Alcatel·Lucent

STRATEGIC WHITE PAPER

Deploying IP/MPLS in Mobile Networks

As mobile service providers prepare for the evolution to mobile broadband, they require a robust transport infrastructure that supports CDMA/EV-DO and GSM/UMTS/HSPA today and is well suited to support WiMAX, LTE and fixed-mobile convergence (FMC). Internet Protocol/Multi-Protocol Label Switching (IP/MPLS) has grown to become a foundation for many fixed, mobile and converged networks. In mobile networks, IP/MPLS consolidates disparate transport networks for different radio technologies, reduces operating expenditures (OPEX) and converges networks on a resilient and reliable infrastructure, while being ready to support further evolution to Fourth-Generation Mobile Network (4G) technologies.

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Introduction

With mobile networks evolving to mobile broadband, Multi-Protocol Label Switching (MPLS) is being deployed by many mobile service providers to consolidate disparate transport networks for different radio technologies, reduce operating expenditures (OPEX) and converge on a resilient and reliable infrastructure. This infrastructure is ready for further mobile evolution to Fourth-Generation Mobile Network (4G) technologies such as Worldwide Interoperability for Microwave Access (WiMAX) and Long Term Evolution (LTE) and full fixed-mobile convergence (FMC).

The Alcatel-Lucent IP/MPLS solutions for mobile service providers allow creating cost-effective mobile and converged network architectures intended for voice, video and data delivery that can be leveraged as the existing mobile networks evolve to an LTE-based network architecture.

The mobile broadband

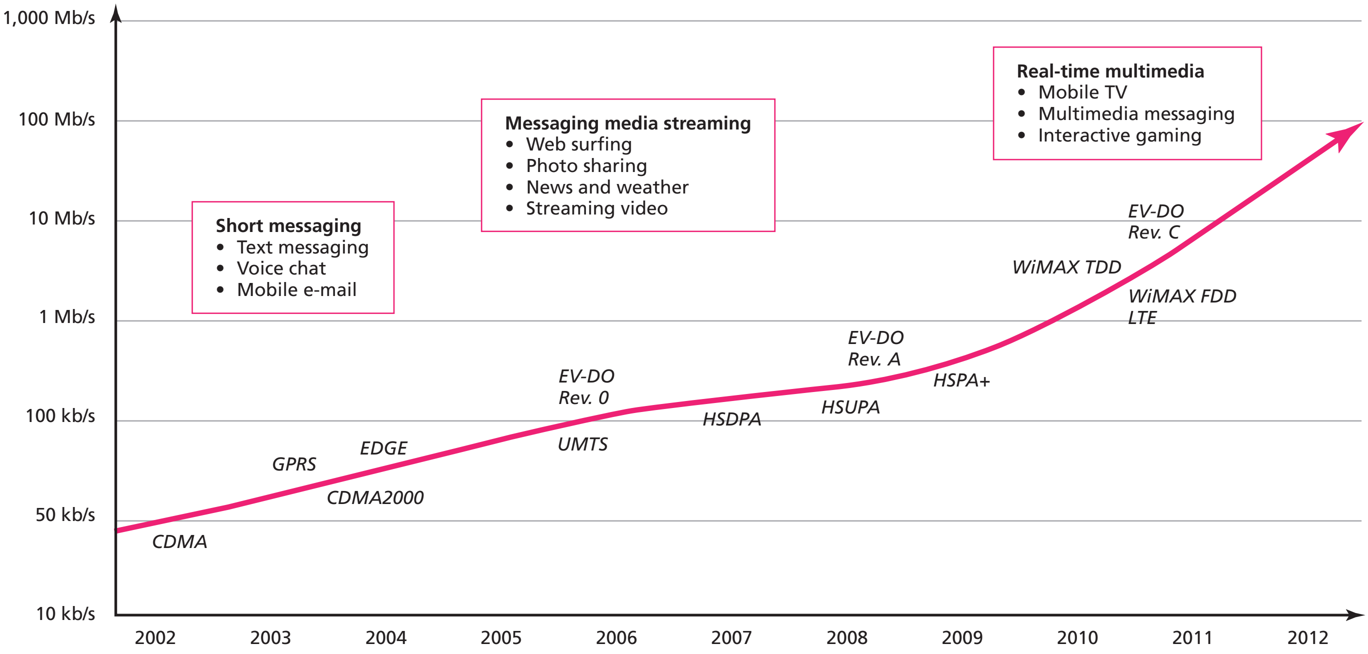
The global geographical reach of mobile networks and their seamless roaming abilities make mobile the first choice for communications today. In both the developed and the developing world, more people are relying on mobile networks as their primary method for voice and data communications.

Radio-technology advancements and the development of smaller, versatile handheld devices and smartphones, are allowing rapid delivery of new, high-speed data and multimedia services.

While these sophisticated handheld devices have a significantly higher novelty factor than previous generations of mobile phones, the key promise of newer technologies lies in the ability to further advance traditional voice, Short Message Service (SMS) and mini web-browsing services and deliver real-time bandwidth-intensive services with same Quality of Experience (QoE) historically available only over fixed networks.

The result of this technological progress is referred to as the mobile broadband (see Figure 1).

Figure 1. Evolution of services and end-user bandwidth in mobile networks



Paradigm change in mobile transport networks

Hoping to use the market interest in the new, multimedia-rich mobile services to attract new customers and find new revenue sources, mobile service providers are embracing new mobile radio technologies, such as EV-DO in the CDMA standard track, and high speed packet access (HSPA) in the Universal Mobile Telecommunications System (UMTS)/Wideband Code Division Multiple Access (W-CDMA) standard track. This opportunity to solve some key business problems, such as declining average revenue per user (ARPU), by increasing subscriber numbers and rapidly deploying new services, comes with some risks. The increased bandwidth volumes demanded by new services cannot be easily carried across the existing mobile network without incurring major transport costs that can account for up to 35 percent of the total OPEX[1].

Mobile service providers are recognizing the need to evolve their transport networks to all-IP for delivering new services and staying competitive, but they have concerns about abruptly changing their network architecture from the long-serving, proven and reliable TDM-based transport. The biggest drawback to TDM transport is that transport costs are linearly proportional to transported bandwidth, with the increased bandwidth required for new services undermining the overall business case. Therefore, mobile service providers are investigating new business models, including new transport network paradigms, with the aim of lowering the overall cost of transport per bandwidth transferred, as well as decoupling the service delivery cost from the overall operation costs, including the transport.

This new, cost-effective all-packet transport must address all mobile technologies:

- CDMA (3G1X) and EV-DO
- GSM, GPRS, EDGE, UMTS, HSPA and HSPA+
- WiMAX and femto cells

The all-packet transport also must be fully aligned with the further evolution of mobile technologies toward LTE and Evolved Packet Core (EPC).

Mobile transport and all-IP

Over the last decade, radio technologies have rapidly progressed and evolved, introducing new network overlays, such as 3G, and demanding new technologies for mobile transport (see Figure 2).

The evolution to 3G and beyond imposes tremendous changes on the mobile-transport side, with estimates indicating that bandwidth-per-cell must increase almost an order of magnitude to support new services. At the same time, existing transport models are no longer viable. To address the constant pressure for improving capital expenditures (CAPEX) and OPEX, mobile transport networks are considered an integral part of the entire mobile network. An increasing number of service providers either already own, or have plans to own, the associated mobile transport network or a larger part of it. This consideration to own the associated transport network makes mobile transport networks subject to the same key principle to clearly separate the cost of introducing new services from the technical requirements for their delivery, including the support for increased bandwidth.

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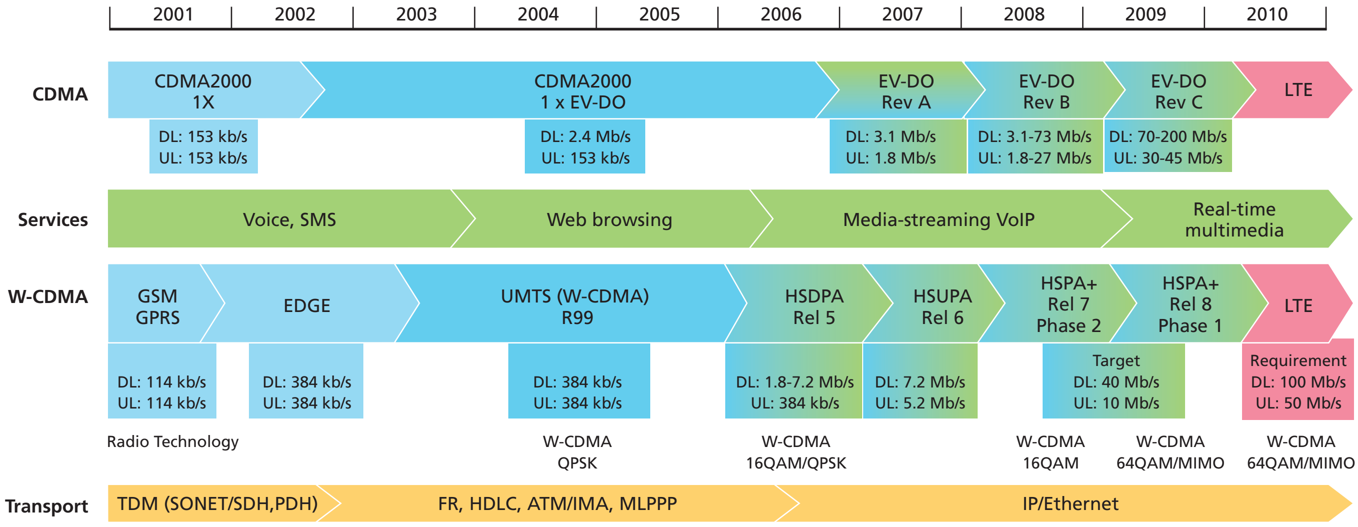
[1] Yankee Group study, 2006

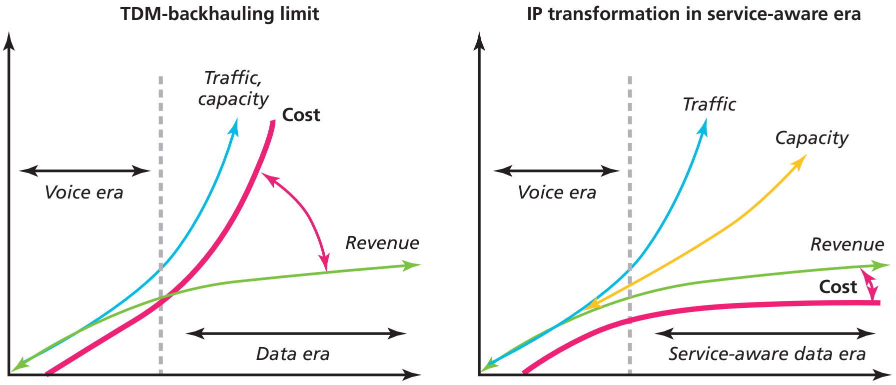
Figure 2. Evolution of mobile radio technologies and associated RAN transport



Although tremendously important, cost is not the only concern that mobile service providers have about the transport network. The transport network also needs to decouple from the mobile technologies being transported, allow the cost-effective mix of different technologies and support any pace of evolution to 4G and all-IP.

The need to change the existing transport paradigm from its TDM-based T1/E1 granularity of leased-lines to a new, cost-effective model also provides an opportunity to create a forward-looking, all-IP transport network that can support evolving and scaling the mobile services for years to come (see Figure 3).

Figure 3. Decoupling transport costs, capacity and revenues



Source: Unstrung Insider/Heavy Reading

Source: Alcatel-Lucent Corporate Stragegy

Key benefits of IP/MPLS for mobile transport

With lower-cost per bit and better granularity steps than traditional SONET/SDH transport (from T1/E1 to DS3/E3 and OC-m/STM-n), Carrier Ethernet provides significant benefits for large-scale deployments of bandwidth-intensive services. While availability of Ethernet at cell towers is increasing, the vast majority of towers continue to connect to the backhaul network using legacy T1/E1 transport or PDH/SONET/SDH. A large number of mobile networks also rely on microwave-based systems for very cost-effective and reliable mobile backhaul.

To properly address diverse network requirements for interface types and network protocols, often within a single mobile-service-provider environment, new mobile transport networks must overcome first-mile media restrictions. These networks also must provide common technological and operational frameworks for allowing an arbitrary mix of access types, such as copper, fiber and microwave, and technologies, such as TDM, ATM and IP/MPLS, while being fully capable of addressing the paramount requirement for all-IP readiness.

Over the last several years, MPLS has become the technology of choice for many fixed, mobile and converged networks, with an impressive list of advantages:

- Allows mixed deployment of new, low-cost, Ethernet-based transport infrastructures and existing legacy transport networks such as SDH/SONET and PDH
- Provides quick delivery of new, IP-oriented services while allowing a full suite of legacy services by virtue of their emulation using pseudowires, such as ATM, frame relay (FR) and TDM
- Supports all network topologies, including star, ring and mesh
- Acts as a unifying layer for upper-layer protocols, with consistent Quality of Service (QoS)
- Offers extensive traffic engineering capabilities that allow implementing multiple and hierarchical QoS and guaranteed service level agreements (SLAs)
- Allows massive scaling of point-to-point and point-to-multipoint services, including virtual private LAN service (VPLS) and virtual private networks (VPNs), through full Layer 2 and Layer 3 capabilities with Layer 3 routing and connection-oriented traffic flows
- Delivers carrier-grade reliability and resiliency with fast and flexible protection mechanisms
- Satisfies requirements for reliable timing distribution over packet-based networks
- Delivers common management and OAM framework for all services
- MPLS-based infrastructure can facilitate service convergence — in cases where service providers are looking to combine their metro Ethernet infrastructure, used for business and residential services, with mobile transport infrastructure

While Ethernet availability and cost-effectiveness are the key factors for the mass acceptance of Ethernet-based transport, for true carrier-grade features, pure Layer 2 Ethernet must be enhanced to allow scaling and provide the necessary end-to-end QoS.

Deploying Carrier Ethernet based on IP/MPLS ensures carrier-grade capabilities, large-scale network scalability, end-to-end QoS delivery with comprehensive OAM and allows full service convergence.

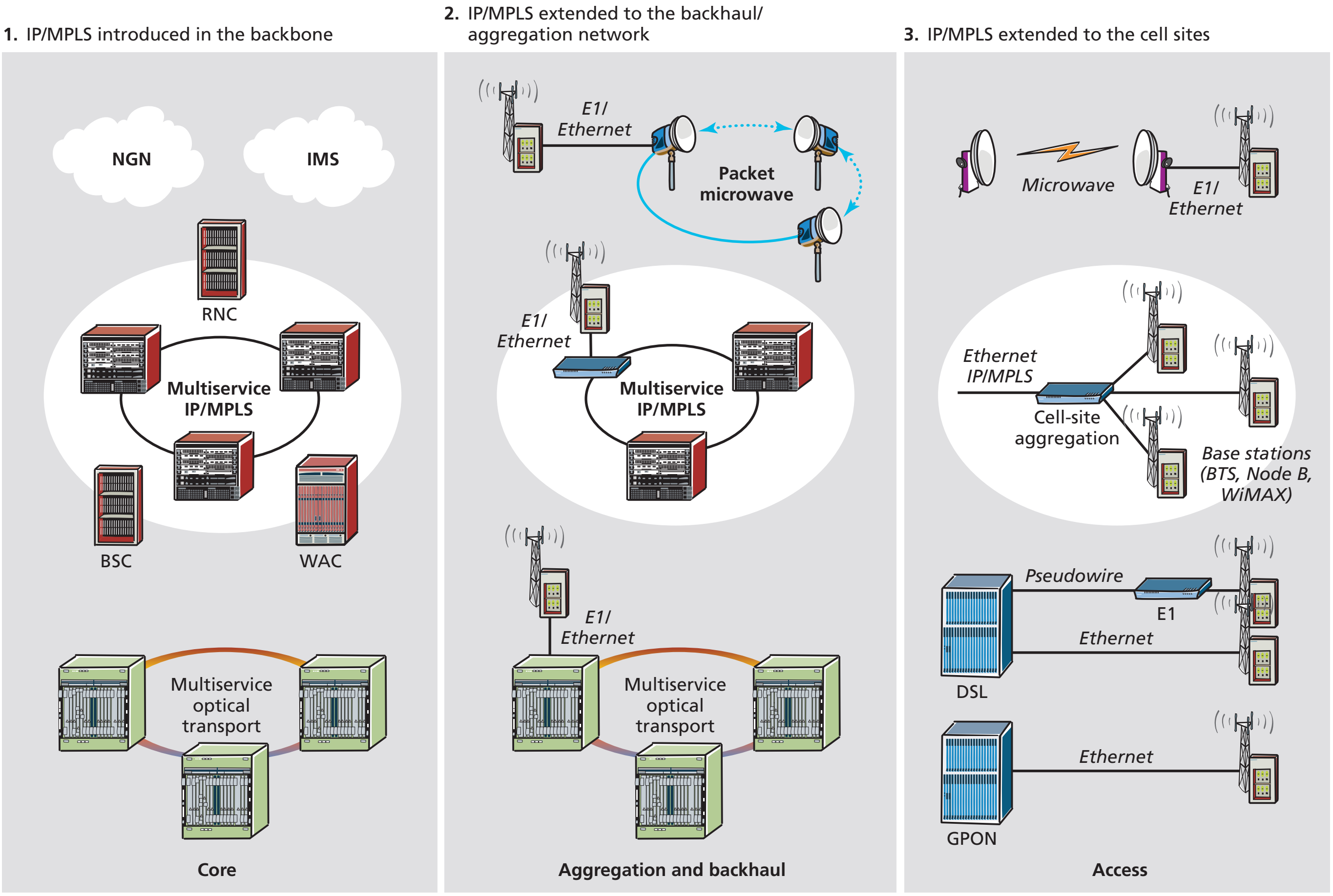
Staged evolution to IP/MPLS in mobile networks

Evolving mobile transport networks using IP/MPLS is a multistep process. For most mobile service providers, the first step is introducing the dedicated IP/MPLS mobile backbone as a part of the mobile core, as per the Third-Generation Partnership Project (3GPP) Release 4 specification. The next steps of mobile transport transformation are in evolving the mobile hub and aggregation sites to IP/MPLS, with extension of IP/MPLS to cell sites, graphically shown on Figure 4.

With the extension of MPLS to cell sites, the entire mobile transport network effectively becomes all-IP.

This evolved mobile transport network can reliably and cost-effectively support all existing and new services, and accommodate any pace of all-IP evolution on the radio side, to WiMAX, LTE and femto cells. MPLS is well positioned to address consolidation of Circuit Switched (CS) and Packet Switched (PS) mobile cores into a converged core and the evolution to a common EPC, as well as end-to-end consolidation around IP.

Figure 4. Waves of IP/MPLS transformation in mobile transport networks



1. IP/MPLS introduced in the backbone

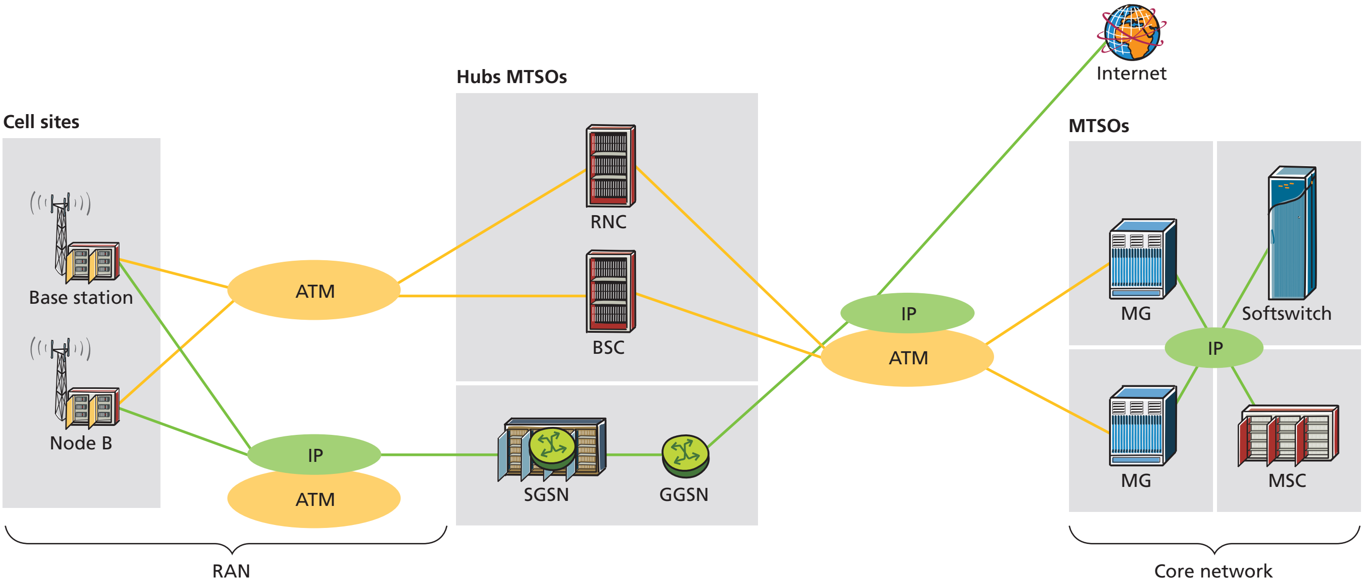
2. IP/MPLS extended to the backhaul/ aggregation network

3. IP/MPLS extended to the cell sites

Mobile backbone and IP/MPLS

Historically, the 3GPP R4 set of standards specified the mobile core, or Bearer Independent Mobile Network, and the associated dedicated data backbone network to interconnect Mobile Switching Centers (MSCs), media gateways (MGs) and media gateway controllers (MGCs), or SoftSwitches (see Figure 5).

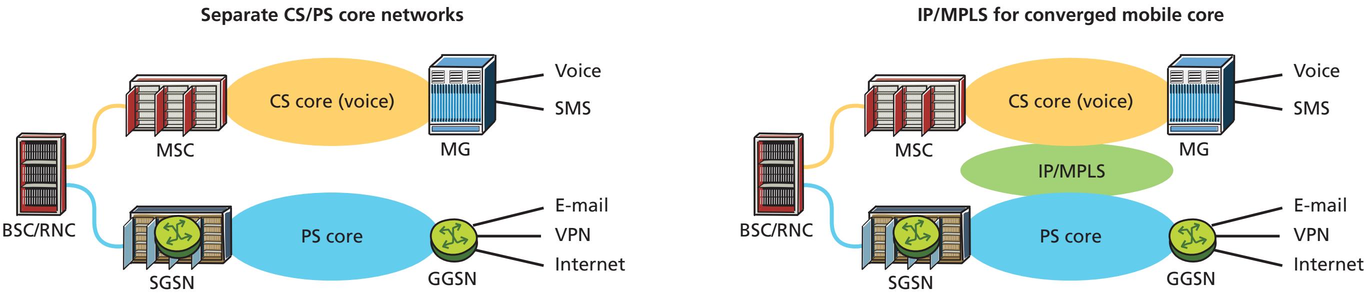
Figure 5. RAN and mobile core network in UMTS



The 3GPP R4 specification allowed choosing between ATM and IP for the core network packet technology, while the subsequent 3GPP Release 5 and IP Multimedia Subsystem (IMS) mandated the use of IP.

With all-IP as the end goal, most of service providers transforming their network architectures to 3GPP R4 and beyond have opted to go with the IP option for both their mobile core and the associated data backbone, having in mind the evolution to Voice over Internet Protocol (VoIP). This choice was made with the understanding that the actual implementation will be a combination of IP and MPLS, referred to as IP/MPLS (see Figure 6).

Figure 6. IP/MPLS data backbone convergence on IP/MPLS for CS and PS mobile cores



IP/MPLS fully addresses key requirements for the modern mobile core network architectures. Table 1 shows these key requirements for the mobile core and how IP/MPLS addresses them.

Table 1. Requirements and benefits of deploying IP/MPLS

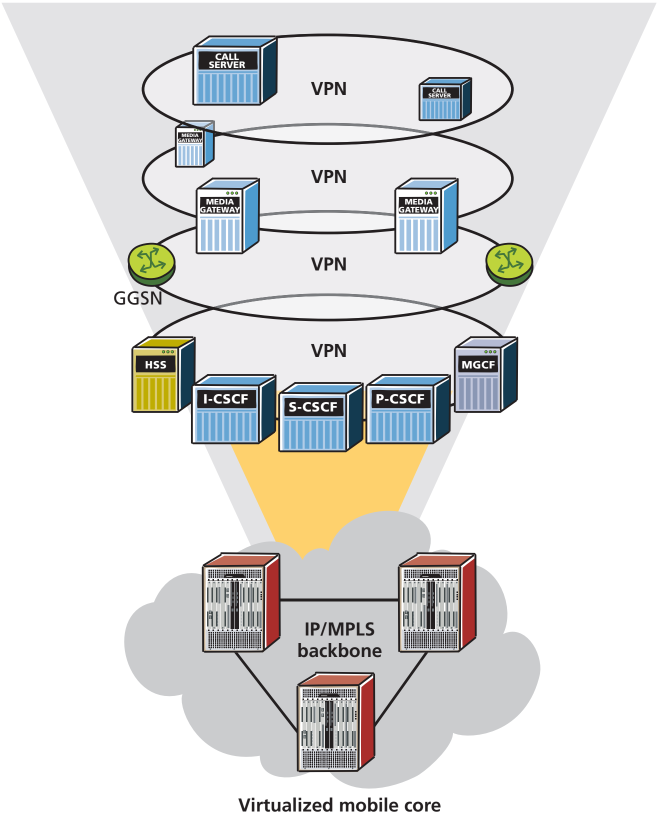
MOBILE CORE REQUIREMENTS	BENEFITS OF DEPLOYING IP/MPLS IN MOBILE CORE
High reliability and availability	• Matches performance standards set in TDM networks • Allows redundant architectures at all levels, with no single point of failure • Delivers network-wide reliability through MPLS fast reroute (FRR) and global repair mechanisms for fast recovery
Guaranteed per-service, per-subscriber QoS	• Consolidates transport of existing data services while protecting premium voice traffic • Introduces new data and multimedia services based on IP with appropriate QoS guarantees, for example, for video streaming and interactive applications • Satisfies core network QoS requirement for voice transport (transit delays, jitter and packet loss) • Supports dynamic control plane mechanisms to help service provisioning without involving external systems
Manageability	• Supports the end-to-end management and engineering tools required for rapid rollout of service and efficient network operations
Proven, scalable solution	• Proven and deployed in largest IP network transformation projects • Smoothly scales with consistent network-wide features • Allows gradual evolution to 3G/4G and next-generation network (NGN)/IMS
Service flexibility	• Ability to offer both Layer 2 and Layer 3 services, supporting concurrent deployment of point-to-point and point-to-multipoint service types

With high reliability and resiliency to match the standards set by TDM switching technology, IP/MPLS allows mobile backbones to scale in a controlled and managed way, while delivering guaranteed per-service QoS, full traffic isolation and security in the form of VPNs.

The establishment of VPNs allows traffic and services to be separated and managed independently and results in a virtualized mobile core, where different elements and applications in the mobile core are interconnected over separate VPNs, including Layer 2 or Layer 3 VPNs. At the same time, this mobile core virtualization allows a smoother evolution to IMS and the ubiquitous delivery of new services over mobile and converged network infrastructures (see Figure 7).

For more details on IP/MPLS in the mobile core, please consult the relevant dedicated application notes.

Figure 7. Virtualized mobile core

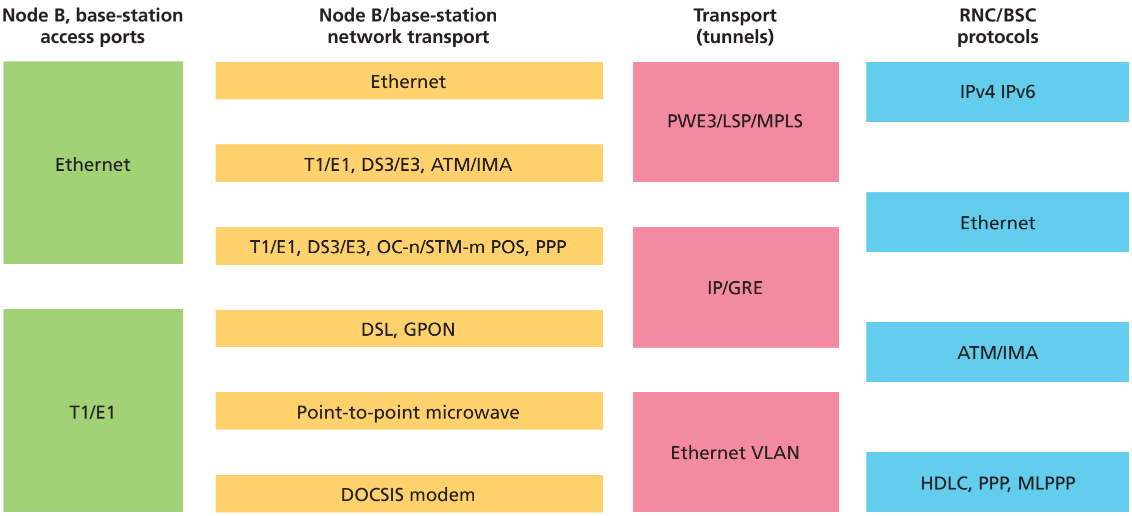


Improving mobile backhaul

In size and complexity, the Radio Access Network (RAN) exponentially surpasses the core network. The mobile RAN comes with a rich and varied set of access interfaces and protocol types because each generation of mobile transport technology has brought new network elements tailored to new mobile radio-interface specifications. In addition, mobile service providers continue to ingeniously incorporate all available transport mechanisms, for example, gigabit passive optical network (GPON), digital subscriber line (DSL) and microwave, to reduce their transport costs and improve the overall business case.

Figure 8 graphically illustrates this RAN complexity by showing the protocol diversity in the RAN.

Figure 8. A snapshot of 2G and 3G backhaul protocols



2G and 2.5G networks commonly use T1/E1 circuits through SONET/SDH transport or over point-to-point microwave links. With 3G networks, ATM/IMA has scaled fairly well as a transport technology for delivering the statistical benefits of ATM multiplexing, along with QoS and traffic engineering capabilities. ATM also allows further traffic optimization and convergence of transport for 2G and 3G.

Increasingly, base stations and their associated controllers are arriving with built-in support for Ethernet and IP. For these evolved elements of the RAN, Ethernet-based transport networks with IP/MPLS architectures provide a better technological complement, because their combined deployment results in end-to-end all-IP environments.

Therefore, a RAN transport network needs to address all important RAN issues, including:

- Diversity of access media: fiber, copper or microwave
- Multiple aggregation technologies: TDM grooming, ATM/IMA and Multilink Point-to-Point Protocol (MLPPP)
- Coexistence of existing 2G and 3G and new technologies, such as WiMAX, femto and LTE
- Scaling capability to support thousands of network elements with different network requirements

Mobile service providers must address all these issues in an extremely reliable manner, matching or exceeding the carrier-grade standards set by fixed service providers and legacy transport technologies.

Mobile backhaul and IP/MPLS

While MPLS has by now gained universal acceptance as the networking technology for improving the transport of multiple protocols over diverse transport technologies, it also delivers traffic engineering extensions, allowing end-to-end network management and also offers extensive OAM capabilities for the ideal operation of large networks.

In brief, the key factors for the wide acceptance of MPLS in mobile backhaul networks are:

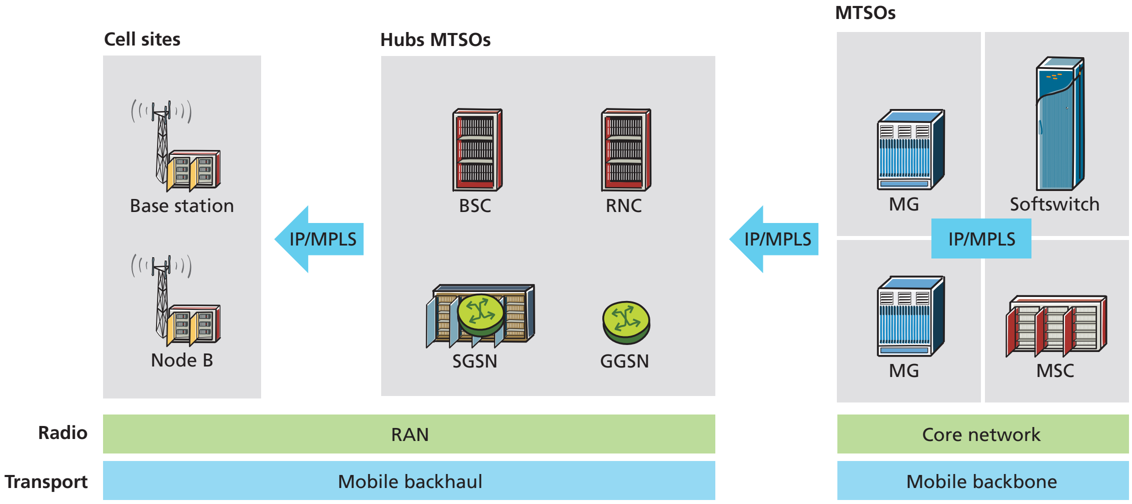
- Suitability for new, IP-based, high-bandwidth multimedia-rich services that require end-to-end QoS
- Ability to evolve to new networking technology with consistent OAM, including OAM interworking with legacy protocols
- Ability to reliably distribute timing information over all-packet transport using strict QoS and traffic management

Network-wide deployment of IP/MPLS in mobile networks has become a phased evolution, with MPLS first being deployed at major mobile telephone switching office (MTSO)/MSC locations, then, with MPLS boundaries and requirements being pushed to the aggregation/hub points, with MPLS eventually being extended all the way to cell sites (see Figure 9).

While perfectly suited for the all-IP and Ethernet-based WiMAX and LTE mobile networks, IP/MPLS also supports a range of existing underlying transport infrastructures, based on legacy SONET/SDH, and allows creating multigenerational, cost-effective, converged, scalable and multipurpose transport networks, including 2G, 2.5G, 3G and 4G.

Continued deployment of existing radio technologies, such as 3G and 2G, and transport protocols, such as ATM/IMA, High-Level Data Link Control (HDLC), MLPPP and TDM, is enabled by using pseudowire technology, where different types of protocols and technologies are emulated over MPLS in the form of MPLS tunnels. For example, 2G/2.5G traffic is transported over TDM pseudowires, and 3G traffic is transported over ATM pseudowires. Some RAN control/management traffic is carried in the form of Ethernet pseudowires over MPLS.

Figure 9. Evolution of IP/MPLS in mobile networks



Strategies for introducing IP/MPLS in mobile backhaul networks

Mobile service providers are embracing two evolution strategies to benefit from more cost-effective Ethernet-based transport, while taking into consideration their transport network capabilities.

- One strategy offloads the data traffic originating from new high bandwidth services onto a dedicated data transport network — either a new or existing data network — while continuing to use the existing transport model, predominantly TDM or ATM-based, for voice traffic.
- The other strategy creates a unified, converged transport network, equally suitable for transporting new bandwidth-demanding data services and traditional voice services.

These two strategies offer two alternatives for mobile backhaul (see Figures 10 and 11):

- *Hybrid backhaul* – where new, high bandwidth data services are offloaded onto a parallel, and separate transport infrastructure (for example, metro Ethernet, DSL and GPON)
- *Full packet backhaul* – where a converged, data-optimized backhaul network is created

Using MPLS for the associated data transport network has gained equal acceptance in both of these alternative approaches, both for the key technology deployed for alternative backhaul in the hybrid scenario and also as the key technology used in the full packet scenario.

In many networks, the hybrid option is chosen as the first step to fully evolving to end-to-end IP/MPLS solution for their mobile backhaul network.

In addition, deploying all-packet transport networks based on IP/MPLS allows mobile service providers and network operators to extend their business to converged networks. For more details on IP/MPLS RAN and pseudowires, please consult the dedicated application notes.

Figure 10. Hybrid backhaul option

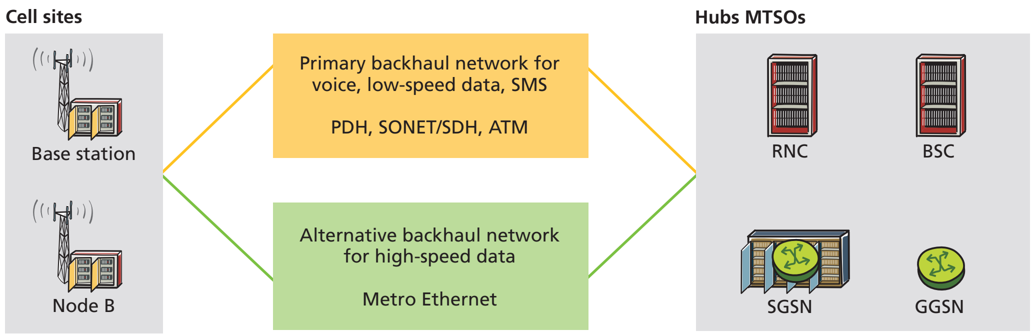
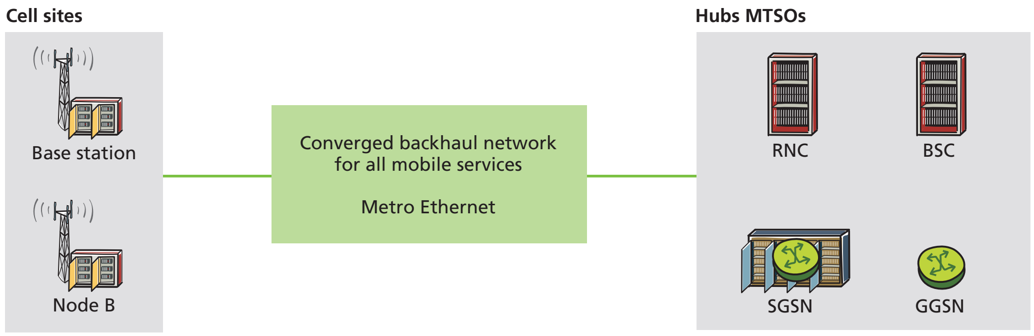


Figure 11. Full packet backhaul option



LTE and IP/MPLS

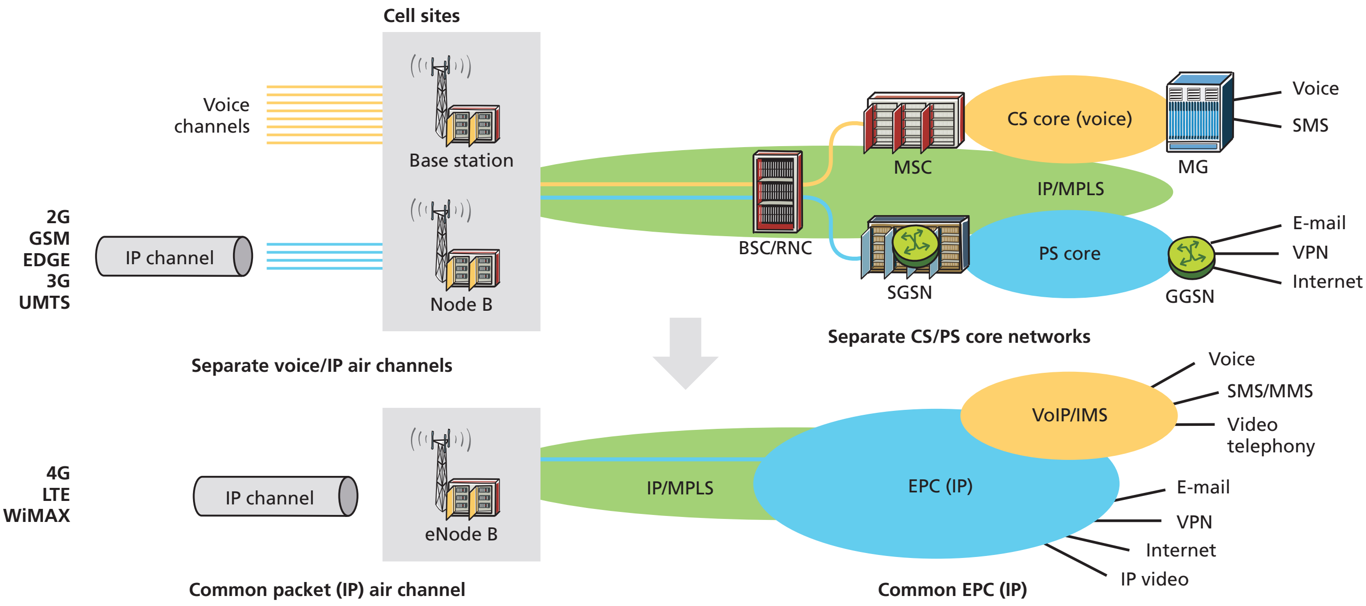
With the formal definition and publishing of the LTE specification in the form of 3GPP Release 8 in January 2008, as well as the announced plans for LTE adoption by major UMTS operators and even by some large CDMA operators, there is no doubt that the acceleration toward the fully mobile broadband will bring LTE sooner than originally expected.

LTE adoption requires major changes in the network architecture and also calls for a seamless coexistence with existing mobile technologies. The strict distinction existing in all previous mobile generations between the radio elements, such as base stations and controllers, the packet data elements, such as Serving GPRS Support Node (SGSN) and Gateway GPRS Support Node (GGSN) and the transport elements, such as TDM/ATM switches and routers, may be coming to an end in the LTE world. In particular, introduction of the new mobile core, EPC, will result in less protocol hierarchy between all these disparate network elements and more network flattening built around one key networking protocol — IP.

By offering the ability to seamlessly and smoothly transition to an LTE-based architecture, MPLS safeguards investments made by service providers today. Using MPLS as a networking protocol now offers the advantage of reusing the same technology in LTE. MPLS allows the seamless coexistence with existing mobile technologies that continue to use MPLS for reliable and efficient bearer and control transport of 2G and 3G mobile traffic.

In addition, MPLS-capable network elements can address the flat-IP requirements by delivering Layer 3-based functionality. These network elements also can extend their function from the efficient transport of legacy mobile traffic over cost-effective, Carrier-Ethernet transport using pseudowires to fully participating in Layer 3 routing, while allowing full service and network interworking with the pseudowire-based overlay for 2G/3G (see Figure 12).

Figure 12. LTE: toward flat-IP and EPC



Alcatel-Lucent Mobile Transport Evolution Architecture (META)

Alcatel-Lucent is a leader in IP transformation of mobile transport networks with the Alcatel-Lucent Mobile Evolution Transport Architecture (META), the industry's first and most comprehensive vision for evolving mobile transport networks from TDM to all-IP.

Designed to help mobile service providers meet new objectives and make a profitable transition to a more cost-effective mobile network infrastructure, the Alcatel-Lucent META supports the delivery of new multimedia services and applications and reduces the cost of the mobile transport network, creating a profitable evolution path to all-IP.

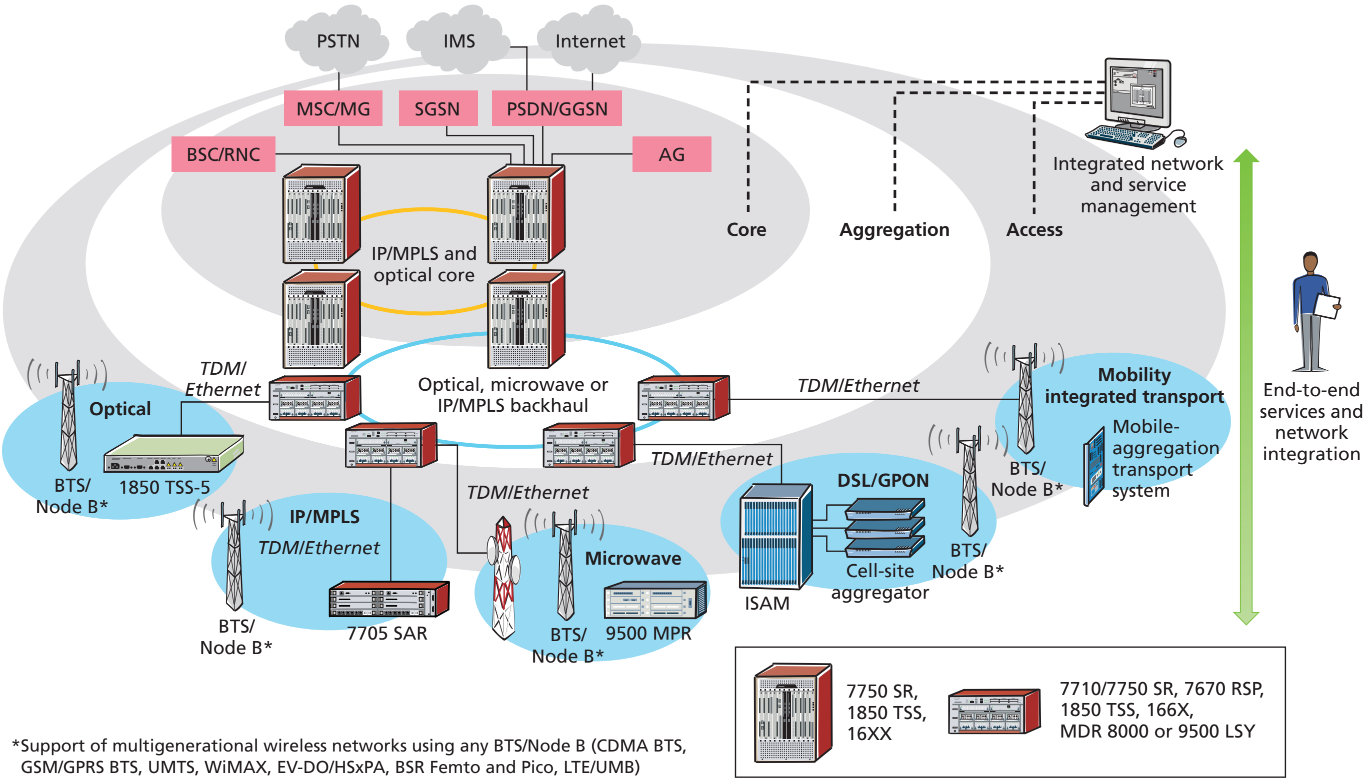
The Alcatel-Lucent META combines industry-leading IP/MPLS, access, optical, microwave and network management products with associated professional services to deliver an integrated framework for mobile backbone and backhaul solutions.

Offering a more graceful approach than a direct migration from one technology to another, the Alcatel-Lucent META addresses capacity and margin pressures and provides integrated, end-to-end management across multiple technology domains to further simplify operations and lower costs.

A business case analysis, based on deploying the Alcatel-Lucent META, showed an estimated 44-percent savings in five years over traditional TDM-based networks (see Figure 13).[2]

One of the key parts of the Alcatel-Lucent META is the Alcatel-Lucent industry-leading IP/MPLS portfolio, which allows the creation of end-to-end, cost-effective and reliable all-IP transport for mobile networks.

Figure 13. The Alcatel-Lucent Mobile Evolution Transport Architecture (META)



*Support of multigenerational wireless networks using any BTS/Node B (CDMA BTS, GSM/GPRS BTS, UMTS, WiMAX, EV-DO/HSxPA, BSR Femto and Pico, LTE/UMB)

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[2] See Alcatel-Lucent META brochure for more details

Alcatel-Lucent IP/MPLS portfolio for mobile transport

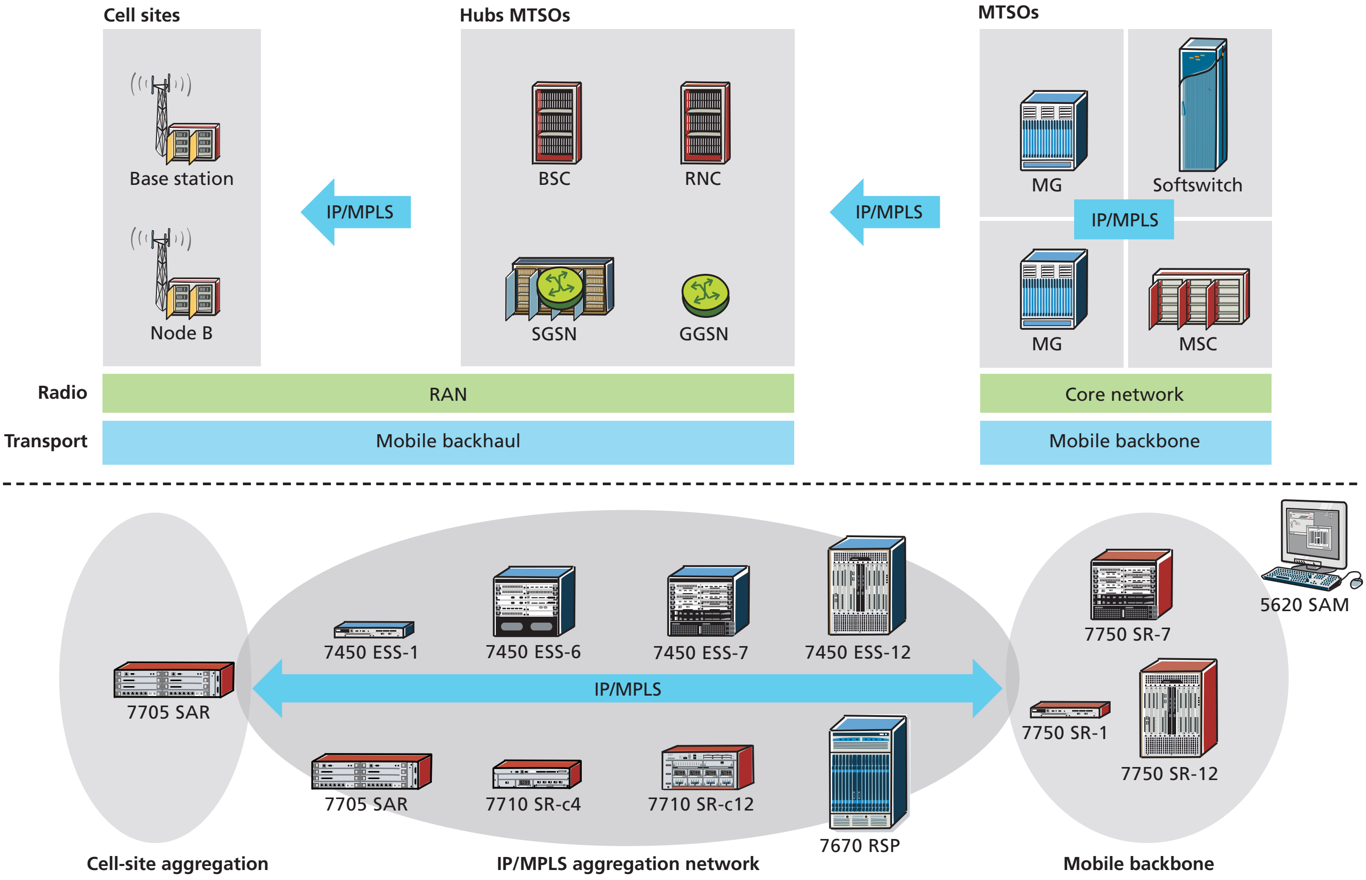
Alcatel-Lucent IP/MPLS solutions for mobile transport are based on deploying the Alcatel-Lucent Service Routers (SRs), Alcatel-Lucent Ethernet Service Switches (ESSs) and Alcatel-Lucent Service Aggregation Routers (SARs), with end-to-end network and service management by the Alcatel-Lucent 5620 Service Aware Manager (SAM) (see Figure 14).

These industry-leading solutions for cost-effective mobile transport deliver:

- High network reliability and service availability
- Service resiliency with service end-point protection and end-to-end path recovery
- Service awareness: ability to perform flexible correlation to mobile QoS, classify and prioritize traffic and ensure required and guaranteed QoS performance, including delay, jitter and packet loss
- Efficient bandwidth management
- Multiple traffic-flow aggregation and transportation
- Powerful management and engineering tools
- Comprehensive end-to-end OAM and SLA performance and troubleshooting capabilities
- Reliable network timing distribution using packet-based mechanisms for supporting clock distribution to the base stations, including frequency, phase and time synchronization
- Network monitoring and capacity planning tools
- Network security for control and data plane

For more details on the Alcatel-Lucent META and Alcatel-Lucent IP/MPLS solutions and product portfolio refer to the dedicated application notes and datasheets.

Figure 14. Alcatel-Lucent IP/MPLS portfolio for end-to-end IP/MPLS in mobile transport networks



Summary: IP/MPLS in mobile transport networks

IP/MPLS has become the foundation for many fixed, mobile and converged networks. Its acceptance has been equally driven by the cost-effectiveness of fiber access and Ethernet, as well as by its ability to act as the uniform and unifying layer for many underlying transport technologies.

MPLS has gained wide acceptance because of its many advantages:

- Adapts to different types of access transmission technologies, including copper, microwave and fiber, and accommodates a flexible mix of access interfaces, for example, E1, STM-1, DSL, Fast Ethernet (FE) and Gigabit Ethernet (GE), and technologies such as PDH, SDH, ATM and ATM/IMA, Point-to-Point Protocol (PPP), HDLC, FR and Ethernet
- Supports legacy, including TDM, ATM and HDLC, and future, IP-based interfaces between base stations and Base Station Controller (BSC)/Radio Network Controller (RNC) complex
- Offers robust traffic engineering capabilities
- Enables end-to-end QoS for all services
- Delivers advanced OAM and troubleshooting capabilities
- Supports the evolution to all-IP and converged deployment of existing mobile technologies as well as WiMAX, femto and LTE
- Perfectly addresses FMC

With the evolution to mobile broadband, MPLS is being deployed by many mobile service providers to consolidate disparate transport networks for different radio technologies, reduce OPEX and converge on a resilient and reliable infrastructure ready for further mobile evolution to 4G technologies such as WiMAX, LTE and full FMC.

The Alcatel-Lucent IP/MPLS solutions for mobile service providers allow creating cost-effective mobile and converged network architectures intended for voice, video and data delivery that can be leveraged as the existing mobile networks evolve to LTE-based network architecture.

Abbreviations

1850 TSS-5	Transport Service Switch
5620 SAM	Service Aware Manager
7450 ESS	Ethernet Service Switch
7705 SAR	Service Aggregation Router
7710/7750 SR	Service Router
2G	Second-Generation Mobile Network
3G	Third-Generation Mobile Network
3GPP	Third-Generation Partnership Project
4G	Fourth-Generation Mobile Network
AG	access gateway
ARPU	average revenue per user
ATM	Asynchronous Transfer Mode
BSC	Base Station Controller
BTS	Base Transceiver Station
CAPEX	capital expenditures
CDMA	Code Division Multiple Access
CS	Circuit Switched
DL	downlink
DOCSIS	Data over Cable Service Interface Specification
DS	digital signal
DSL	digital subscriber line
E1	E-carrier system
EDGE	Enhanced Data rates for Global Evolution
EPC	Evolved Packet Core
ESS	Ethernet Service Switch
EV-DO	Evolution-Data Optimized
FDD	frequency division duplex
FE	Fast Ethernet
Femto cells	residential short-range, small-size mobile cells
FMC	fixed-mobile convergence
FR	frame relay
FRR	fast reroute
GE	Gigabit Ethernet
GGSN	Gateway GPRS Support Node
GPON	gigabit passive optical network; gigabit PON
GPRS	General Packet Radio Service
GRE	Generic Router Encapsulation
GSM	Global System for Mobile Communications
HDLC	High-Level Data Link Control
HSDPA	High-Speed Downlink Packet Access
HSPA	high-speed packet access
HSS	Home Subscriber Server
HSUPA	high-speed uplink packet access
I-CSCF	Interrogating Call Session Control Function
IMA	inverse multiplexing over ATM
IMS	IP Multimedia Subsystem
ISAM	Intelligent Services Access Manager
IP	Internet Protocol
LSP	label switched path
LTE	Long Term Evolution
META	Mobility Evolution Transport Architecture
MG	media gateway
MGC	media gateway controller
MGCF	media gateway control function
MLPPP	Multilink Point-To-Point Protocol
MMS	multimedia messaging service
MPLS	Multi-Protocol Label Switching
MSC	Mobile Switching Center
MTSO	mobile telephone switching office
NGN	next-generation network
OC	optical carrier
OAM	operations, administration, and maintenance
OPEX	operating expenditures
P-CSCF	Proxy Call Session Control Function
PDH	Plesiochronous Digital Hierarchy
PDSN	Packet Data Serving Node
POS	packet over SONET
PPP	Point-to-Point Protocol
PS	Packet Switched
PSTN	Public Switched Telephone Network
PWE3	psuedowire emulation edge to edge
QoE	Quality of Experience
QoS	Quality of Service
RAN	Radio Access Network
RNC	Radio Network Controller
SAR	Service Aggregation Router
S-CSCF	Serving Call Session Control Function
SDH	Synchronous Digital Hierarchy
SGSN	Serving GPRS Support Node
SLA	service level agreement
SMS	Short Message Service
SONET	Synchronous Optical Network
SR	Service Router
STM	Synchronous Transport Module
T1	T-carrier system
TDD	Time Division Duplexing
TDM	Time Division Multiplexing
TPSDA	Triple Play Service Delivery Architecture
UL	uplink
UMB	Ultra Mobile Broadband
UMTS	Universal Mobile Telecommunications System
VLAN	virtual local area network
VoIP	Voice over Internet Protocol
VPLS	virtual private LAN service
VPN	virtual private network
WAC	WiMAX Wireless Access Controller
W-CDMA	Wideband Code Division Multiple Access
WiMAX	Worldwide Interoperability for Microwave Access

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