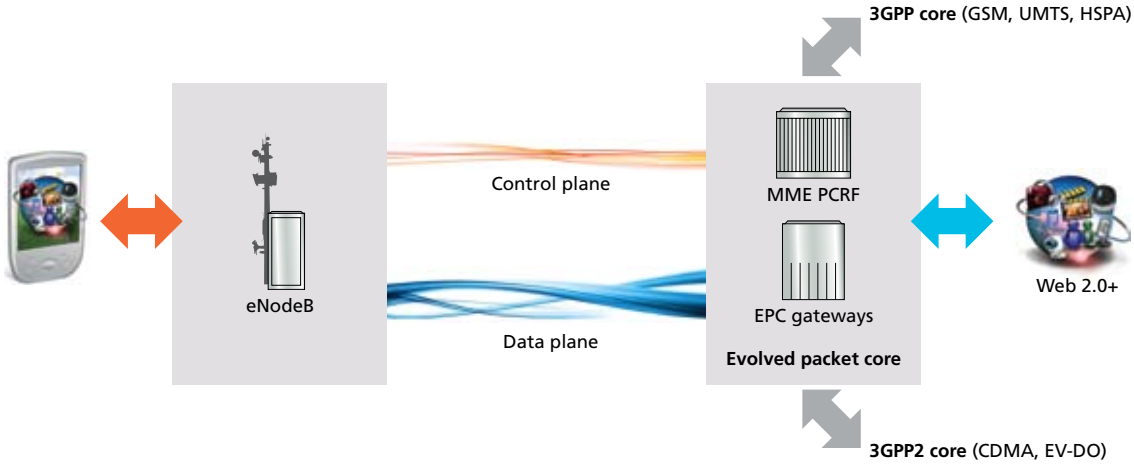
2.1 Different network requirements for data and control plane in LTE

While LTE introduces a clear delination of the data (user) plane and a control plane, it also imposes two sets of distinct technical requirements on the data plane and control plane:

- *Data plane* – needs to address requirements for high bandwidth, high availability and scalability, with aggregate throughput (per gateway) easily reaching over 100 Gb/s. At the same time, the data plane needs to allow unaffected wirespeed performance with sophisticated processing of millions of service data flows and data bearers turned on, while being able to provide sophisticated, fine-granular (per-application, per-service, per-user) QoS.
- *Control plane* – needs to address the requirements for high scalability and high availability of secure mobility and connection management, along with highly reliable and scalable network-wide policy and subscriber management.

Figure 3 shows how the distinct LTE requirements for data and control planes are addressed.

Figure 3. Addressing distinct LTE requirements for data and control planes



2.2 Alcatel-Lucent's approach to EPC

Alcatel-Lucent is addressing different technical requirements imposed on the data (user) and control planes in EPC/LTE with network elements that are purpose-built and optimized to perform dedicated data and control plane functions:

- EPC gateways are delivered through an in-house, proven and leading service-aware IP/MPLS routing platform with advanced QoS processing.
- EPC control plane functions are realized through dedicated mobility and policy management elements based on in-house ATCA platform.

Figure 4 shows the purpose-built elements of the EPC.

Figure 4. Alcatel-Lucent EPC: Purpose-built elements

Serving Gateway
Packet Data Network (PDN) Gateway
EPC gateways based on 7750 Service Router

- **Serving gateway**: serves a large number of eNodeBs, with focus on highly scalable and secure data connectivity
- **PDN gateway**: responsible for IP management ("IP anchor") and connection to external data networks; focus on highly scalable data connectivity and QoS enforcement

Mobility Management Entity
Policy and Charging Rules Function
MME and PCRF based on in-house ATCA platform

- **MME**: control-plane element responsible for high volume mobility management and connection management; managing thousands of eNodeBs
- **PCRF performs network control of flows**: detection, gating, QoS and flow-based charging, authorizes networkwide use of QoS resources (manages millions on service data flows)

All Alcatel-Lucent EPC components are forward-looking, purpose-built elements, developed in-house and optimized for the future of wireless broadband.

2.3 EPC Gateways: Serving Gateway and Packet data Network (PDN) Gateway

With the addition of a Mobile Gateway Integrated Services Module (MG-ISM), Alcatel-Lucent is elevating its advanced and successful 7750 Service Router into an EPC gateway, building upon its leadership in the areas of Service IP Routing. Alcatel-Lucent 7750 SR is a massively scalable service-aware IP routing platform, already proven across multiple segments (business VPNs, triple play, mobile backbone and backhaul). Figure 5 shows the EPC data plane elements that make up the EPC gateway.

Figure 5. Alcatel-Lucent EPC data plane elements: EPC gateways

7750 SR | MG-ISM (Mobile Gateway Integrated Services Module) | EPC (S/P) Gateway

Service Awareness on the 7750 SR is instrumental to ensure the delivery of advanced QoS needed for the ultimate wireless broadband Quality of Experience (QoE). EPC gateways come with a full suite of IPv4/IPv6 functionality, along with integrated DPI capabilities.

The 7750 SR SGW is a data plane element whose primary function is to manage user-plane mobility and act as a demarcation point between the RAN and core networks. SGW maintains data paths between eNodeBs and the PDN Gateway (PGW). From a functional perspective, the SGW is the termination point of the packet data network interface towards E-UTRAN.

Like the 7750 SR SGW, the 7750 SR Packet Data Network Gateway (PDN GW) is the termination point of the packet data interface towards the Packet Data Network(s). As an anchor point for sessions towards the external Packet Data Networks, the PDN GW supports:

- Policy Enforcement features (applies operator-defined rules for resource allocation and usage)
- Packet filtering (for example, deep packet inspection for application type detection)
- Charging support (for example, per-URL charging)

2.4 Alcatel-Lucent Mobility and Policy Management

The Alcatel-Lucent MME is a purpose-built high-performance network element, designed and manufactured for carrier-grade reliability. It has redundant hardware architecture and high availability ensured with built-in self-healing fault monitoring and recovery capabilities, including in-service software upgrades.

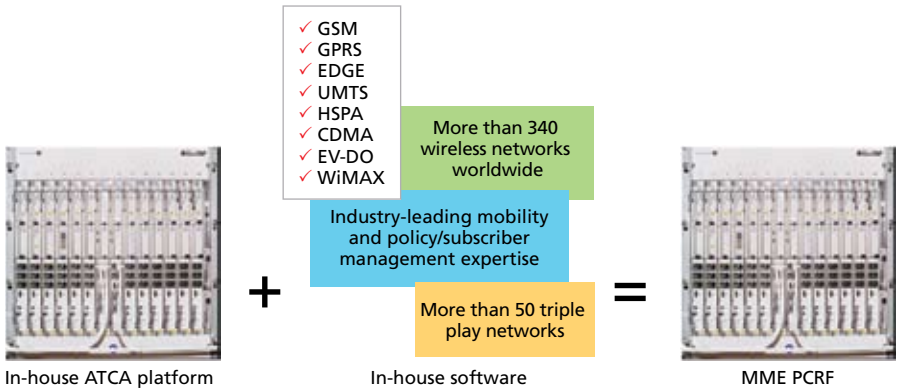
The Mobility Management Entity (MME) is a nodal element within the LTE EPC. It performs the signaling and control functions to manage the User Equipment (UE) access to network connections, the assignment of network resources and the management of the mobility states to support tracking, paging, roaming and handovers. MME controls all control plane functions related to subscriber and session management.

The Alcatel-Lucent PCRF is a carrier-grade, purpose-built policy management system, capable of dynamic scaling and high performance. It provides tight integration with EPC gateways and the MME, as well as with LTE/EPC network and service management platforms.

In the generic policy and charging control 3GPP model, the Policy and Charging Enforcement Function (PCEF) is the generic name for the functional entity that supports service data flow detection, policy enforcement and flow-based charging. The Application Function (AF) here represents the network element that supports applications that require dynamic policy and/or charging control. In the IMS model, the AF is implemented by the Proxy Call Session Control Function (P-CSCF).

Although based on the common ATCA hardware, MME and PCRF are realized as two separate elements. Figure 6 graphically represents the approach taken by Alcatel-Lucent when delivering these purpose-built control plane elements for LTE.

Figure 6. Alcatel-Lucent EPC control plane elements: MME and PCRF



3. Delivering technical innovation for LTE core: Alcatel-Lucent EPC

Alcatel-Lucent EPC solution brings significant innovation to EPC in these key areas:

- Service-aware IP routing with advanced end-to-end QoS capabilities
- Non-compromising scalability
- Secure and dynamic mobility and policy management
- Integrated end-to-end network and service management

3.1 Service-aware IP routing with advanced end-to-end QoS capabilities

Service Awareness, used in the context of IP routing, is the unique ability of Alcatel-Lucent's EPC gateways to analyze, understand and process LTE traffic (service data flows and bearers), without affecting the system's wirespeed performance. The advanced processing of traffic takes into consideration different traffic types and service requirements from the perspective of network flows (L1-L3), sessions and applications (L4-L7).

Advanced end-to-end QoS capabilities are achieved through advanced traffic management, with end-to-end visibility of all network resources. EPC gateways guarantee high performance and scalability with fine granularity of multiple service levels (QoS definitions) per-subscriber, or per traffic or application type. This ability to perform advanced QoS and traffic management on several levels is referred to as hierarchical QoS or H-QoS.

H-QoS provides additional control over network resources and optimizes bandwidth efficiency and service quality, while ensuring maximum isolation and fairness between various services and applications. H-QoS enables bandwidth allocation and management according to the bandwidth budget and/or priority of each base station type, individual traffic or service category (and potentially for individual applications used within a service category). For example, voice traffic can be granted the highest priority, followed by video services, and finally high-speed Internet traffic (with various quality grades for specific Internet applications). OTT Internet traffic (for example, YouTube) can be detected and managed using a pre-defined network policy. H-QoS can also optimize resource utilization by ensuring that any unused bandwidth allocated to higher priority services automatically becomes available, as needed, for lower classes of service.

3.2 Non-compromising scalability

Alcatel-Lucent EPC gateways can address the most stringent LTE scalability requirements, because they are architecturally tailored to allow unrestricted scaling without performance degradation. A typical advanced multiservice router currently on the market cannot address this requirement for scaling without serious performance degradation. The Alcatel-Lucent EPC gateway addresses LTE requirements without any impact on the performance.

3.3 Secure and dynamic mobility and policy management

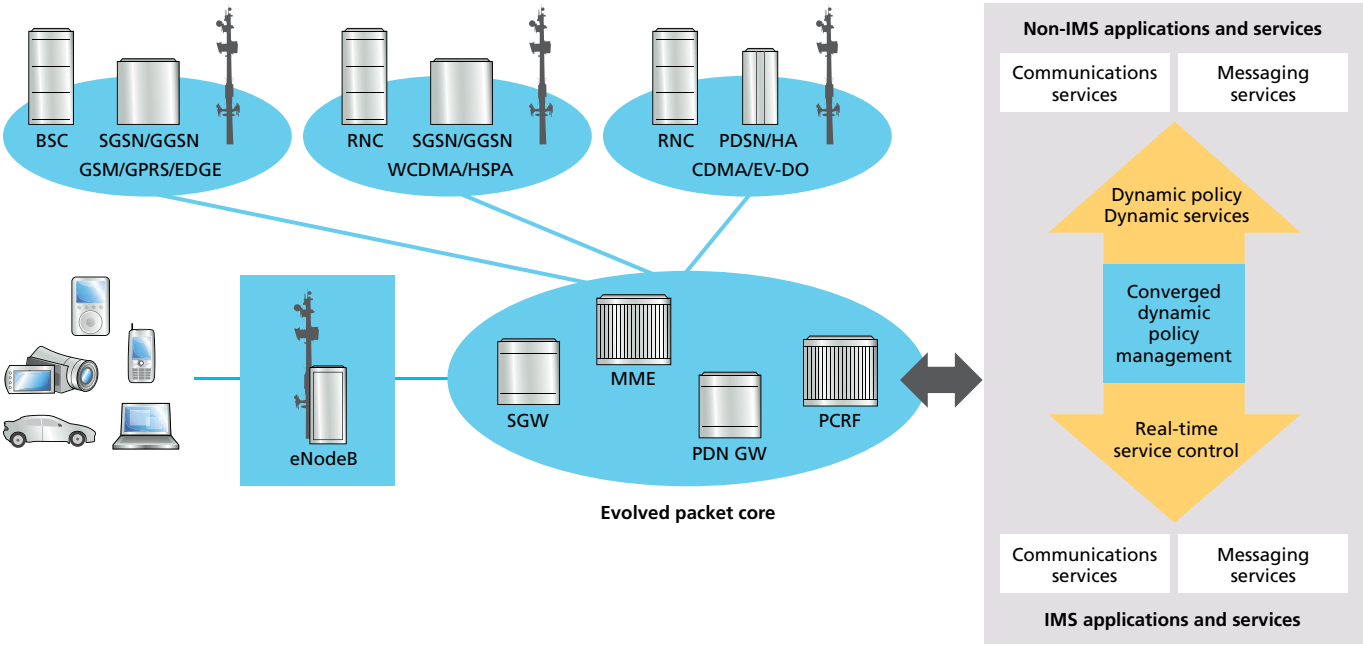
Alcatel-Lucent's architecture of the EPC control plane elements — MME and PCRF — has been chosen to also address a very important aspect of security.

MME has been designed for high-volume computing and extreme performance, in order to support the increased signaling load and direct control plane management of thousands of eNodeBs, while ensuring the interworking with multiple standards legacy networks.

At the same time, the Alcatel-Lucent PRCF platform is a result of Alcatel-Lucent's industry leadership in fixed broadband. The PRCF platform is developed using Alcatel-Lucent's leading expertise in subscriber management and its vast experience in managing large IPTV installations (for example, AT&T's Lightspeed network).

Figure 7 illustrates the secure and dynamic mobility and policy management in EPC.

Figure 7. Secure and dynamic, highly reliable and scalable mobility and policy management in EPC



3.4 Integrated cross-domain network and service management

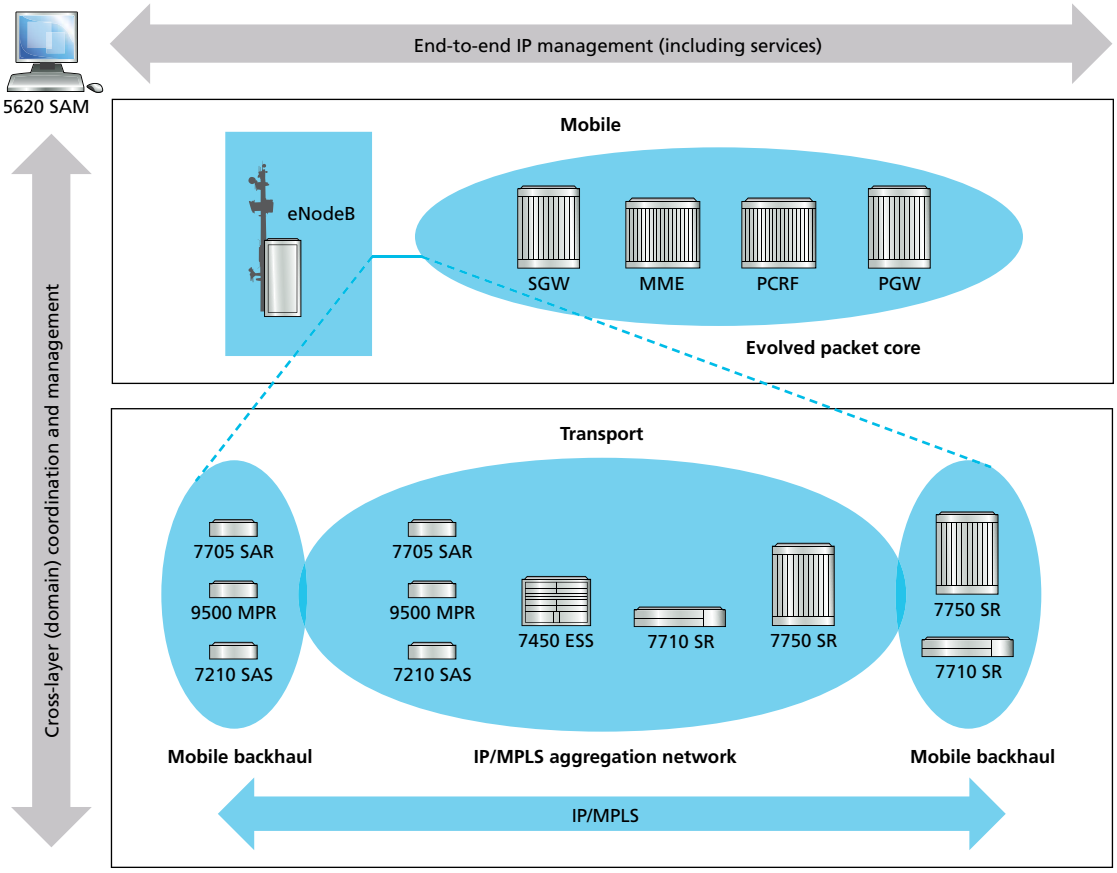
Network and service management also play a key role in LTE networks. The LTE QoE — in terms of coverage, bandwidth, latency, and mobility (handover) — is directly impacted by the configuration and management of LTE network elements (eNodeBs, gateways, MME, PCRF) as well as the inter-working with legacy 2G and 3G layers. From an operator standpoint, an efficient and consolidated management system is crucial to contain the total cost of network ownership, optimize asset usage, and streamline multi-technology network operations.

With Alcatel-Lucent's integrated network management system, operators will experience continuity in look and feel and usability for GSM, W-CDMA to LTE, and EV-DO to LTE management tools — now managing IP capabilities end-to-end across mobile and transport domains. Under the 5620 Service Aware Manager, the EPC seamlessly merges with the IP/MPLS transport network and the 5620 SAM allows:

- Common IP management domain
- Common security procedures, network level fault isolation, detection and resolution
- Coordinated management/provisioning across network elements
- Seamless inter-technology QoS continuity ensuring smooth service continuity between legacy and LTE networks
- Tight integration of mobile and transport

Figure 8 shows the Alcatel-Lucent 5620 SAM's network management solution.

Figure 8. Common network management across EPC mobile and transport domains using the Alcatel-Lucent 5620 Service Aware Manager



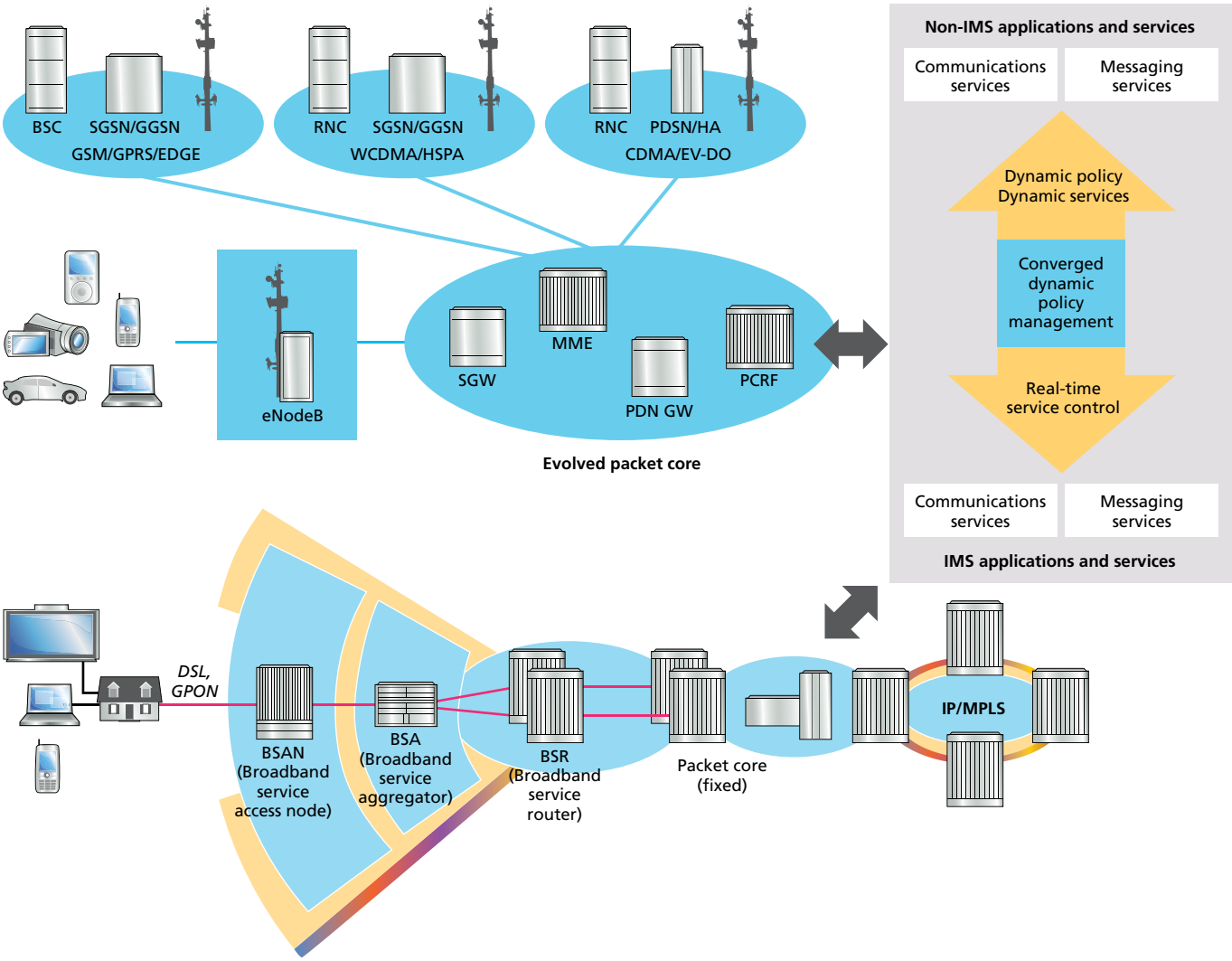
4. Fixed-mobile convergence

Alcatel-Lucent views the introduction of the LTE as a fundamental shift in mobile networks towards all-IP wireless broadband. This is the reason Alcatel-Lucent EPC has been engineered and built to act as a foundation for wireless broadband for many years to come — addressing multi-dimensional scalability of network bandwidth, applications, services, users and terminals. With a full suite of IP capabilities already widely deployed in many fixed environments, Alcatel-Lucent EPC delivers advanced end-to-end IP capabilities to LTE mobile environments.

As such, Alcatel-Lucent EPC solution is perfectly suited to evolve to a multi-access, multiservice core that will be the cornerstone of the full convergence of fixed and mobile environments — with common service delivery and policy management domain — delivering ubiquitous universal broadband over any type of access.

While it may take some time for this vision to become reality, Alcatel-Lucent EPC solution (see Figure 9) is fully capable of addressing these requirements, as already proven in the largest IP transformations in many fixed and mobile environments.

Figure 9. Alcatel-Lucent EPC as a cornerstone for multi-access, multiservice core convergence



5. Conclusion

Alcatel-Lucent's EPC solution delivers a new, service-aware all-IP mobile core for LTE, capable of true wireless broadband QoE, with advanced end-to-end QoS with secure and dynamic bearer, mobility and policy management.

Table 1 outlines key innovation areas of Alcatel-Lucent's EPC solution.

Table 1. Key innovation areas of Alcatel-Lucent's EPC solution

KEY INNOVATION AREAS IN ALCATEL-LUCENT'S EPC SOLUTION	RELEVANCE TO EPC/LTE
Service-aware IP	Provides network awareness of connections and traffic flows and their mapping to services. This is essential when introducing new service models, and it aligns with LTE service requirements. This is also important for advanced packet processing, such as Deep Packet Inspection (DPI).
Advanced, hierarchical QoS capabilities (per-session, per-flow, per-subscriber)	Ensures end-to-end QoS of new services and service bundles.
Secure and dynamic bearer, mobility and policy management	Addresses LTE requirements and interworking with existing systems. It also allows new charging models while protecting network resources.
Data and Control Plane scalability	Essential for delivery of evolved wireless broadband capabilities in LTE environment. Minimizes further hardware upgrades in the network.
High availability	Allows support for real-time communication services.

6. Abbreviations

3GPP	3rd Generation Partnership Project
3GPP2	3rd Generation Partnership Project 2
AF	Application Function
AS	Access Stratum
CDF	Charging Data Function
CDMA	Code Division Multiple Access
CDR	Charging Data Record
CGF	Charging Gateway Function
CRF	Charging Rules Function
CS	Circuit Switched
CSCF	Call Session Control Function
DL	Downlink
E-UTRAN	Evolved-UTRAN
EDGE	Enhanced Data rates for GSM Evolution
EMM	EPS Mobility Management
eNodeB	evolved NodeB
EPC	Evolved Packet Core
EPS	Evolved Packet System
GERAN	GPRS EDGE Radio Access Network
GGSN	Gateway GPRS Support Node
GMSC	Gateway Mobile Switching Center
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
GTP	GPRS Tunnelling Protocol
HLR	Home Location Register
HSDPA	High Speed Downlink Packet Access
HSPA	High Speed Packet Access
HSS	Home Subscriber Server
HSUPA	High Speed Uplink Packet Access
IETF	Internet Engineering Task Force
IEEE	Institute of Electrical and Electronics Engineers
IMS	IP Multimedia Subsystem
IMSI	International Mobile Subscriber Identity
IMT-2000	International Mobile Telecommunications 2000
ISIM	IMS Subscriber Identity Module
ITU	International Telecommunication Union
LTE	Long Term Evolution
MBMS	Multimedia Broadcast and Multicast Service
MIMO	Multi Input Multi Output
MGCF	Media Gateway Control Function
MGW	Media Gateway
MME	Mobility Management Entity
MMD	MultiMedia Domain
MNC	Mobile Network Code
MSC	Mobile Switching Center
MT	Mobile Terminal
NAS	Non Access Stratum
NGN	Next Generation Network
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access.
P-GW	PDN Gateway
PCEF	Policy and Charging Enforcement Function
PCRF	Policy and Charging Rules Function
PDCP	Packet Data Convergence Protocol
PDF	Policy Decision Function
PDP Context	Packet Data Protocol Context
PLMN	Public Land Mobile Network
PoC	Push-to-talk over Cellular
PS	Packet Switched domain
PSTN	Public Switched Telephone Network

RNC	Radio Network Control
S-GW	Serving Gateway
SAE	System Architecture Evolution
SDF	Service Data Flow
SGSN	Serving GPRS Support Node
SIM	Subscriber Identity Module
SIP	Session Initiation Protocol
SM	Session Management
SMS	Short Message Service
TA	Tracking Area
TCP	Transmission Control Protocol
TDMA	Time Division Multiple Access
TDD	Time Division Duplex
TE	Terminal Equipment
TISPAN	Telecommunication and Internet converged Services and Protocols for Advanced Networking
UDP	User Datagram Protocol
UE	User Equipment
UL	Up-Link
UMB	Ultra Mobile Broadband
UMTS	Universal Mobile Telecommunications System
USIM	Universal Subscriber Identity Module
UTRAN	Universal Terrestrial Radio Access Network
WCDMA	Wide band Code Division Multiple Access
WiMAX	Worldwide Interoperability Microwave Access

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