STRATEGIC WHITE PAPER

LTE Mobile Transport Evolution

As 4G cell sites are rolled out in support of Long Term Evolution (LTE) services, and the increase in mobile data services continues unabated, it is expected that average bandwidth requirements will increase to tens of Mb/s per site. To keep pace with this growth, service providers need an end-to-end architecture — from cell site to core — that supports a variety of network evolution alternatives and service provider deployments. This paper discusses the changes that LTE will bring and examines their impact on mobile transport networks. It also introduces the Alcatel-Lucent Mobile Evolution Transport Architecture (META). META is an end-to-end LTE-ready network architecture offering the service intelligence, flexibility, simplicity and cost-effectiveness necessary to serve the massive growth in demand for mobile broadband services while continuing to optimize 2G and 3G service delivery.

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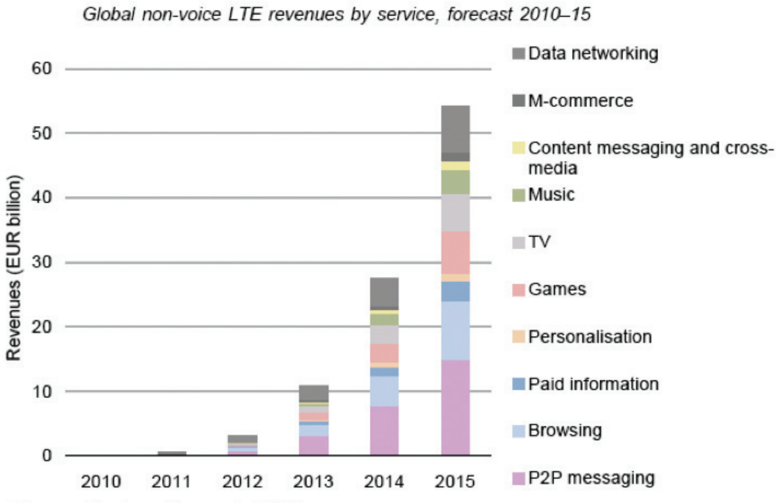
1. LTE and service innovation

In an effort to differentiate their offerings and increase profitability, mobile service providers (MSPs) have begun to augment traditional low-bandwidth services like e-mail and short message service (SMS) with new mobile broadband services, such as real-time video, gaming, music and other rich multimedia applications. Alcatel-Lucent primary research on 4G service demand suggests there is strong interest in entertainment-related services among consumers and interest in productivity-enhancement services among business customers. With these new services comes an increase in the capacity required of the mobile transport network and the need for a cost-effective delivery infrastructure. The move to high-speed Long Term Evolution (LTE) networks will foster further innovation and the development of services and applications. Service providers will be able to provide much higher capacity on an all-IP network which developers can exploit to create new mobile services. According to Analysis Research, as a result of the availability of faster downlink and uplink speeds, in combination with lower per-megabit distribution costs, it is anticipated that non-voice services such as mobile TV, games, browsing and data networking will become the main contributors to service providers' data revenues in the coming years (see Figure 1).

Figure 1. LTE non-voice revenue forecast



[Source: Analysys Research, 2007]

The increased speeds that LTE will bring hold the promise of changing the manner in which mobile services are consumed. Indeed, the new LTE ecosystem will drive the development of rich new broadband services. The availability of mobile devices with enhanced features such as larger screens, higher resolution, faster speeds, and longer lasting batteries will help to drive service demand by creating a more enjoyable end-user experience. LTE will transform existing services by delivering a faster, richer user experience. This type of change is already happening, for example, with point-to-point messaging such as SMS, multimedia messaging service (MMS) and low priority e-mails, which are evolving towards photo messages, instant messaging (IM), mobile e-mail and video messaging. LTE will also change the mobile browsing experience with usage likely to be closer to the PC experience and the availability of super-fast browsing speeds and greater interaction with social networking sites such as MySpace™ and Facebook™. LTE is also expected to foster greater personalization of mobile sites, with users able to upload pictures and other content to their own mobile portal. This shift reinforces the need for the transport network to be optimized for data.

1.1 Evolution to all-IP

The transition to Ethernet transport from the mobile core to cell site is already occurring. While the shift to pure Ethernet-based transport from cell sites may take some time, Ethernet is currently being deployed in hybrid or alternate transport configurations to support high-speed data. With the announced plans for LTE deployments by major service providers in the 2010 timeframe, the evolution towards mobile broadband networks via Ethernet will accelerate.

The new LTE mobile network paradigm will unleash next-generation broadband wireless capabilities and require an order of magnitude jump in bandwidth to the cell sites. LTE will rely on Ethernet for interconnection between the various functional elements, driving an evolution from legacy-based transport to cost-effective, Carrier Ethernet transport. At the same time, the shift to IP creates a need to support the large base of existing 2G/3G services that will continue for years to come using new packet-based infrastructures.

Among the benefits that service providers hope to gain from LTE networks are faster data rates, reduced latency, improved spectral efficiency, flexible channel bandwidths, lower transport/distribution costs, and a simpler/flatter IP network. LTE invokes changes in the network architecture resulting in less protocol hierarchy between disparate network elements and more network flattening built around one key networking protocol — IP.

2. Implications of LTE on mobile transport

LTE networks offer the promise of supporting the explosion in traffic arising from a new generation of mobile devices and applications. The introduction of LTE has several implications on the transport network as described below.

2.1 Higher capacity at lower cost

Traditionally, bandwidth demand in mobile networks was driven primarily by voice services and exhibited a steady growth rate. Now, demand for mobile data services is growing, and these services represent an increasingly larger portion of network traffic overall.

Traditional voice applications relied on and were tied to subscribers and their growth. These applications did not change much over time and the slow but steady growth in bandwidth could be accommodated. The arrival of data services that were bursty in nature increased bandwidth demand but these too could be accommodated using traditional backhaul approaches. Now, however, service providers need to be able to support new packet-based applications like Internet video downloads, peer-to-peer networking, streaming video, web surfing, and machine-to-machine communications, which can consume vastly higher amounts of bandwidth and for longer durations. To meet these requirements, service providers need to evolve their infrastructures to more cost efficient, higher capacity Ethernet backhaul alternatives.

The trend toward Ethernet backhaul is no surprise since the selected transport technology generally performs most efficiently when it is transporting information already "packaged" in the same transport format. Therefore, packet-based data traffic is naturally more efficiently transported in Ethernet form.

Just as important is Ethernet's ability to scale in support of the much higher bandwidth requirements of an LTE infrastructure. While there has been much hype in the industry with regards to LTE's theoretical limits, the average load required will be determined by several factors, including:

- Spectral efficiency (which decreases as distance from cell site increases)
- Amount of licensed spectrum owned
- Number of sectors used
- Speed of mobile devices
- Number of subscribers and speed at which they are traveling (higher speeds lending themselves to increased transmission errors)

As LTE cell sites are rolled out, it is expected that bandwidth requirements will range on average from 50 to 100 Mb/s. This is a significant increase over 2G/3G systems and further reinforces the need to be able to scale transport capacity at lower cost and increase transport efficiency by migrating to packet backhaul.

2.2 Multiservice transport

Service providers have traditionally used either TDM (T1/E1) interfaces or microwave to backhaul 2G/3G cell site traffic to the mobile telephone switching office (MTSO) and more recently have begun to adopt Ethernet backhaul as well. Given the ubiquity of these technologies, it makes sense to rely on them for transport and service providers have invested in infrastructure supporting this model. This large, installed base of 2G/3G wireless systems drives the need for continued support of TDM backhaul in the coming years.

As service providers begin to gradually introduce LTE, they will leverage existing 2G/3G sites where possible. This site reuse means that the backhaul network must be scalable enough to support the coexistence and cumulative capacity of LTE with either CDMA or W-CDMA networks. It also means that the backhaul network will need to support a combination of TDM, ATM, and Ethernet/IP traffic while enforcing the control of quality of service (QoS)-related parameters (such as jitter and delay) to meet the "deterministic behavior" of TDM circuits when transported over fully-loaded packet links. In some cases, service providers will leverage existing TDM infrastructure in support of traditional voice services. The mobile backhaul solution should incorporate native TDM interfaces or the use of circuit emulated services (CES) / pseudowire technology for legacy transport and enhanced clock recovery mechanisms that support the accurate timing required for base station handoffs.

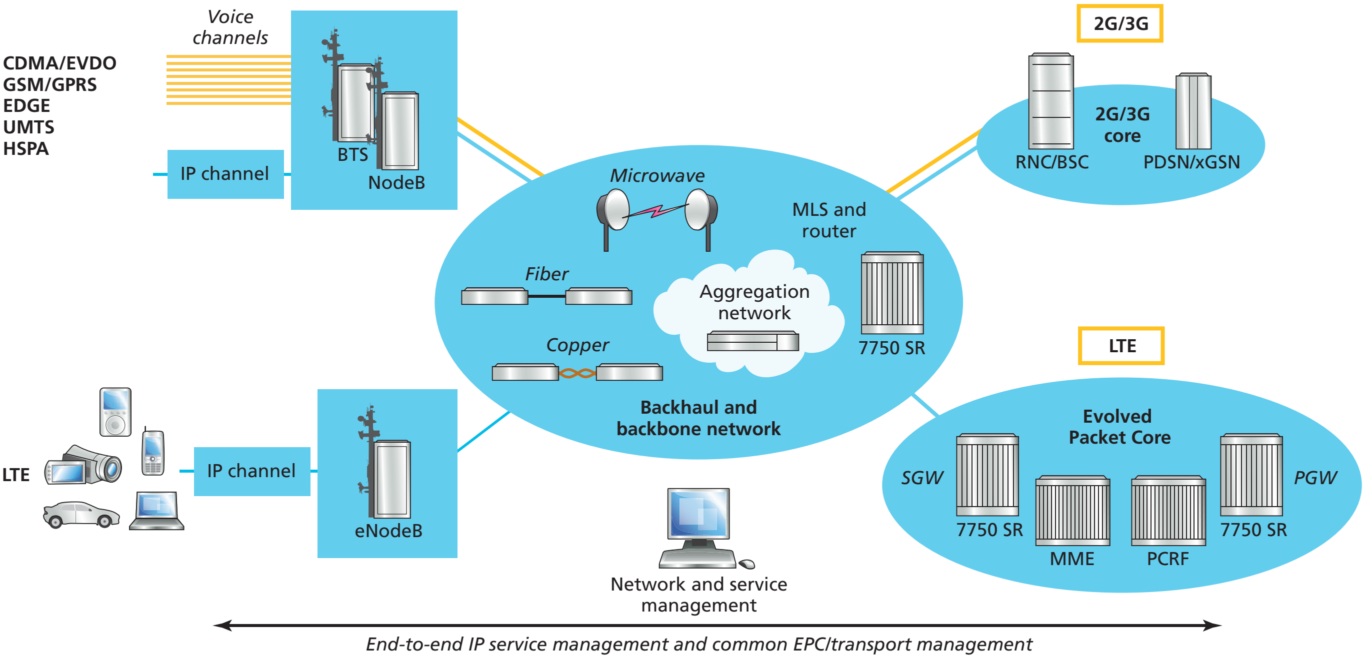
2.3 Low latency and quality of service

The delivery of real-time, performance-sensitive services, such as video or VoIP, introduces stringent requirements for the transport layer in terms of QoS management and end-to-end delay management from the eNodeB to the Evolved Packet Core and between eNodeBs. To meet the stringent QoS requirements of real-time traffic, the IP backhaul network must integrate many of the qualities and attributes of switched networks: predictability, reliability and manageability. A mobile backhaul solution utilizing MPLS/MPLS-TP and Carrier Ethernet can provide the QoS, traffic engineering and management capabilities necessary to support all mobile services as well as business applications and consumer Internet services over an IP/Ethernet transport network. The provision of deterministic QoS provides equitable treatment to individual traffic streams (and appropriate priority, for example, for highly delay-sensitive applications) and allows synchronization mechanisms to converge rapidly across the packet radio access network (RAN).

Beyond providing transport class-of-service, there is an opportunity to offer an enriched quality of experience through tighter integration of the transport and mobile layers (see Figure 2). By implementing a mobile core with dynamic, policy-driven QoS, service providers can transition from providing QoS on a class-of-service basis with minimal end-to-end performance guarantees, to providing enhanced QoS, which takes into account subscriber profiles, usage, location, device, time/date, network resources and other parameters. In doing so, service providers can make optimal use of network resources to reduce their total cost of ownership while providing subscribers with a more personalized and enhanced customer experience. The expansion of service level agreement (SLA) support on a per-subscriber and/or application basis will help service providers looking to stave off commoditization and better monetize new services. This added intelligence will provide several additional benefits, including:

- Enhanced visibility into end-user traffic patterns, which will help service providers with network planning and the development of new services
- Ability to better safeguard the network by restricting applications based on preconfigured “fair use” policies
- Improved policy enforcement, which will enable service providers to optimize network resources among subscribers or applications
- Ability to create tiered services that balance price and performance
- Support for new business models with third parties, as a result of new application-aware interfaces that enhance application performance and enable new services

Figure 2. End-to-end IP service management[1]



2.4 Convergence of backhaul/backbone

In existing mobile networks, the base station controllers or BSCs (for 2G) and radio network controllers or RNCs (for 3G) perform radio resource management and mobility management functions. Typically, these controllers reside at the local MTSO and the connection between the base station and the controllers is enabled via the backhaul network. The backbone network is not involved and can be functionally separate, being utilized primarily for interconnection of MTSOs (see Figure 3).

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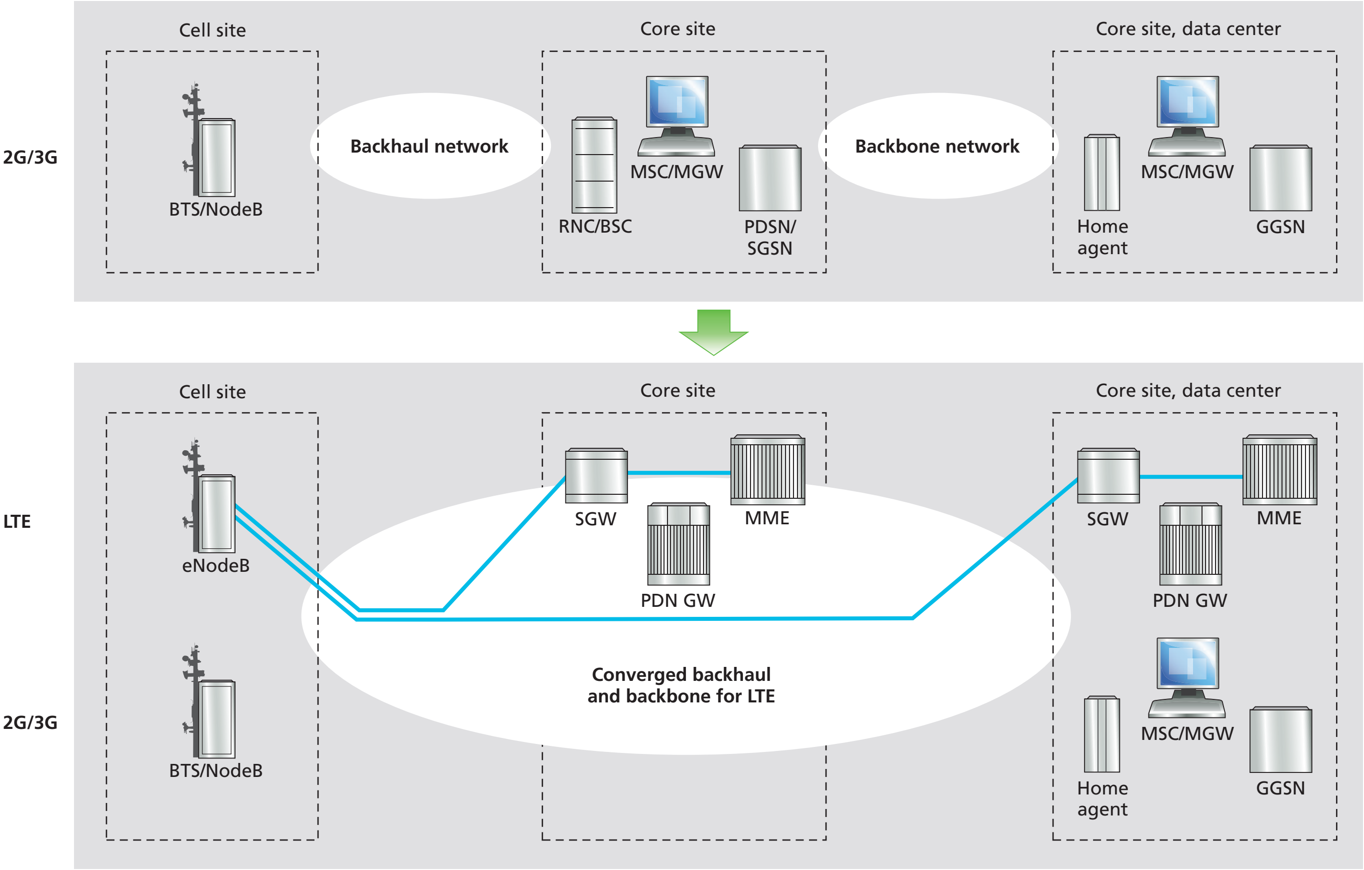
[1] All product references and abbreviations used in figures are expanded in the Abbreviations list at the end of this paper.

Figure 3. Backhaul/backbone convergence



With LTE, the mobility management functions are performed by the mobility management entity (MME). The MMEs, serving gateways (SGWs) and PDN gateways (PGWs) can be distributed across either local, regional, or national (data center) sites with each eNodeB connecting to MMEs at any of these levels. The mobile transport network must enable connectivity between the eNodeBs and the MMEs and S/PGWs at the lowest cost per bit. For service providers who own the transport network, it is advantageous to utilize the same transport technology end-to-end to gain synergy and cost reductions from common operations, administration and maintenance.

2.5 Increased connectivity and load sharing

While existing 2G/3G transport networks are typically hub-and-spoke in nature with traffic flowing primarily between the base station and the local MTSO, LTE introduces new transport networking options with direct inter-base-station connectivity, via the X2 interface, between adjacent eNodeBs for handover. As a result, the deployment of a partial mesh network is beneficial, as traffic does not have to flow through a hub site.

The ideal transport solution will support either Layer 2 or Layer 3 virtual private networks (VPNs) with simple, fast forwarding schemes (such as bridging) providing any-to-any connectivity in support of varying service provider strategies. The any-to-any model can be implemented using various technologies like native Ethernet (PBB), MPLS-TP, and IP/MPLS, as either Layer 2 or Layer 3. In a Layer 2 approach, a VPN is established to provide either point-to-point (E-line) or multipoint Ethernet-based connectivity (E-LAN) to cell sites. Layer 2 VPNs provide transparent connectivity between the eNobeB and S/PGW endpoints with IP processing being done at the edge nodes connected to the eNodeB and Access Gateways (aGW) after a “hand-off” of traffic at the Ethernet level.

This approach could be supported via packet-optical systems that employ MPLS-TP traffic engineering or service routers that employ IP/MPLS. In a Layer 3 VPN approach, MPLS is used for IP service-aware transport. The IP/MPLS service routers provide a mesh architecture that enables cell sites to communicate directly with one another, which improves performance and provides significant operational savings. Both Layer 2 and Layer 3 VPN options meet LTE requirements for QoS, latency, synchronization, security and load balancing. Operating at a lower layer, the Layer 2 VPNs tend to be cost effective and simple to manage, while Layer 3 VPNs can support an IPSec distributed architecture, providing service scalability and broadcast domain reduction. These aspects can also be addressed by Layer 2 VPNs by using a service router for reducing the broadcast domain and Ethernet bridging for service scalability.

Many service providers will favor using an “E-Line-to-hub” model where cell sites are connected using point-to-point links passing through a hub (so called “hair pinning”). This method has merit given the operational simplicity and support for simple SLAs. However, there could be cases where the use of E-Line with “short-cut” path configurations prove more advantageous. This architecture is useful in rural areas where the cell sites are located relatively far away from the hub. Another case would be in high traffic areas where sufficient inter-base-station traffic warrants the use of a direct point-to-point link. In these cases, hair pinning through the MTSO may not be cost effective.

Another capability that LTE brings is the incorporation of a flexible architecture. The S1-flex interface enables load sharing of traffic across the aGWs and MMEs serving a local EUTRAN as well as increased resiliency through geographic diversity. Effectively, a pool of aGWs and MMEs is created with eNodeBs having connectivity to multiple aGWs and MMEs. Here, the use of either VPLS or IP VPNs can provide operational simplification and cost savings, especially as the EUTRAN grows. The mobile backhaul network should take advantage of load balancing in order to efficiently optimize transport resources when possible.

2.6 Reconfigurability and network agility

In 2G/3G networks, the low-bandwidth, legacy data services (such as SMS) could be accommodated using the “over-provisioned” available capacity. With the higher aggregate capacity and bursty nature of the broadband data services enabled by LTE and high speed 3G technologies, service providers will need to ensure that adequate capacity in the mobile transport network can be provisioned quickly where and when needed.

The use of WDM within the metro fiber transport networks can help service providers to accelerate the time-to-service, simplify operations, and improve overall performance, providing a better total cost of ownership. In particular, the use of WDM systems with “zero touch photonics” capabilities will eliminate the need for frequent on-site interventions and provide a WDM network that is easily reconfigured according to changing traffic demands. With these systems, in-service capacity upgrades are possible. Furthermore, using WDM, these systems can transparently transport any protocol (SDH/SONET/Ethernet/ATM) and support multi-generational mobile traffic.

Optical layer management in support of photonic operations, administration, and maintenance (OAM) will also need to be considered. For this, a “wavelength tracker” mechanism can deliver wavelength-path tracing and monitoring capabilities, enabling delivery of true optical SLAs while reducing network operational costs. A wavelength tracker enables next-generation optical network functionality through protected wavelengths and extension to higher degree nodes.

2.7 Accurate clock synchronization

Typically, 2G/3G base stations are synchronized using one of two methods. The clock reference provided by the BSC/RNC over the T1/E1 connections linking the two network elements may be used or synchronization may be acquired from an external source such as GPS. The clock reference is maintained as the traffic is transported over the TDM network. The migration towards IP/Ethernet networks that do not transport the clock reference transparently requires strict QoS implementation rules to keep delay and jitter within ITU-T recommendations, and to ensure recovery of the clock reference. With physical layer approaches (such as Network Timing Recovery (NTR), GPON PHY, Synchronous Ethernet (SyncE) and microwave radio carrier), the clock is extracted from the synchronous data stream. This has proven to be an effective means of maintaining frequency synchronization and can also support LTE base stations. With SyncE, for example, the Ethernet physical layer is used to distribute clocking analogous to the SONET/SDH architecture. All data and VoIP applications work well on a free-running eNobeB using these approaches. An effective end-to-end approach to clock synchronization can be implemented using the various physical layer techniques that are specific to the different backhaul technologies.

Physical layer approaches can also be complemented with timing over packet approaches, such as IEEE 1588v2, when physical layer techniques cannot be applied and when phase/time synchronization distribution is required (as is the case with TDD, MBMS, network MIMO and synchronized networks). Approaches like 1588v2 will be particularly useful for backhaul transport providers selling wholesale cell site backhaul since it requires implementation only at the end nodes and not in intermediate metro nodes which might be part of third-party leased services.

2.8 Security

Mobile service providers need to protect mobile data integrity and subscriber data confidentiality from interception by unauthorized entities and several options for encoding and authenticating cell site traffic exist. In both GSM and UMTS systems, all user data is ciphered between the user equipment and the RNC, providing a reasonable level of protection against eavesdropping. Some IP-capable transport interfaces on NodeBs support the IPSec suite of standards. Otherwise, external devices can provide IPSec transport/tunneling to a security gateway collocated with the RNC.

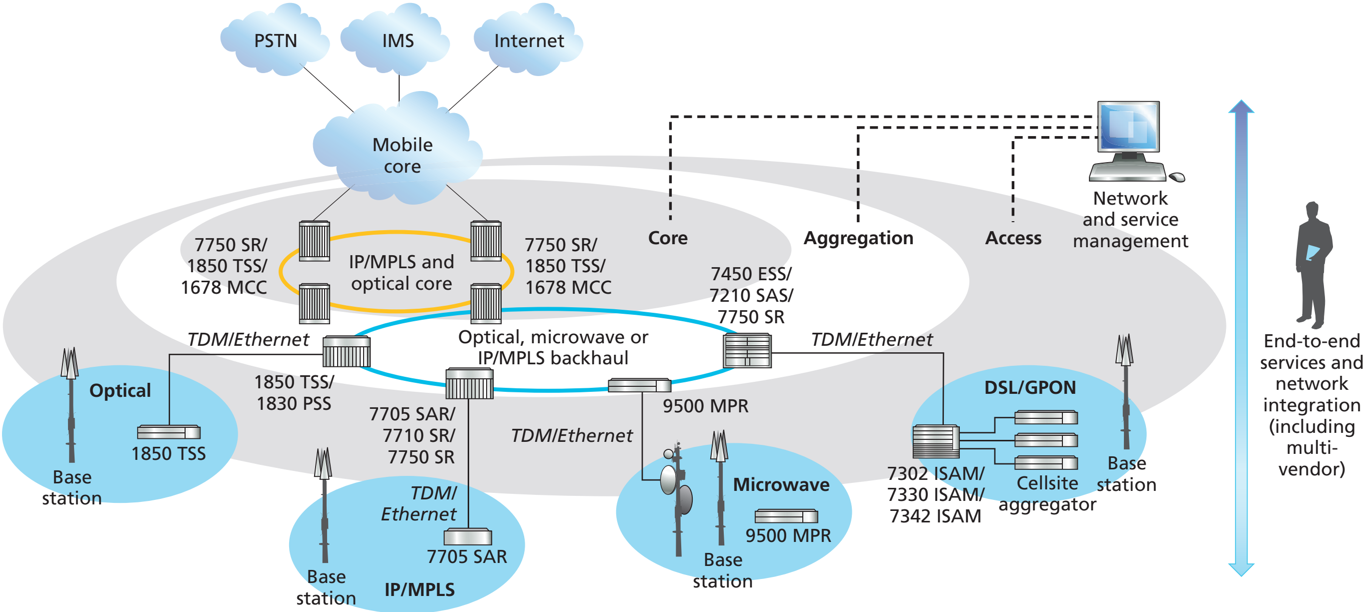
With LTE, encryption is performed at the eNodeB. However, in some cases LTE base station cabinets may not be deployed in secured locations. Femto cells will also become part of the LTE network infrastructure. As a result, some MSPs are looking to support encryption within the transport network, especially if using third-party backhaul transport providers or public Internet transport. It may also be considered for cases where IP transport facilities do not meet minimum security requirements.

For LTE, IPSec tunneling between the eNodeB and the security gateway can be used to secure data and provide QoS for service providers choosing to administer security centrally. Additionally, the use of 802.1X, which acts as a gatekeeper for basic network access by denying access to the network before authentication is successful, can complement IPSec. A distributed security gateway at the hub can be beneficial as this scales IPSec, provides optimized routing in the RAN (via the X2 interface), provides flexible load-sharing connectivity, and runs IPSec from the eNodeB to a trusted site in the aggregation network, providing the required security.

3. Alcatel-Lucent Mobile Evolution Transport Architecture

Alcatel-Lucent META provides an end-to-end network architecture that enables service providers to migrate and scale their networks profitably. This architecture is LTE-ready today, offering the service intelligence, flexibility, simplicity and cost-effectiveness necessary to serve the massive growth in demand for mobile broadband services while continuing to optimize 2G and 3G service delivery.

Figure 4. Alcatel-Lucent Mobile Evolution Transport Architecture



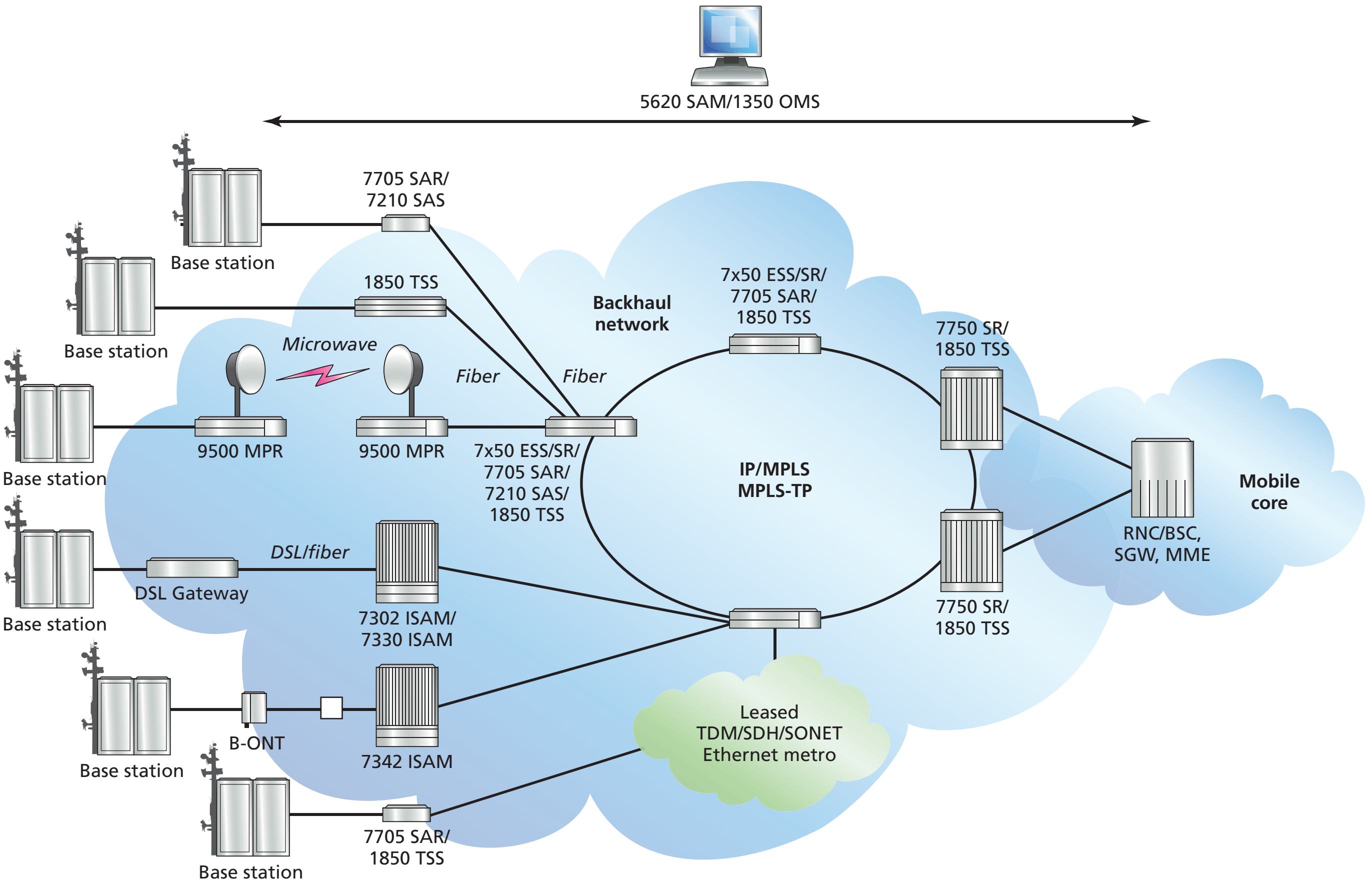
Using the optimal cost points of Ethernet, coupled with the proven scalability, availability and service-aware capabilities of MPLS, META enables MSPs to leverage existing infrastructure investments and evolve to all-IP networking with the quality of experience that customers have come to expect from traditional wireline services.

3.1 Cost-effective backhaul through converged transport

Alcatel-Lucent META gives service providers complete control over the network transformation process. It can be tailored to meet diverse backhaul network evolution requirements, including hybrid data offload approaches. META leverages the optimal cost points of newer transport technologies such as Carrier Ethernet and MPLS/MPLS-TP, which helps service providers prepare for the profound changes that LTE will bring. A key component of the architecture is an IP-optimized, data-aware transport infrastructure suitable for the full range of legacy and new mobile broadband services. This infrastructure supports advanced QoS capabilities to manage and prioritize LTE applications along with 2G/3G applications. The provisioning of deterministic QoS is important as it provides equitable treatment to individual traffic streams (and appropriate priority to, for example, highly delay-sensitive applications). It also allows synchronization mechanisms to converge rapidly across the packet RAN.

As shown in Figure 5, MSPs can use META to support multi-generational access across a range of backhaul technologies including IP/MPLS, packet-optical, microwave, DSL, and GPON. This allows MSPs to leverage their investments in existing infrastructure and evolve the network to support lower-cost IP/Ethernet backhaul.

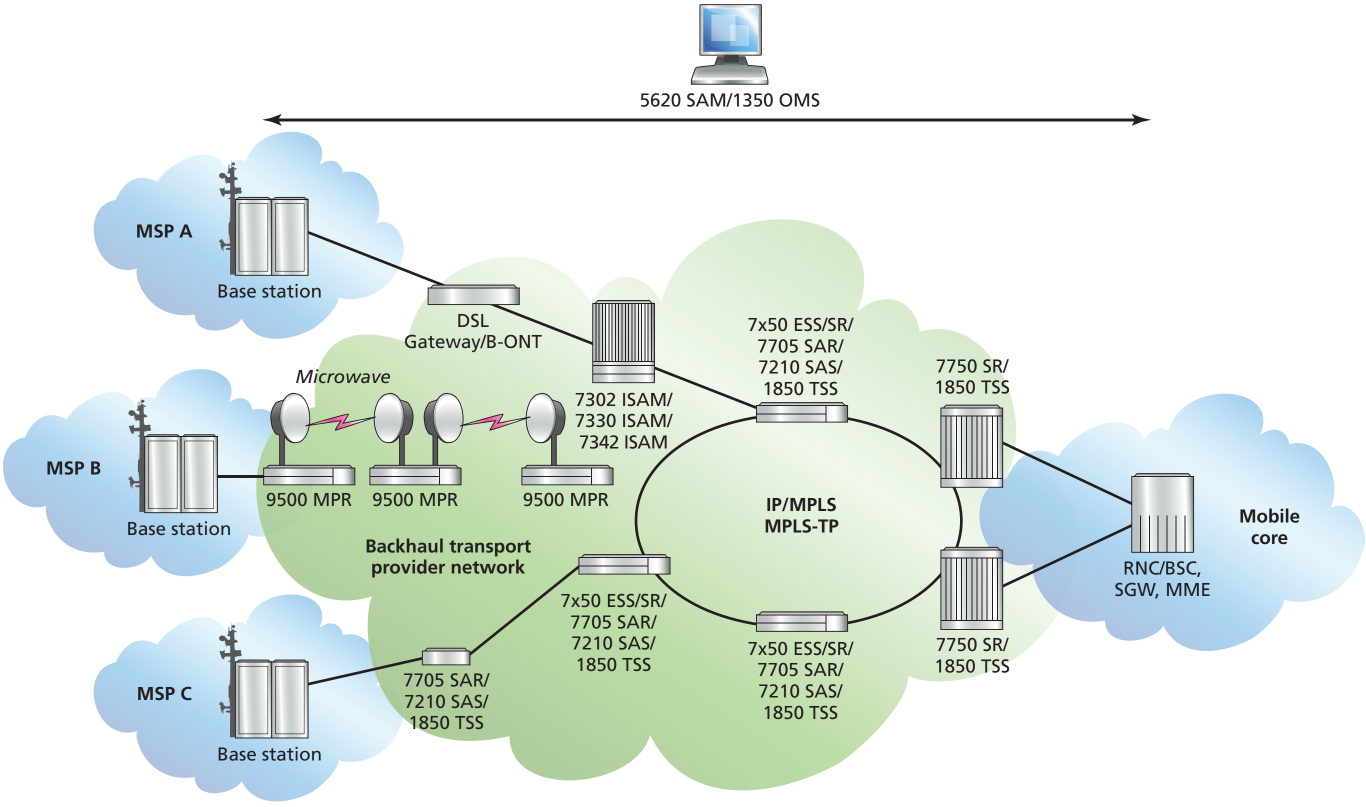
Figure 5. Alcatel-Lucent Mobile Backhaul Solution for MSPs



Additional flexibility is provided by allowing service providers to take the IP/MPLS and MPLS-TP edge, and the capabilities of service routing and Carrier Ethernet transport, to intermediate hub locations in the RAN. This allows a common, shared infrastructure to be used for all aggregated traffic between the hub and the mobile core. It also delivers significant leased line savings because Carrier Ethernet or packet-optical connections can be used for backhaul. Furthermore, it provides a cell site aggregation solution in which small clusters of base stations can be linked and the CDMA/EVDO or GSM/UMTS/HSPA and LTE traffic groomed to reduce backhaul costs. Through the implementation of Carrier Ethernet between the cell site and the mobile core, traffic can be aggregated efficiently and end-to-end service delivery upheld.

As shown in Figure 6, Alcatel-Lucent META can similarly enable BTPs to lower costs by converging the traffic of multiple MSPs while keeping each stream virtually separate. META provides access for 2G/3G and LTE base stations via simultaneous support for TDM/PDH, SONET/SDH/WDM, MLPPP, ATM with IMA, and Ethernet/IP as the access network evolves.

Figure 6. Alcatel-Lucent Mobile Backhaul Solution for BTPs



BTPs can use a service router or transport service switch to interconnect mobile elements, thereby allowing service providers to optimize resources and the networking flexibility of inter-element connections to drive costs out of the RAN. Provisioning and monitoring of all services (2G/3G/LTE) would be provided through either the Alcatel-Lucent 5620 Service Aware Manager (SAM) system or Alcatel-Lucent 1350 Optical Management Suite (OMS). Both systems support end-to-end QoS across the Ethernet backhaul network and mobile core.

3.2 Cell site aggregation

Alcatel-Lucent META provides additional benefits by extending IP/MPLS, MPLS-TP and Ethernet aggregation towards the cell site. In the cell site, there are opportunities for aggregation solutions that converge multi-generational traffic streams and/or adapt legacy base station interfaces onto packet transport infrastructures. This is accomplished through the deployment of cell site aggregators either collocated with a mobile base station or at intermediate aggregation (hub) sites. The Alcatel-Lucent 7705 Service Aggregation Router (SAR), Alcatel-Lucent 7210 Service Access Switch (SAS), Alcatel-Lucent 1850 Transport Service Switch (TSS), or Alcatel-Lucent 9500 Microwave Packet Radio (MPR) can all perform the aggregator function and enable a dedicated, fully-managed, end-to-end backhaul solution capable of supporting any combination of wireless access technologies and vendors.

These cell site aggregation solutions can also help service providers by linking small clusters of base stations and grooming the traffic to reduce backhaul costs. Through the implementation of Carrier Ethernet between the eNodeB and the mobile core, traffic can be aggregated efficiently and end-to-end service delivery upheld.

3.3 OAM tools

To support Ethernet-based services effectively and proactively, service providers need effective OAM tools that help reduce network complexities and enable them to roll out new services quickly. Alcatel-Lucent provides comprehensive unified OAM management support at both the NMS/OSS and node levels that has been specifically designed to automate the management of large networks. This enables the collection of real-time information on all critical devices, network tunnels, connectivity services and control plane health, and the correlation of different events into a meaningful report.

The comprehensive Alcatel-Lucent OAM toolkit includes:

- Standard implementations of Ethernet-focused OAM tools for connectivity checks and fault detections that can span across all network layers, including access, metro aggregation and backbone.
- Comprehensive OAM tools for physical interface and service layers, from network tunnel tests to in-band service tests for customer service verifications.
- Industry-leading service and performance analysis with integrated service mirroring and service assurance.
- Service mirroring that delivers analyzed data without any performance impact, and which is flexible enough to continually evolve to support the complex service provider environment.
- Service assurance that can detect any impending issues and proactively monitor the health of different services in the networks by analyzing the packet delay, jitter and loss.
- Integration with centralized unified management tools, such as the Alcatel-Lucent 5620 SAM and Alcatel-Lucent 5650 Control Plane Assurance Manager (CPAM) or Alcatel-Lucent 1350 OMS, to simplify network operation and enable a service provider to conduct real-time detailed forensic audits and quick correlations of network events.

In general, Ethernet OAM is separated into Link OAM, which monitors a single link, and Service OAM, which spans one or more links. Ethernet OAM is desirable for fault management, connectivity management, and performance monitoring of the Ethernet service. For example, Ethernet OAM for each subscriber Ethernet virtual circuit (EVC) at the user-network interface (UNI) could be implemented in the RAN network controller and RAN base station to convey Ethernet connectivity state and performance. The MEF Mobile Backhaul Implementation Agreement (MEF22) refers to standards that include Link OAM (IEEE 802.3ah), and Service OAM (both IEEE 802.1ag and ITU-T Y.1731).

3.4 Consultative services

Alcatel-Lucent Professional Services delivers comprehensive end-to-end consulting services, with activities ranging from business analysis and modeling to design. Using proven business and economic modeling tools jointly developed with Bell Labs, and leveraging its expertise in managing over 50 major transformations, Alcatel-Lucent develops strategies to optimize the total cost of ownership of the backhaul network and helps determine the best solution to evolve gracefully to all-packet networks.

Alcatel-Lucent consultative services ensure key business requirements are met through efficient management of all aspects of the provider's business including networks, services, and operations. This includes lowering the cost structure, expanding network capacity, and generating new business models for more revenue. Alcatel-Lucent develops a model of the present mode of operation and proposes a strategy based on the model. Next, consultants design a blueprint for the future mode of operation, taking into consideration the importance of a flat-IP architecture in support of LTE. Then, they validate that the design meets the service provider's business requirements. Finally, the consultants provide a financial comparison of the present and future modes of operation, including cash flow and sensitivity analyses. Working closely with the service provider, consultants define the project scope and applicable solution/solution components for the network transformation, including the precise number, size, and location of nodes to be deployed, and they provide consistent management control throughout the network transformation.

3.5 IP Transformation and wireless migration expertise

Proper planning for backhaul network transformation is a comprehensive, complex undertaking spanning numerous technical, operational and business functions. Alcatel-Lucent has significant experience in these areas and in working with multi-technology, multi-vendor transport networks around the world. Alcatel-Lucent's transformation approach helps service providers to take advantage of the cost savings available through different technology options.

The transformation process includes analysis of the current infrastructure, and evaluation of the network database information in its current form, followed by the development and mapping techniques for provisioning and migrating to the new IP network. Alcatel-Lucent's transformation capabilities include migration planning and design, process definition and rollback strategy, migration execution and stability monitoring, all supported by migration control management.

To further support service providers, Alcatel-Lucent has invested in a network of integration facilities across the world known as IP Transformation Centers (IPTC). In the IPTC's Hosted Integration Lab, service providers have one-stop access to a live test environment where their own multi-vendor network can be replicated, configured, and pre-integrated and tested on an end-to-end solution basis encompassing terminals, network infrastructure, service application platforms and OSS/BSS. These facilities help services providers ensure that the infrastructure they implement is the best solution for their specific needs. The pre-integrated backhaul and Evolved Packet Core ensures a smooth transition with minimal risk.

4. Conclusion

With mobile traffic evolving to become fully IP-based, the mobile transport network needs to address key new requirements for guaranteed, enhanced QoS and low latency. At the same time, the mobile transport network needs to provide the required scalability while ensuring service reliability and flexibility.

Service providers who are employing mobile packet transport based on Alcatel-Lucent META can leverage the same packet transport network architecture for LTE. This gives MSPs and BTPs a clear evolution path to LTE, and allows the coexistence of LTE with previous generations of mobile technologies through cost-effective, converged transport. META provides a comprehensive solution addressing the introduction of LTE by supporting:

- Scalability to match LTE bandwidth requirements
- Multiservice transport and efficient coexistence of 2G/3G with LTE
- Enhanced QoS through integration of the mobile and transport layers
- Flexible support for either aggressive or conservative LTE migration strategies
- Ability to converge backhaul and backbone transport for maximum flexibility in LTE roll-out and growth
- Field-proven clock synchronization techniques that support smooth handoffs
- Security and resiliency features in support of migration to all-IP services

By delivering a multi-technology solution, Alcatel-Lucent META enables the reliable transport of all-IP traffic over packet-optical, microwave, IP/MPLS, or DSL/GPON transport networks. To ensure the continuity of services based on existing mobile technologies while introducing LTE, META allows advanced traffic management and processing, and full separation and prioritization of different service traffic, in order to deliver guaranteed end-to-end, managed QoS. Through the implementation of the Alcatel-Lucent Mobile Evolution Transport Architecture, service providers can consolidate capital expenditures and rationalize operating expenditures while benefiting from a more scalable, flexible, resilient and secure transport network.

5. Abbreviations

1350 OMS	Alcatel-Lucent 1350 Optical Management Suite
1678 MCC	Alcatel-Lucent 1678 Metro Core Connect
1830 PSS	Alcatel-Lucent 1830 Photonic Service Switch
1850 TSS	Alcatel-Lucent 1850 Transport Service Switch
5620 SAM	Alcatel-Lucent 5620 Service Access Manager
7210 SAS	Alcatel-Lucent 7210 Service Access Switch
7302 ISAM	Alcatel-Lucent 7302 Intelligent Services Access Manager
7330 ISAM	Alcatel-Lucent 7330 Intelligent Services Access Manager
7342 ISAM	Alcatel-Lucent 7342 Intelligent Services Access Manager
7450 ESS	Alcatel-Lucent 7450 Ethernet Service Switch
7705 SAR	Alcatel-Lucent 7705 Service Aggregation Router
7710 SR	Alcatel-Lucent 7710 Service Router
7750 SR	Alcatel-Lucent 7750 Service Router
9500 MPR	Alcatel-Lucent 9500 Microwave Packet Radio
aGW	access gateway
ATM	Asynchronous Transfer Mode
B-ONT	business optical network terminal
BSC	base station controller
BTP	backhaul transport provider
BTS	base transceiver station
CDMA	Code Division Multiple Access
CES	Circuit Emulated Services
DSL	Digital Subscriber Line
E-Line	Ethernet line service
EPC	Evolved Packet Core
EUTRAN	Evolved UMTS Terrestrial Radio Access Network
EVC	Ethernet virtual circuit
EVDO	Evolution Data Optimized
GGSN	Gateway GPRS Support Node
GPON	Gigabit Passive Optical Network
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
GW	gateway
HSPA	high speed packet access
IMA	Inverse Multiplexing over ATM
IMS	IP Multimedia Subsystem
IP	Internet Protocol
LAN	local area network
LTE	Long Term Evolution
MBMS	Multimedia Broadcast Multicast Service
MEF	Metro Ethernet Forum
META	Mobile Evolution Transport Architecture
MGW	media gateway
MIMO	multiple input and multiple output
MLPPP	Multilink Point-to-Point Protocol
MLS	multilayer switch
MME	mobility management entity
MMS	multimedia messaging service
MPLS	Multiprotocol Label Switching
MPLS-TP	Multiprotocol Label Switching-Transport Profile
MSC	mobile switching center
MSP	mobile service provider
MTSO	mobile telephone switching office
OAM	operations, administration and maintenance
P2P	point-to-point
PBB	Provider Backbone Bridge
PCRF	policy and charging rules function
PDH	Plesiochronous Digital Hierarchy
PDN	Public Data Network
PDSN	Packet Data Serving Node
PGW	PDN gateway
QoS	quality of service
RAN	radio access network
RNC	radio network controller
SDH	Synchronous Digital Hierarchy
SGSN	Service GPRS Support Node
SGW	serving gateway
SLA	service level agreement
SMS	short message service
SONET	Synchronous Optical Network
SyncE	Synchronous Ethernet
TDD	Time-Division Duplex
TDM	Time Division Multiplexing
UMTS	Universal Mobile Telecommunications System
UNI	user-network interface
VoIP	Voice over Internet Protocol
VPLS	Virtual Private LAN Service
VPN	Virtual Private Network
W-CDMA	Wideband Code Division Multiple Access

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