WHITE PAPER

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Simplifying the Migration to 4G Networks

- Smooth 2G/3G to 4G migration without a "forklift" upgrade – in a single common core platform
- Fast and seamless transition to Evolved Packet Core (EPC), all-IP core network that supports higher throughput, lower latency, and mobility between 3GPP and non-3GPP radio access technologies
- Core network solution that optimizes backhaul
- Converged mobility and policy management so operators can choose any access technology without a complete overhaul of existing IP core or IP core overlay
- Intelligence in the network to deliver higher bandwidth multimedia services – interacting and understanding key elements within the multimedia core

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Over the past two decades, the way people communicate, stay informed, and are entertained has changed dramatically. There have been two major technologies driving this change: the Internet and mobile wireless communication. We have grown accustomed to the wealth of information available through the Internet and the mobility provided with wireless communications. Now these two forces are merging to enable the mobile Internet. With this convergence, mobile data services have grown significantly each year.

However, people have a certain expectation for their Internet experience that the mobile wireless environment has not fully met since the speed at which they can access their services has been limited. Mobile operators realize if they are to succeed in today's communications landscape, they must address the quality of experience for their users. As a result, they are deploying broadband network technologies, such as 3G or third generation and enhanced 3G, including UMTS, HSPA, and CDMA2000 1xEV-DO Rev A. Going forward, mobile operators will continue to evolve their networks to improve the user experience and service opportunities. One such evolutionary technology is the 3GPP Long Term Evolution (LTE) specification.

Designated as a 4G or fourth generation mobile specification, LTE is designed to provide multi-megabit bandwidth, more efficient use of the radio network, latency reduction, and improved mobility. This combination aims to enhance the subscriber's interaction with the network and further drive the demand for mobile multimedia services. With wireless broadband, people will more readily access their Internet services, such as on-line television, blogging, social networking, and interactive gaming—all on the go.

Changes in mobile communications have always been evolutionary, and the deployment of LTE will be the same. It will be a transition from 3G to 4G over a period of several years, as is the case still with the transition from 2G to 3G. As a result, mobile operators must look for strategies and solutions that will enhance their existing 3G networks, while addressing their 4G deployment requirements without requiring a "forklift" upgrade.

Specifically, mobile operators need the multimedia core network to be readily upgradeable to the requirements of another 4G architecture called Systems Architecture Evolution (SAE).

Solutions already deployed in the market may include many of the elements required of the 4G network, including integrated intelligence, simplified network architecture, high bandwidth performance capabilities, and enhanced mobility. In order to avoid a costly replacement of the existing systems, only solutions capable of supporting multiple functions in a single node through a software upgrade will protect today's investment for tomorrow's network.

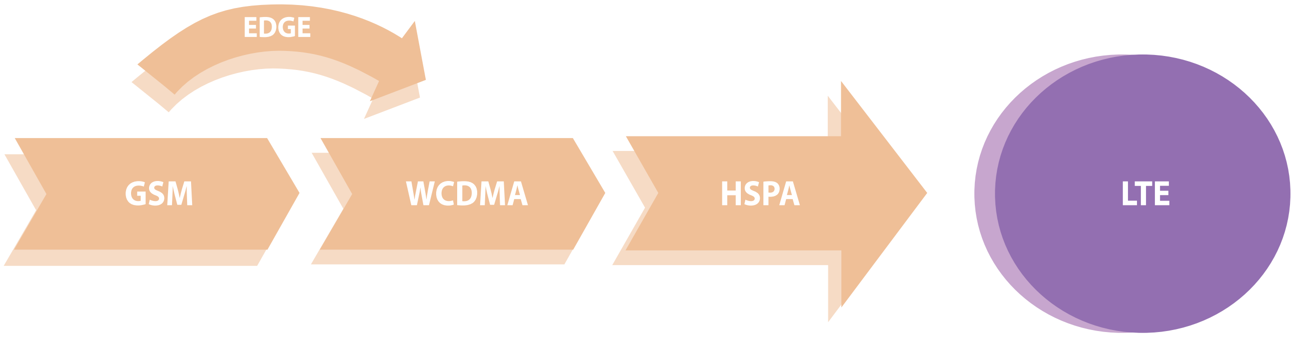
Evolving the Packet Core

Radio access solutions are a primary consideration of the LTE deployment strategy, as it impacts the mobile operators' most valued asset, spectrum. As an equally important part of this equation, the multimedia core network will play a central role in enhancing mobility, service control, efficient use of network resources, and a seamless migration from 2G/3G to 4G. As a result, SAE calls for a transition to a "flat," all-IP core network, called the Evolved Packet Core (EPC), that features a simplified architecture and open interfaces as defined by the 3GPP standards body. A key EPC goal is to enhance service provisioning while simplifying interworking with non-3GPP mobile networks. The standards promise an all-IP core network with a simplified and flattened architecture that supports higher throughput, lower latency, as well as support for mobility between 3GPP (GSM, UMTS, and LTE) and non-3GPP radio access technologies, including CDMA, WiMAX, WiFi, High Rate Packet Data (HRPD), evolved HRPD (eHRPD), and ETSI-defined TISPAN networks.

As a result, mobile operators are looking for the best multimedia core solutions to deliver an optimum user experience and build an efficient network. Key considerations for the multimedia core network include:

Upgrade Paths to Wireless Broadband

LTE is the next step on the migration path to wireless broadband.

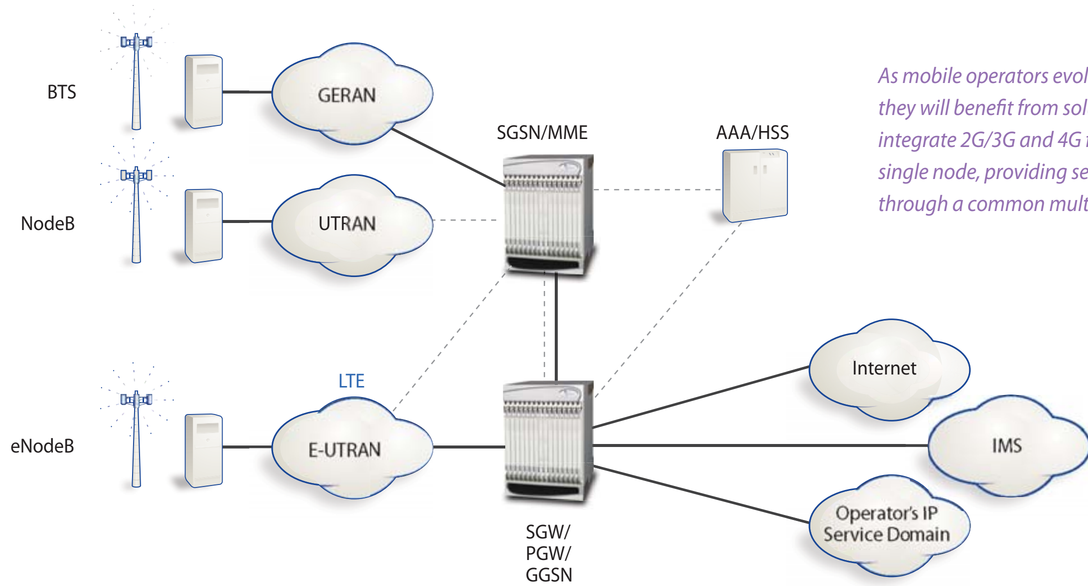


- **Integration of intelligence at the access edge**—As a greater variety of services and user types cross the mobile network, it is critical to have greater network and subscriber intelligence. Through this intelligence, including Quality of Service (QoS) and policy enforcement, mobile operators will better understand individual users and their transactions and be able to shape the service experience and optimize network efficiency.
- **Simplified network topology**—In order to effectively deliver the enhanced performance of LTE, the network will need to be simplified and flattened with a reduction of elements involved in data processing and transport.
- **Optimized backhaul**—With the introduction of 4G, the transport backhaul is a key consideration that many are realizing after the fact. It is very important to deploy a core network solution that is flexible enough to offer smooth migration from centralized (longer backhaul) to distributed (shorter backhaul) core network nodes.
- **Converged mobility and policy**—Maintaining the subscriber session is an important consideration during 4G to 2G/3G mobility events. Additionally, unified policy management in the network is very important to perform efficient service delivery over mixed 4G and 2G/3G networks. Due to these considerations, it is important to deploy a core network based on a single mobility and policy control paradigm.
- **Increased performance characteristics**—Clearly the intent of LTE is to improve the performance and efficiency of the network. In order to realize the full potential of LTE, it will be critical to deploy core solutions that can meet the demands generated by increased mobile multimedia services and a growing subscriber base, including increased network capacity requirements, thousands of call transactions per second, and significant throughput.
- **2G/3G to 4G migration**—As mobile operators migrate their networks to LTE, they will look to minimize cost and maximize subscriber usage. This will require core solutions that can address 2G/3G network requirements, while at the same time be utilized for 4G network introductions. Operators will want to avoid a "forklift" upgrade, while deploying "best-of-breed" solutions based on open standards. Additionally, mobile users will expect a uniform service experience across both networks, with consideration to the bandwidth differences.

According to the UMTS Forum, there is consensus in the industry that the first commercial launch of an LTE network and initial availability is expected to begin in 2010, with associated revenue to occur the following year.[1] While it is likely the evolution to 4G technologies will take many years, it is imperative for mobile operators to identify multimedia core elements now that will most effectively migrate them to a 4G network in the future.

Solutions designed for the specific requirements of the next generation multimedia core network include the ability to support both 2G/3G and 4G functionality in a single platform and provide major benefits to mobile operators that want to smoothly migrate their networks, maximize their investments, and offer an exceptional experience to their customers.

1. UMTS Forum white paper: "Towards Global Mobile Broadband: Standardizing the future of mobile communications with LTE (Long Term Evolution)", February 2008



As mobile operators evolve to LTE they will benefit from solutions that can integrate 2G/3G and 4G functions in a single node, providing separate access through a common multimedia core.

Standard Interfaces and Protocols

EPC also supports standard interfaces and open protocols aimed at enabling operators to launch services and applications with Internet speed, while also reducing the overall cost-per-packet through the inherent advantages of going all-IP.

Standardized interfaces and protocols also enable operators to achieve a "best-of-breed" approach with their network infrastructure. By eliminating proprietary protocols, operators can operate an open network that empowers them to select the vendors they deem most qualified to deliver a specific network function without having to worry about interoperability issues.

Converged Mobility and Policy Management

In 2G/3G networks, diverse schemes were used for mobility management within and across the access technology boundary. So, an operator choosing to deploy 2G access technology of one kind and 3G access technology of a different kind had to deploy two divergent mobility management schemes in the same network. This caused serious issues, and more importantly impeded rapid deployment of some access technologies. EPC is an attempt toward addressing this divergent mobility management issue.

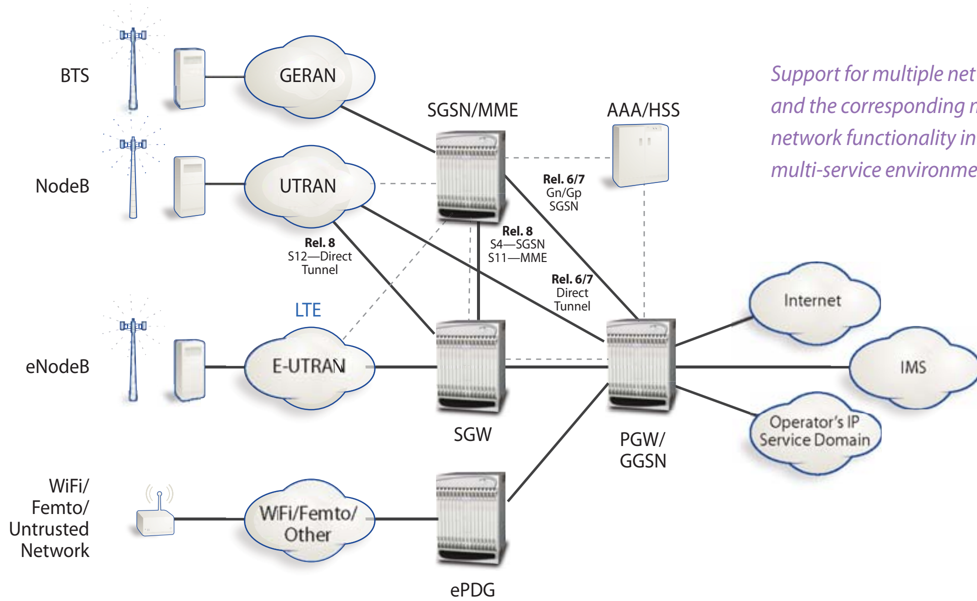
With a single comprehensive architecture, EPC supports all access technologies, i.e. 2G/3G and 4G from all standards defining organizations. The basis of this convergence is the use of an IETF defined mobility management protocol such as Proxy Mobile IPv6 (PMIPv6). If an operator wants to deploy any access technology with an EPC, a single mobility management protocol, such as PMIPv6 is all they need. This is a significant step toward building a single common IP core for future access technologies with seamless mobility. This gives operators the freedom to choose any access technology without having to worry about a complete overhaul of their existing IP core or an IP core overlay.

Common Core Platform

EPC highlights the growing importance of a common packet core across multiple access technologies. As many operators transition from disparate 3G specifications (UMTS and CDMA2000) to LTE and EPC, there is the potential for significant network simplification and cost savings, while also introducing greater efficiencies within the core network.

Integrating EPC Network Functions

The EPC specifications call out the Mobility Management Entity (MME), Serving Gateway (SGW), and Packet Data Network Gateway (PGW) as specific network functions, but do not define them as separate nodes in the network. In keeping with the simpler and flatter architecture intentions, these three functions can logically be integrated into one node. However, this will require a solution that is capable of this integration and can deliver the benefits of such integration.



Support for multiple network technologies and the corresponding multimedia core network functionality in a multi-access, multi-service environment.

For instance, the MME, SGW, and PGW can be combined into one carrier-class platform. By collapsing these functions, operators could reduce the signaling overhead, distribute session management, and leverage the control and user plane capabilities of the carrier-class node.

Alternatively, an operator could deploy the MME separate from the combined SGW and PGW, resulting in reduced signaling overhead (S5 and S8 would be internal), fewer hops on the bearer path, less backhaul, reduced signaling on the S7 interface, and lower session requirement for the PGW. This also provides for a single location for policy enforcement and charging data generation.

Additionally, co-location of 2G/3G SGSNs with the MME will reduce signaling and context transfer overhead significantly. This co-location will also be key to 2G/3G and 4G mobility and session management. The advantage of integrating or collapsing functional elements into one carrier-class node is paramount to the goals of simplifying and flattening the network while also reducing latency.

Convergence of 3G and 4G Core Networks

The concept of collapsing EPC functions can be taken a step further. The move to LTE will be an evolution, meaning many 3G, 2.5G, even 2G networks—whether 3GPP or 3GPP2—will remain operational for many years to come. Mobile operators can seize this opportunity to combine EPC functions with GPRS and UMTS functions (3GPP GGSN and SGSN), easing network migration, reducing signaling overhead, enhancing resource utilization by sharing common session data storage, and improving mobility between 2G/3G and 4G access systems. Most importantly, operators have the potential to achieve this without a "forklift" upgrade by leveraging their existing 3G deployed base. This results in dramatic capital and operational savings and reduces risk involved in adding a new, unproven access technology.

Easing The Migration

Innovative solutions currently deployed around the globe already meet many of the requirements of LTE and EPC, such as integrated intelligence, simplified network architecture, high bandwidth performance capabilities, and enhanced mobility. Some are capable of supporting 2G/3G today on a single platform, and through software upgrades can support 4G functionality when LTE networks are deployed.

Mobile operators will benefit from solutions that can provide 2G/3G functionality now and evolve to 4G functionality later without "ripping and replacing" costly systems and equipment that will still be needed to support legacy networks while subscribers transition to the new network.

Integration of Multiple Core Functions

Whether existing systems are deployed as SGSN, GGSN, PDSN, Home Agent, or other gateway functions, they must be designed to be integrated with or upgraded to the 4G functional elements—MME, SGW, PGW, and ePDG—through a simple software upgrade.

Intelligence in the Network

Key to creating and delivering high bandwidth multimedia services in 2G/3G and 4G networks—and meeting subscriber demand—is the ability to recognize different traffic flows, which allows functional elements to shape and manage bandwidth, while interacting with applications to a very fine degree and delivering the quality of service required. This is done through session intelligence that utilizes deep packet inspection technology, service steering, and intelligent traffic control to dynamically monitor and control sessions on a per-subscriber/per-flow basis.

The interaction with and understanding of key elements within the multimedia call—devices, applications, transport mechanisms, and policies—requires:

- Intelligent QoS control based on service type, user profile, and business policy
- Visibility of the access technology type in the EPC nodes. For example, automatically adapting QoS for ongoing sessions when the user equipment performs a handover between an LTE and 2G/3G/WiMAX network
- Providing a greater degree of information granularity and flexibility for billing, network planning, and usage trend analysis
- Sharing information with external application servers that perform value-added processing
- Exploiting user-specific attributes to launch unique applications on a per-subscriber basis
- Extending mobility management information to non-mobility aware applications
- Enabling policy, charging, and QoS features

EPC Network Functions

EPC defines a series of new network functions that flattens the architecture by reducing the number of nodes in the network, which promises to reduce capital and operational expenditures; thereby reducing the overall cost per megabyte of traffic running over the EPC, while improving network performance.

- **Mobility Management Entity (MME)**—The MME resides in the control plane and manages states (attach, detach, idle, RAN mobility), authentication, paging, mobility with 3GPP 2G/3G nodes (SGSN), roaming, and other bearer management functions.
- **Serving Gateway (SGW)**—The SGW sits in the user plane where it forwards and routes packets to and from the eNodeB and Packet Data Network Gateway (PGW). The SGW also serves as the local mobility anchor for inter-eNodeB handover and roaming between two 3GPP systems.
- **Packet Data Network Gateway (PGW)**—The PGW (sometimes called the PDN Gateway) acts as the interface between the LTE network and Packet Data Networks (PDNs), such as the Internet or SIP-based IMS networks (fixed and mobile). The PGW is the mobility anchor point for intra-3GPP access system mobility and for mobility between 3GPP access systems and non-3GPP access systems. The function is responsible for IP address allocation, charging, deep packet inspection, lawful intercept, policy enforcement, and other services.
- **Evolved Packet Data Gateway (ePDG)**—The ePDG is the primary element responsible for interworking between the EPC and untrusted non-3GPP networks, such as a wireless LAN. The ePDG uses Proxy Mobile IPv6 (PMIPv6) to interact with the PGW when the UE is in an untrusted non-3GPP system. The ePDG is involved in the Policy and Charging Enforcement Function (PCEF), meaning it manages Quality of Service (QoS), flow-based charging data generation, gating, deep packet inspection, and other functions.

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SUMMARY

The deployment of LTE is another step in the evolution of the mobile network. While the deployment of 4G radio access networks receives considerable attention, the Evolved Packet Core has emerged as a critical element in the delivery of next generation mobile broadband services. As such, mobile operators are looking for solutions that provide them with the highest levels of flexibility in architecting their networks, including co-location of 2G/3G and EPC functionality in a single platform, open interfaces, and the high-performance and intelligence required for an enhanced subscriber experience.

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