Building a Next-Generation Mobile Operator Business on an IP Foundation

Cisco Mobile Architecture

Mobile operators are facing an unprecedented period of transition as they consider how to transform their second-generation (2G) or 3G networks to an all-IP infrastructure to support Evolved High-Speed Packet Access (HSPA+), Long Term Evolution (LTE), and the evolution to 4G. The changes are not just at the physical level; they must reflect what customers want to do – today and tomorrow.

More and more carriers are looking at HSPA+ as part of their LTE-readiness program so that they can transform their business from commodity-based service provider to experience provider offering premium value-added services.

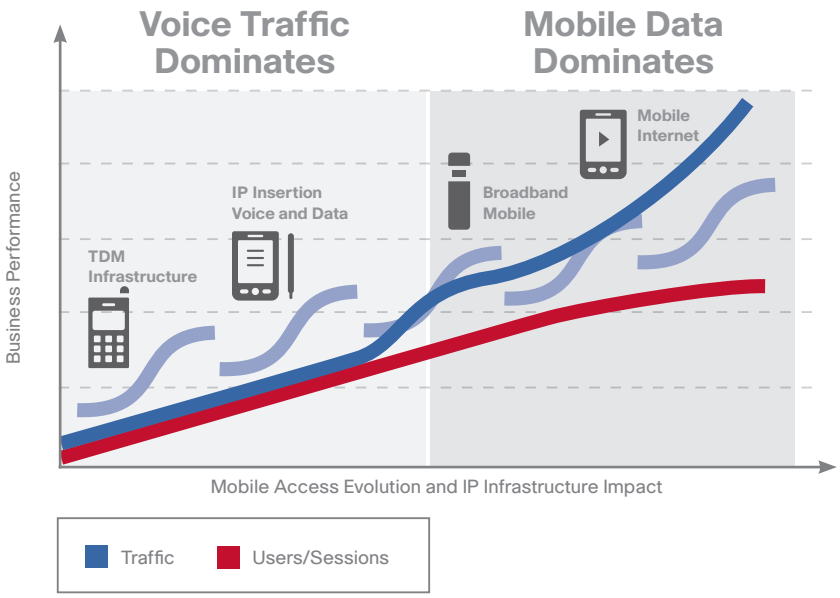
In this briefing document, Cisco summarizes the challenges facing mobile operators and explains how changes to the underlying network architecture are essential to reducing capital expenditures (CapEx) and operating expenses (OpEx), while enabling the deployment of new value-added services.

Cisco believes that there are three critical elements in the transformation of mobile architecture:

- **The first element** relates to mobile backhaul and how networks need to develop to meet the increasing demands of the mobile evolution
- **The second element** is the mobile core and this relates to both the core IP infrastructure and the core mobile entities such as evolved packet core (EPC) gateways
- **The third element** relates to the overall IP Next-Generation Network (IP NGN) architecture and how it provides multiple end-to-end services on a single converged network in a very scalable and manageable manner.

Cisco's mobile backhaul strategy focuses on offering multiple services on a single converged network. These services could include PWE3/Layer 2 VPNs for traditional 2G and 3G components and Ethernet pseudowires or Layer 3 VPNs for Ethernet-enabled 3G components. Cisco's aim is to offer a scalable, resilient, manageable network with the capability to support advanced features like network synchronization (physical layer and packet based), Hierarchical QoS, and fast convergence. Cisco is analyzing the network requirements associated with the LTE and Service Architecture Evolution (SAE) and there are many factors that need consideration when designing a backhaul infrastructure. These include security features such as IP Security (IPsec) and authentication, IPv6 support, and direct EnodeB communication through the X2 interface.

In Cisco's vision for mobile architecture, the mobile core will provide a single platform for 2G, 3G, and 4G data, together with key mobile Internet services such as dynamic policy management. It is essential that there is seamless, optimized interworking between the mobile core and the mobile backhaul infrastructure. Cisco understands the scalability issue in terms of traffic throughput and has addressed this with the Direct Tunnel architecture specified in 3GPP Release 7, where the Serving GPRS Support Node (SGSN) is bypassed from a data plane point of view. Cisco is also analyzing the possibility of a distributed architecture for the EPC gateways in LTE/SAE. To accommodate the multiplicity of end devices and service offers, there is a trend for a reduction of access point names (APNs) and a need for granular service control at the gateway level. This results in the need for enhancements to flexible traffic steering and routing, billing capabilities, QoS management, and security management.



A Cisco® IP NGN can help service providers increase revenues and competitive differentiation. The intelligent IP-based infrastructure is optimized for video delivery and supports new social and visual networking trends, including online video and mobile applications, IPTV, video on demand, and TelePresence. Cisco's IP NGN offers outstanding scalability and manageability to help service providers deliver video-based services more profitably and with unmatched quality of experience (QoE) to millions of users. In the world's first independently conducted mega test by European Advanced Network Test Center (EANTC), Cisco's IP NGN achieved a number of industry-leading performances.

- Two million emulated IP video subscribers with QoS – highest ever tested in the industry with a myriad of video applications
- 160 Gbps-per-slot wire-rate performance – highest per-slot edge capacity ever tested in the industry
- 8000+ Multicast groups per router interface – highest ever tested in the industry to support future growth of subscribers and channels
- 40 Gbps-per-slot Vidmon performance – highest ever tested in the industry for compressed and uncompressed video.

By migrating to an end-to-end IP-based infrastructure in partnership with Cisco, operators can reduce the cost of doing business while maximizing the service quality and intelligence essential to supporting advanced applications. They can then use that IP architecture to develop a business model that monetizes the explosive growth of mobile data traffic while protecting existing voice revenues. The architecture will enable them to differentiate the business and increase revenue and customer loyalty by allowing users to customize a basket of services to meet their needs and customize the way they interact with their end device.

Cisco, a global leader in IP networking with over 20 years' experience and deployments with more than 300 operators, has the vision, technology, solutions, expertise, and professional services to help operators launch new services and run their networks more efficiently.

Cisco's vision and depth of IP experience will also help operators protect their investment as the market moves toward the forecast tipping point of 4G in 2015 and developments such as IPv6 and machine-to-machine become more important.

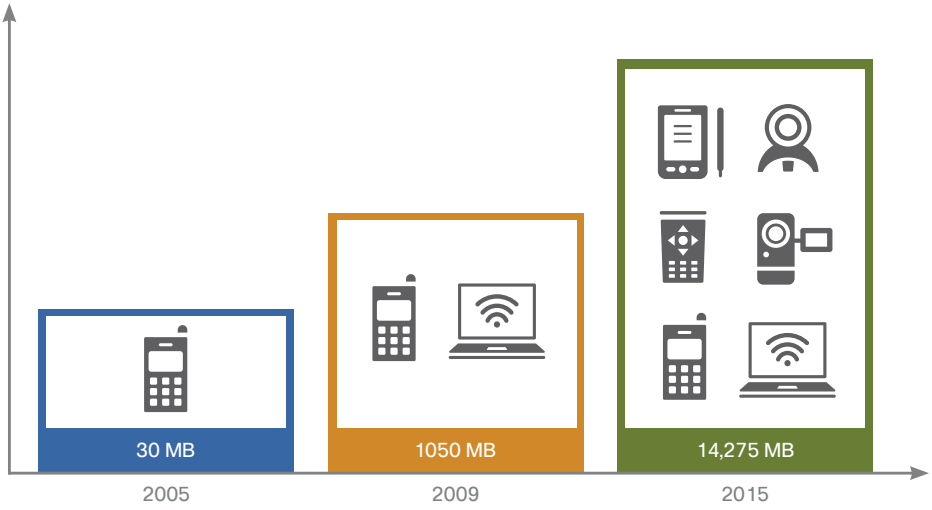
Contents

Introduction

Mobile operators face a difficult challenge – data traffic is increasing dramatically, but revenue is not increasing at the same rate. Operators must drastically reduce the cost per bit transported. And, with the majority of revenue coming from voice and a very small amount coming from mobile data, there is also a clear need to increase the value add of mobile data while protecting existing revenues.

Transport network architectural requirements are changing with a transition from the dominance of voice to mobile traffic. The mobile service mix is changing too, with data becoming the main element and the mobile Internet explosion creating new network challenges. The implications of ubiquitous, high-speed mobile data for traffic will be considerable as the mobile data traffic footprint of a single mobile subscriber in 2015 could conceivably be 450 times what it was in 2005. (source: Cisco Visual Networking Index 2009)

Potential Growth in Data Traffic from a Single Mobile Subscriber



These changes are creating pressure for improvements in speed, scale, and services, while controlling and reducing the cost per bit in the transport network. However, experience indicates that although 3G could scale, legacy mobile networks and underlying E1-based transmission infrastructures cannot meet these new demands.

Cisco believes that significant changes in architecture are required to meet the new demands on operators. The transformation will be based on IP and will be led by the coming availability of LTE/SAE as part of an evolution to an all-IP infrastructure that will provide the platform for delivering next-generation mobile services and reducing costs. In this type of environment, network intelligence is highly desirable. An IP-based network from Cisco will put the essential intelligence required by next-generation applications and content into the infrastructure.

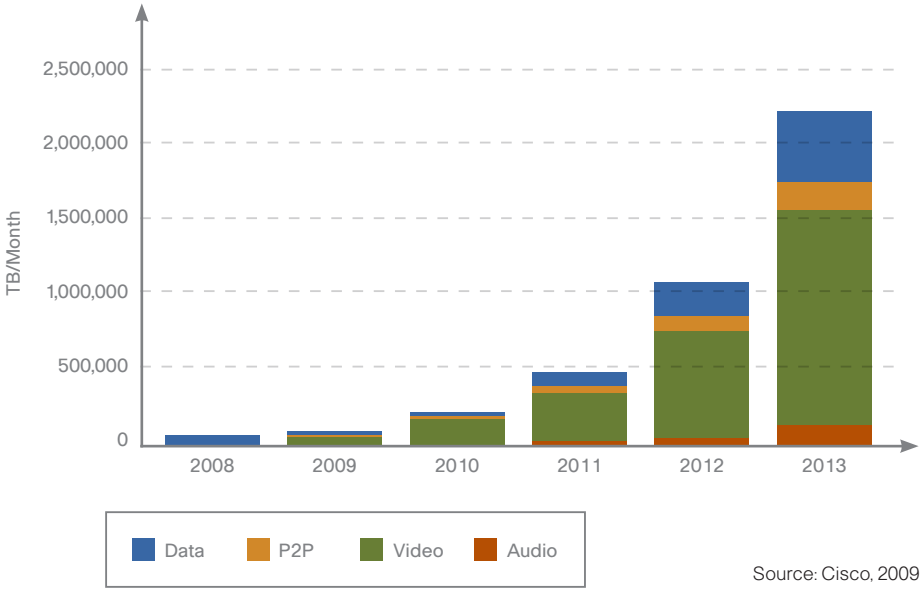
This paper details the challenges facing mobile operators and explains the case for IP in the mobile network. It also describes how Cisco's depth of IP expertise can help operators transform the mobile infrastructure, with Cisco solutions playing a key role in aggregation networks and mobile/Internet gateways, as well as offering advanced applications such as mobile WebEx and TelePresence.

Changing Customer Demands

Mobile operators face changing patterns of user behavior with more devices, more advanced applications, and demand for seamless access anywhere, anytime. For example, the Apple iPhone and its integrated applications are radically changing mobile consumer behavior, with increased content downloading and longer mobile Internet sessions. As a result, the iPhone is influencing mobile operators' requirements for network capacity upgrades and increased service control capabilities. Similarly, many European operators are looking for solutions to help them deal with the bottlenecks caused by the increasing use of YouTube and Dailymotion videos on last-generation mobile handsets.

In line with these trends, a recent release of Cisco's Virtual Networking Index (VNI) initiative (source: Cisco Visual Networking Index 2009) expect a 66-fold increase in mobile data traffic between 2008-2013, driven by consumers and businesses using the mobile Internet in innovative new ways for:

- Information exchange
- Entertainment
- Social networking
- Business productivity.



Source: Cisco, 2009

Analysts believe that high levels of mobile data will originate from home - as much as 60% by 2013 (source: Informa Telecoms and Media, Mobile Broadband Access at Home report, August 2008). There are also likely to be major changes in business usage, with mobile business devices, originally perceived as an access technology to the corporate infrastructure, now providing connectivity to video and the Internet, with many compelling applications now available on mobile.

The advent of laptops and smartphones onto mobile networks will be a key driver of traffic, since these devices offer users content and applications not supported by the previous generation of mobile devices. Video will be the largest of the new sources of traffic, but other applications such as peer-to-peer (P2P) are already making an impact. Despite the relatively small number of laptops with mobile broadband aircards today, P2P traffic from those devices already accounts for 20 percent of all mobile data traffic globally (source: Cisco Visual Networking Index 2009). A single laptop can generate as much traffic as 450 basic-feature phones, and a high-end handset such as an iPhone or Blackberry device creates as much traffic as 30 basic-feature phones (source: Cisco Visual Networking Index 2009).

Some mobile operators are already dimensioning their networks for 70 kbps per provisioned user. This level may seem high, but it assumes large numbers of laptop users - and laptops can generate a great deal of traffic. 3G iPhones are driving 500 MB per month in usage, or a 10-fold increase compared to legacy devices (source: Scaling the Mobile Internet, Cisco Systems 2009).

As developments in mobile broadband and advanced handsets supporting new data-intensive applications continue to bring more bandwidth-intensive data traffic to the mobile network, users will expect the same quality of experience that they are accustomed to on fixed broadband networks. They will want to connect to any device using any technology to access resources and information that are personalized to meet their needs. Beyond 2012, users will have an even greater variety of devices, including ultra-portable computers and handsets with larger screens. Video calling is also likely to be more common after 2015.

Cisco believes that a true, rich mobile experience is not dictated by the type of radio, but by the quality of the network. To meet these changing requirements and optimize the quality of customer experience, mobile operators must focus on the effective convergence of mobile networks and the Internet, with a common platform across the network to take in different access methods, including wireless and wireline.

HSPA+ (up to 80 Mbps) will grow and many carriers will use this as their LTE readiness plan. LTE is expected to be introduced to test markets (data-only first, followed by full service with voice later on) by the end of 2010 and more in 2011. Large-scale LTE rollout will take until 2015. Cisco believes that, based on data from several industry analysts, the tipping point will be around 2015. At that time Cisco anticipates 3G flattening or even beginning to decrease in favor of LTE.

These changing customer demands will create significant challenges to traditional mobile networks.

Operational Challenges to Traditional Mobile Networks

Changing customer demands will create massive capacity challenges. However, traditional mobile networks, designed primarily for voice, do not have the capacity or scalability to handle the projected data volumes. As an example, traditional radio base stations require three or four E1 (2 Mbps) circuits. LTE backhaul is currently projected to scale to bandwidths in the region of 100 Mbps and greater in the future. Scaling traditional backhaul solutions for SDH/SONET or ATM environments that were originally designed for voice has involved the addition of expensive E1 or T1 access lines. An estimate from Telecommunications Magazine suggests that the number of E1 or T1 lines would need to increase from one or two per cell site to eight to 16. As the volume of traffic grows, the costs for this type of backhaul will render the service unprofitable.

At the same time, decreasing revenue per bit means operators need to drastically lower the cost of bandwidth. Legacy architectures are not cost-effective for increased bandwidth requirements, with TDM bandwidth charges increasing in proportion to the bandwidth required. This problem of linear cost growth means that it is time to cap investment in older technologies such as TDM or ATM in favor of a scalable architecture such as IP. Cisco believes that operators must evolve the architecture and the underlying transmission infrastructure to meet the key objective of reducing the cost per Mbps.

Mobile data growth is also straining the Radio Access Network (RAN), which currently depends on SDH technology. 2G networks were primarily designed for voice using TDM/SDH, while 3G networks have tried to support both voice and data, but are facing scaling issues using ATM.

Clearly, SDH cannot scale to meet the new demands, so operators need to evolve the radio network from TDM access technology to high-speed Ethernet while still supporting TDM and ATM solutions associated with 2G and 3G technologies. With the emergence and deployment of new IP-based technologies, mobile networks will need to take in traffic from a multiplicity of radio access methods, including LTE, Wi-Fi, HSPA, and femtocell.

To take commercial advantage of changing customer requirements and monetize mobile data, operators need to accelerate the development and deployment of new services and reduce time to revenue. This creates challenges in three areas:

- **Client:** Customers can now access their content using a multitude of mobile devices, including laptops, notebooks, and smartphones. Operators will need to ensure that their infrastructure can serve all of these end devices seamlessly and cost-effectively.
- **Content:** Operators will need to manage and deliver applications and content from many different providers, including smaller-scale, semi-professional producers and over-the-top (OTT) providers, with one coherent experience for users.
- **Control:** To monetize the mobile network effectively, operators will need to manage many different types of subscribers accessing multiple services on multiple devices. These include pre-paid, roaming, or business customers paying different subscription rates for different service bundles.

Mobility is fast becoming a part of every network experience, allowing consumers to access the service of their choice without worrying about their location or the type of device they are using. Significant network intelligence is required to deliver this capability. With the increasing diversity of services traveling across mobile networks, all traffic is not the same. It is vital to be able to identify, classify, and prioritize traffic across the transport network.

However, traditional mobile networks lack the intelligence and quality of service (QoS) to handle this diversity. Traditional mobile networks rely on centralized intelligence where traffic needs to traverse a centralized gateway such as Gateway GPRS Support Node (GGSN). The performance of GGSN is also under pressure with increased traffic demands. Some operators are considering 3G direct tunnel, which separates signaling and bearer and bypasses certain nodes.

The Drive for Wireless/Wireline Convergence

With growing network complexity, operators are also considering the potential of a converged IP NGN to take in various access methods, including wireless and wireline. The overall vision is to offer packages of fixed and mobile services over a single converged network. As well as enabling operators to deliver a wider range of services, this would offer important operating benefits such as:

- Reduced CapEx and OpEx
- Common application integration for all technology types
- Common standards-based interfaces
- Seamless platform evolution throughout the network
- The ability to place services at the most suitable point in the network
- Built-in network simplicity and flexibility.

The network layer of the Cisco IP NGN is built end-to-end on a Carrier Ethernet foundation. It provides the capability of a tightly linked yet flexible Services Exchange Framework (SEF), the service layer, which can effectively deliver a wide range of services. For example, the SEF recognizes time- and usage- based services, enabling mobile providers to allocate resources more efficiently and bill more accurately for their usage.

The ability to place services at the most suitable point in the network gives operators the flexibility to build different services in different ways. For example, gateway management might be centralized where it is most efficient, but, for multicast, it makes more sense to distribute the services and push replication out into the network. Trying to do multicast in the core of the network can block up access bandwidth but distributing the services and replicating far out into the network leads to more efficient use of resources.

Next-Generation Mobile Networks

To meet the massive increase in capacity demand and the requirements of mobile Internet and advanced data-intensive applications, mobile operators must transform their infrastructure. In addition to handling the sheer volume of traffic, mobile operators will need to implement intelligent networking technologies in order to support the diversity and quality requirements of advanced, next-generation mobile applications.

The next-generation mobile infrastructure will require new levels of:

- Capacity to meet forecast increases in traffic levels
- Network-wide scalability to seamlessly support future growth
- Bandwidth to support higher data transmission speeds
- Security to protect the infrastructure and the handset
- Flexibility to take in a wide range of access methods
- Intelligence throughout the network
- Traffic prioritization to handle multiple voice, data, and video services
- Redundancy to maintain network availability
- Availability to ensure the highest levels of customer experience
- QoS to meet the requirements of multiple applications.

In response to these changing requirements and to enable the richer experience users expect, the mobile community is evolving new standards for the next generation of mobile networks – standards that will collectively form the basis for the development of 4G mobile networking. The new standard will be IP-based, providing a wide range of operational and cost benefits, as well as meeting customer demands efficiently and cost-effectively. IP-based networks will enable operators to transform mobile offerings, monetize the mobile Internet and deal with the capacity and operational challenges.

A number of carriers are already beginning the transition to IP by deploying HSPA+. In practice, the 80 Mbps capacity and improved spectrum efficiencies of HSPA+ compared to legacy technologies, coupled with economic realities, could actually slow the transition to LTE. However, the need for IP infrastructure, intelligence, security, and personalized service offerings remain important for the long-term transition to premium experience providers.

Commentators believe that 4G will not be based on any single technology. They also believe that it will be a collection of technologies and protocols, not a single standard. Forrester Research stresses that the 4G standard should include QoS metrics and the ability to prioritize traffic. That way, it will be able to offer mobile customers the classes of service they have come to expect from other business-grade IP services.

According to the World Wireless Research Forum's 4G working group, a 4G solution will run over an open IP infrastructure, interoperate with Wi-Fi and WiMAX and support speeds from 100 Mbps to as high as 1 Gbps. They have defined the following key objectives for the next-generation standard:

- A spectrally efficient system (in bits per second/per Hz and bits per second/per Hz/per site)
- High network capacity with more simultaneous users per cell
- A nominal data rate of 100 Mbps while the client physically moves at high speeds relative to the station, and 1 Gbps while client and station are in relatively fixed positions as defined by the ITU
- A data rate of at least 100 Mbps between any two points in the world
- Smooth handoff across heterogeneous networks
- Seamless connectivity and global roaming across multiple networks
- High QoS for next-generation multimedia support, including real-time audio, high-speed data, HDTV video content, and mobile TV
- Interoperability with existing wireless standards
- An all-IP, packet-switched network.

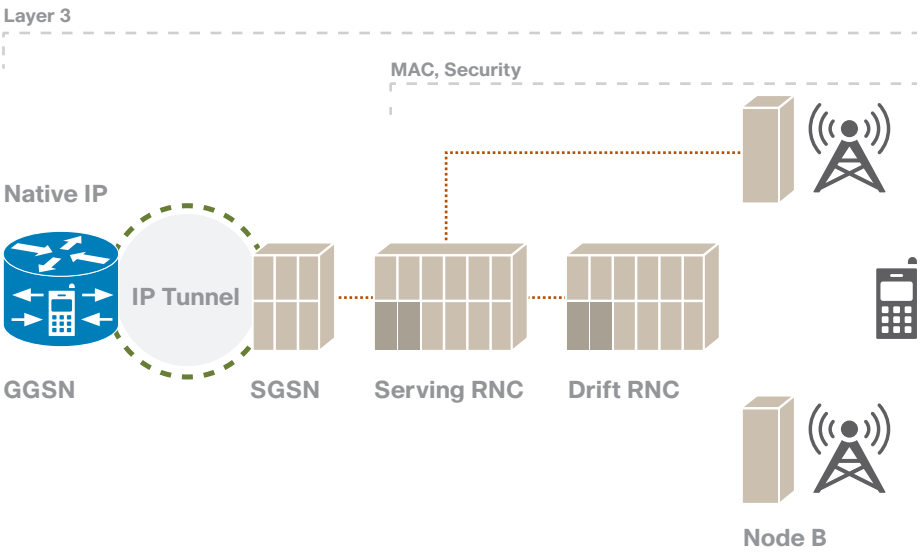
In summary, the next-generation mobile network should dynamically share and utilize network resources to meet the minimal requirements of all 4G-enabled users.

IP in the Mobile Infrastructure

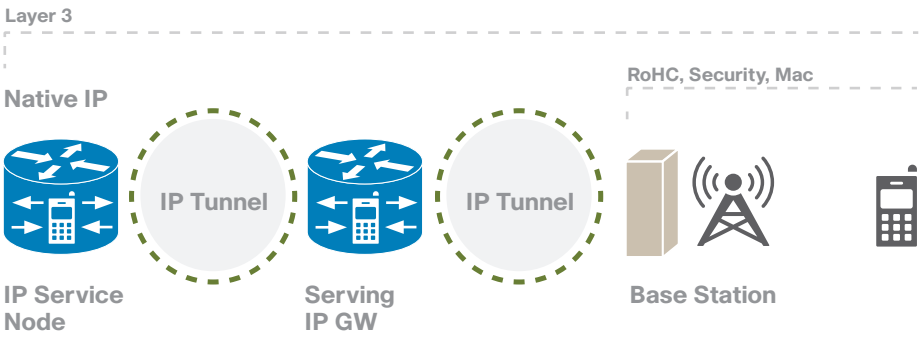
IP next-generation networking is a mature open technology, proven to reduce network cost and complexity by providing a single, converged, high-speed, highly scalable infrastructure for voice, data, and video traffic. It offers the security, network intelligence, QoS, and MPLS class-of-service capability to support multiservice delivery and enables faster development and deployment of advanced and emerging applications.

Mobile Networks - Simplification/Flexibility

Today



Tomorrow



In the mobile infrastructure, an IP solution represents a network-centric approach, reducing the operational complexity of supporting any device, location, and application and overcoming problems of proprietary mobile network solutions. It is an ideal foundation for mobile transformation, providing a common platform for linking subscribers through diverse radio networks to the mobile infrastructure and back to the multiservice core to access services, applications, and operations.

Although IP-based 4G is still a developing standard for the next generation of mobile networks, the first deployments of LTE/SAE will accelerate the transition toward all-IP mobile networks. According to the Global Mobile Suppliers Association, 10 network operators are ready to launch LTE networks by 2010, with a further 16 set to follow after 2010. Handset manufacturers are also promising LTE mobile phones by 2010.

Cisco believes that migration to an-all IP mobile network will deliver a number of important benefits:

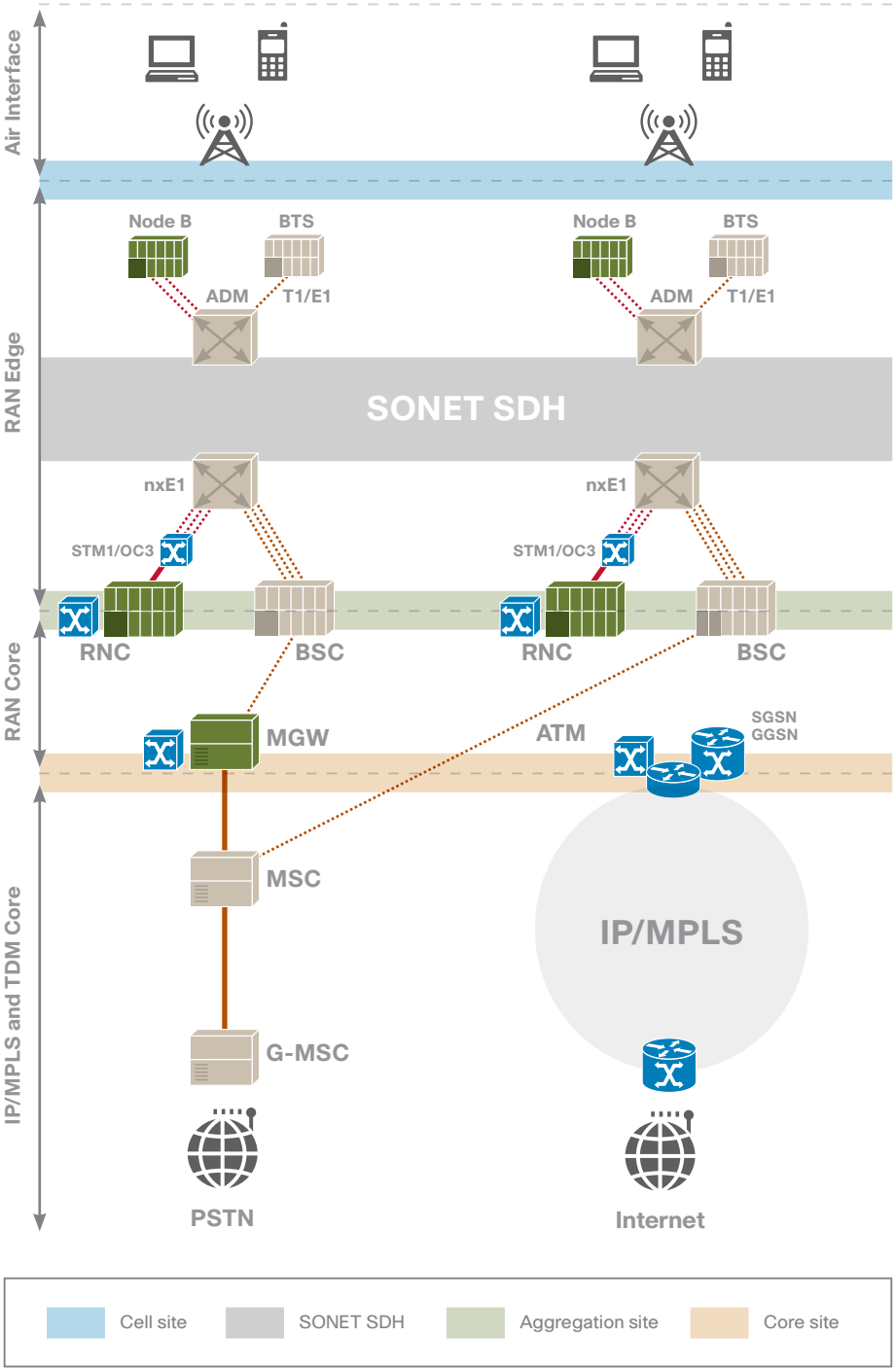
- Help ensure the capacity and scalability to meet future traffic demands
- Offer major cost advantages compared with TDM-based solutions (3-30 times less expensive)
- Enable the higher data transmission speeds required for advanced applications
- Push intelligence throughout the mobile infrastructure to support converged management, troubleshooting, policy enforcement and operation
- Support multiservice voice, data, and video applications with QoS and class-of-service prioritization
- Help ensure the quality of experience customers demand
- Transport and integrate advanced and legacy applications
- Offer global reach, making roaming much easier
- Emulate traditional technologies, enabling operators to support all traffic types over the same network
- Reduce network complexity and costs with single converged infrastructure for voice, data, and video traffic
- Provide an intelligent backhaul infrastructure from the cell sites right back toward the core mobile components and infrastructure
- Provide a scalable solution for the aggregation network that is compatible with diverse radio solutions including LTE, Wi-Fi, HSPA, and femtocell
- Decouple the Radio Access Network from the aggregation network, ensuring complete flexibility for the access network and enabling operators to deploy the radio technology of choice. This access-agnostic approach protects existing investment and allows operators to take advantage of innovation in either area
- Eliminate problems of proprietary mobile networks
- Simplify the addition of more cell sites or new advanced cell site devices with connectionless technology.

IP in the Radio Access Network

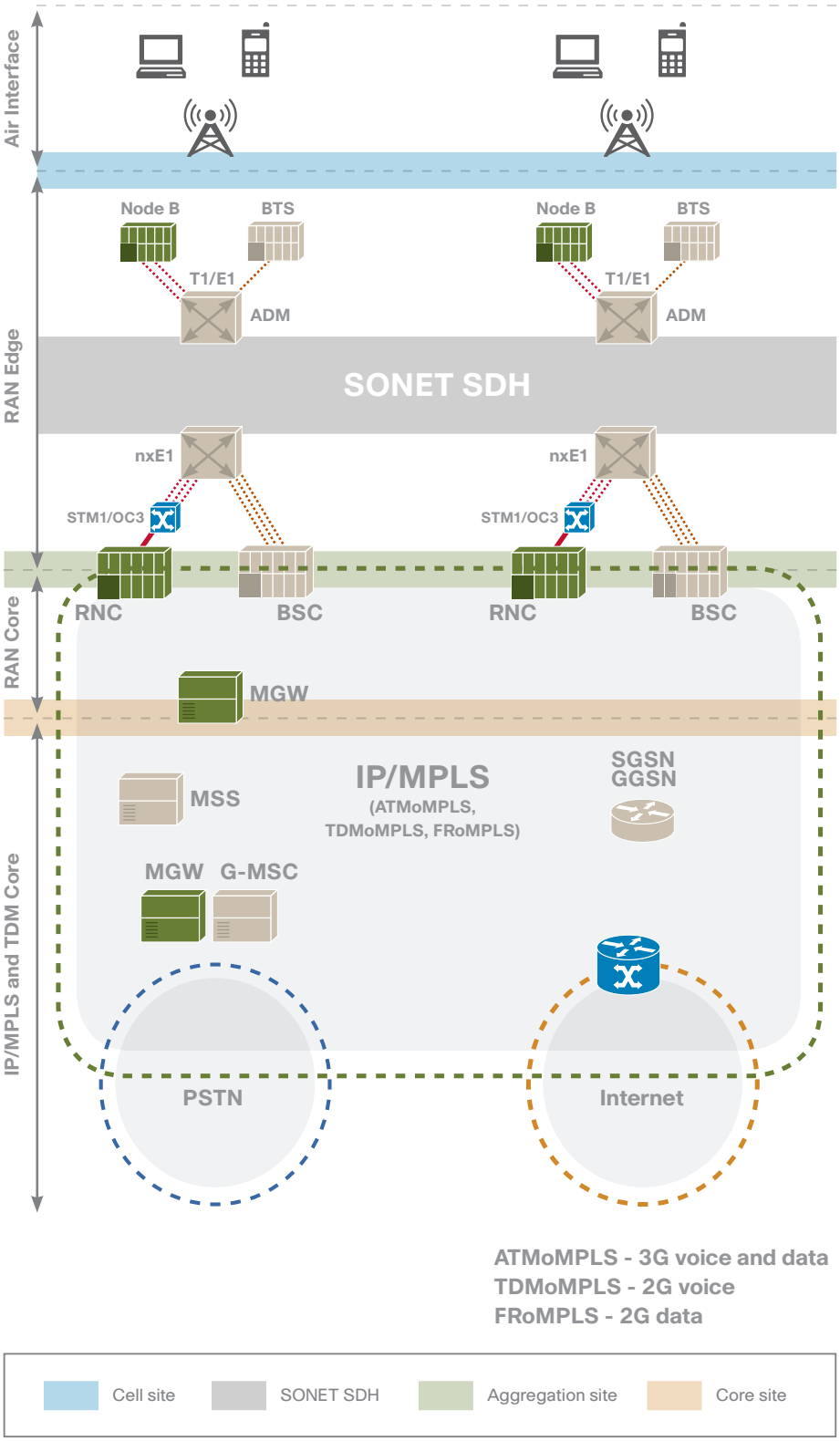
The Radio Access Network (RAN) is one of the key areas for mobile network transformation in the bid to deliver robust mobile Internet services. Mobile operators must dramatically reduce the cost per bit transported in their current backhaul solutions while providing transport for second-generation (GSM) and third-generation UMTS technologies. The move to the all-IP RAN is the single largest infrastructure challenge facing mobile operators.

Current radio infrastructures feature a mix of 2G and 3G technologies, with TDM, ATM, and Ethernet solutions. The convergence of newer and legacy technologies is encouraging mobile operators to move to IP to provision, scale, and manage multiple services in the radio network. Cisco believes that the most cost-effective strategy is to first focus on building an independent transport network not integrated by radio type or generation. An independent backhaul transport based on IP can support all access technologies, and also be the foundation for the next generation to come. It gets rid of the lock-in between the core networking protocol and the radio protocol.

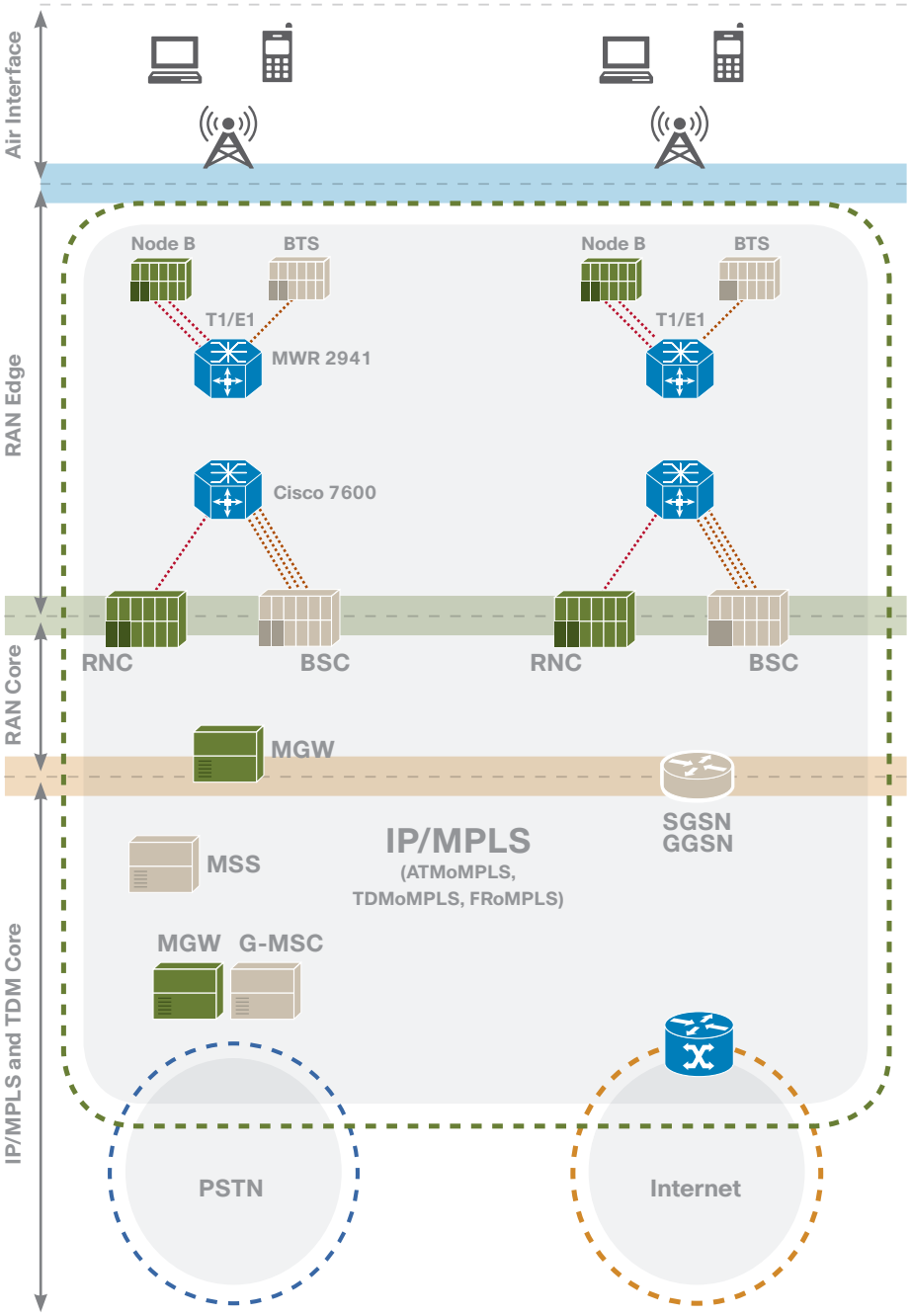
2G & 3G Traditional Network



3G R4 IP/ATM Converged IP Backbone



Emulation/IP Technologies (MToP) to Cell Site



ATMoMPLS - 3G voice and data
TDMoMPLS - 2G voice
FRoMPLS - 2G data

Cell site | Aggregation site | Core site

The deployment of IP in the RAN is moving outwards, as the diagrams show:

- In traditional 2G and 3G networks, the deployment of IP solutions was confined to core applications with ATM in the radio network core and SDH in the radio network edge
- In later 3G R4 deployments, a converged IP backbone extended through the radio network core
- In the next stage of evolution, Mobile Transport over Packet (MToP) takes IP NGN out to the cell sites.

MToP provides many benefits for radio network backhaul:

- Deploys IP transport from the cell site through the core
- Eliminates reliance on fixed bandwidth E1 circuits
- Provides intelligent aggregation in the mobile Internet infrastructure
- Offers SLAs to IP standards
- Helps ensure end-to-end IP security
- Offers a complete mobile transport solution
- Reduces operating and support costs, lowering TCO
- Enables interoperability with radio vendors' systems
- Supports legacy migration and all-IP solutions
- Provides scalable platform for future service evolution.

The use of IP in the radio network is not a new development, operators have been relying on it for a long time and it has worked well. In 3G Release 4, for example, signaling between the core nodes migrated to SIGTRAN and control of voice and the entire network was based on IP. The future of the mobile core rests with IP technology. By getting on the price-performance curve of the IP industry it will be possible for mobile operators to drive costs down even as they carry orders-of-magnitude more traffic. A hundredfold increase in capacity is achievable with IP RAN backhaul networks.

IP in the Backbone

Deploying IP in the backbone network allows mobile operators to support all customer types, regardless of how they access the network. IP provides high-speed packet switching with QoS, traffic engineering, convergence, resilience and multicast, enabling services and applications to be converged cost-effectively. It supports the full range of IP-based applications from high-quality voice and video to best-effort Internet applications.

IP and LTE

Cisco is committed to deliver a full LTE/SAE architecture, providing a set of solutions that will allow operators to efficiently support LTE IP transformation in the core and in the RAN, as well as in the mobility management and control areas. A next generation of mobile Internet gateways is under development and will be released very soon.

LTE presents unique challenges for gateway vendors. It should deliver greater spectral efficiency than older radio access technologies such as HSPA and EV-DO, and that along with wider channel allocations and new antenna technologies means a lot more data traffic will find its way back to the gateways. LTE is also not defined for circuit-switched voice traffic. That means all voice will eventually have to be carried over IP once the transition to LTE is complete. VoIP is especially challenging for the gateways because it means a large number of small packets and the load on a gateway is the same for a large packet as for a small one.

Another challenge is the always-on nature of these connections, which drives up the session count to very high levels. This all adds up to the need for very high-performance and very highly available mobile gateways. Cisco's LTE gateways will be implemented on existing Cisco hardware in order to handle high data traffic and prepare for future growth with potential throughput rates in excess of 40Gbps.

Overall, IP will play a key role in LTE/SAE as the preferred platform for the evolution of the network toward a flat, packet-only, all-IP-based architecture. With SAE consisting of just two node types, eNodeB and the access gateway, the IP-based infrastructure can reduce the latency of the network by a factor of 50–200 percent compared to current 3G deployments. Combined with the high throughput, end-to-end QoS and optimized application routing capability of IP, this will provide essential support for time-sensitive applications like VoIP and video or bandwidth-intensive applications like multipoint on-line interactive gaming.

As more and more intelligence is pushed to the eNodeB, IP provides the essential intelligent infrastructure in an LTE/SAE deployment. The intelligence in the IP infrastructure also provides the logical link that allows the use of X2 interfaces between eNodeBs to ease the gateway traffic load caused by frequent handover.

With security a major concern for operators, IP's end-to-end security capability enables security to be embedded throughout the network, with support for a multilayer, multi-vendor approach. IPsec is a Layer 3 solution that can be used to protect any application traffic across the Internet; applications do not have to be specifically designed to use IPsec.

IP and IMS

The IP Multimedia Subsystem (IMS), as originally defined by 3GPP, has so far not been a major contributor to revenue or cost savings for service providers. Cisco expects increasing traction in IMS, especially for voice control, on new LTE/SAE deployments. As a strategic standardized framework for IP-based communication, IMS influences not only the evolution of service architectures, but also the development of new products, features, and interfaces for targeted mobile, wireline, and cable access services. The IMS integration capability, migration options, and support for interoperability between different end devices and infrastructures are also key drivers for Cisco's mobility strategy, which incorporates IMS support in solutions such as Cisco Mobile PBX and Cisco Session Border Controller.

Converged policy and charging control, access independence, high-quality customer experience, and seamless service mobility are just some of the key benefits of IMS. Open interfaces allow best-in-class multivendor solutions to be deployed with minimal integration effort. Cisco mobile solutions benefit from the performance characteristics of IMS and demonstrate the highest levels of performance and interoperability with existing infrastructures, partner offerings, and interworking certification.

Cisco focuses on optimized IMS support for signaling, security, and QoS in gateways (Cisco Enhanced Gateway GPRS Support Node [eGGSN], P/S GW, network platforms (SBC, DPI), and data center components such as Cisco Unified Computing System (UCS). By actively participating in standardization committees such as IETF, 3GPP, TISPAN, NGN Alliance, CableLabs®, and MSF, Cisco demonstrates its interest and support for a common, converged architecture featuring IMS. Cisco is also a member of the Open IPTV Forum (OIPF), which promotes IMS for IPTV services.

IP and Policy Management

Service providers across all network infrastructures – wireline, wireless and cable – are grappling with explosive growth in demand for network resources. This trend is driven by the availability of and demand for bandwidth-intensive content, applications and services. For many industries, such growth is viewed as prime opportunities to grow revenues and increase market share. For network service providers, this trend is posing serious capacity management issues.

Operators are turning to policy management as a more sustainable solution. Policy management enables service providers to dynamically control IP network resources with real-time policy rules to determine what services are delivered and how they are delivered. Providers can identify, classify, prioritize and charge for services with real-time subscriber, application and session-aware policies. Policy enables service providers to not just optimize network performance but to increase the overall value of their network assets with intelligent IP service control.

Cisco's solution utilizes the management and customization capabilities of the Policy Charging and Rules Function (PCRF) from Cisco or partners, together with the enforcement capabilities of the standards-based Cisco policy-enhanced gateways, such as Cisco eGGSN or standalone Cisco Content Services Gateway (CSG2) and, in the future, the Cisco PDN GW for LTE.

Supporting New Mobile Applications

Cisco is enabling a range of new IP-based applications for the mobile environment, providing additional opportunities for revenue growth and customer retention. Many of these applications are enabled by Cisco intelligent IP networking, service control, and dynamic policy and charging capabilities that give subscribers the flexibility to personalize their services.

Mobile Video

Cisco believes that video, and more specifically high-definition video, will drive the Internet in the future. Video has already had a major impact on wireline traffic and Cisco believes that more and more video-based services will be deployed on mobile, including user-generated video from a video-enabled mobile device, P2P mobile video sharing, session shifting and IP video surveillance. Cisco's experience and vision for Internet video can help operators integrate video into the mobile network in the most efficient way.

Enterprise Unified Communications

Cisco Unified Communications uses the intelligence of the network to combine all forms of business communications into a single, unified solution that gives enterprises powerful new ways to collaborate across companies and work spaces using any combination of clients, applications, and devices. Increasingly, the mobile phone is replacing the desktop phone in the enterprise with users expecting to access the same applications and levels of integration as they would with a fixed phone. Cisco can help mobile operators build the infrastructure to support Unified Communications on mobile devices.

Cisco WebEx Mobile

Cisco has expanded its mobile collaboration portfolio offering by enabling users on a range of 3G smartphones to join Cisco WebEx™ Meeting Center web and audio conferences. Users can participate in audio and web conferencing via 3G or Wi-Fi; attend scheduled meetings; and view presentations, applications, and desktops with live annotations. With Cisco WebEx Mobile meetings on a smartphone, productive meetings with customers, colleagues, and partners are now as easy as a phone call. Service providers can resell Cisco WebEx Mobile services and monetize this compelling user experience.

Subscriber Loyalty Programs

These programs reduce customer turnover and avoid the high cost of acquiring new customers. Customer affinity programs like those used in other industries such as retail and banking can help service providers retain and reward their most loyal and valuable customers, and also increase in revenue by stimulating additional service consumption. Cisco's solution tracks loyalty programs award points for mobile subscribers based on service use, length of relationship, and other metrics.

Tiered Mobile Broadband

Users want unlimited mobile access to their favorite Internet services and applications. While flat-fee 3G mobile data service plans promote high subscriber usage, these "all you can eat" offerings challenge service providers' ability to grow revenues to keep pace with costs of expanding their mobile broadband network. Service providers need to unlock the potential to monetize – while controlling the impact of – peer-to-peer (P2P) and over-the-top (OTT) applications in ways that enable them to value price mobile broadband services.

Cisco's IP NGN provides the subscriber- and application-aware intelligent IP network capabilities to generate revenue from and control usage of mobile broadband networks through content charging, content filtering, and dynamic policy control. Tiered mobile data services provide subscriber-aware allocation of network resources and content according to volume quota limits or protocol blocking. P2P and OTT applications can be monetized by further segmenting the subscriber base with policy-based usage tiers that let subscribers choose and pay for the service plan they want.

Mobile Child Safety

With younger people texting, instant messaging, and using mobile web, email, and social networking sites to keep in touch with friends and family, there is a risk that the mobile phone can also give them access to potentially inappropriate content or can even be a gateway into a world that preys upon children. Cisco's Mobile Child Safety application helps service providers to protect younger users, with parental control services such as mobile content blocking, mobile call blocking, and mobile text messaging and instant messaging restriction.

Corporate Mobile Usage Management

Enterprises that provide mobile devices to employees want to restrict access to non-corporate applications and to websites that feature games, gambling, or adult content. This application helps service providers give enterprise customers the ability to manage costs and the use of mobile services while extending their internal IT policies to the mobile workforce.

Mobile Spending Limits

With the proliferation of smartphones and other advanced mobile devices, many users want to control their own expenses by setting thresholds on the time, amount, or cost of mobile voice, data, and messaging services that they use. Similarly, parents want to set time and spending limits on their children's use of mobile services. The Cisco Content Billing solution helps service providers protect revenues through real-time enforcement of credit limits and offers users a self-care portal to view and set spending limits across their services.

Cost Control

IP architecture is designed for cost efficiency, enabling mobile operators to reduce total cost of ownership (TCO), as well as accelerating time to revenue for new services.

An IP-based mobile infrastructure can lower direct costs by delivering efficiently against traffic and service requirements and reducing the cost per bit. By utilizing open standards, it can also reduce the cost of infrastructure equipment, software, and upgrades, as well as eliminate vendor complexity.

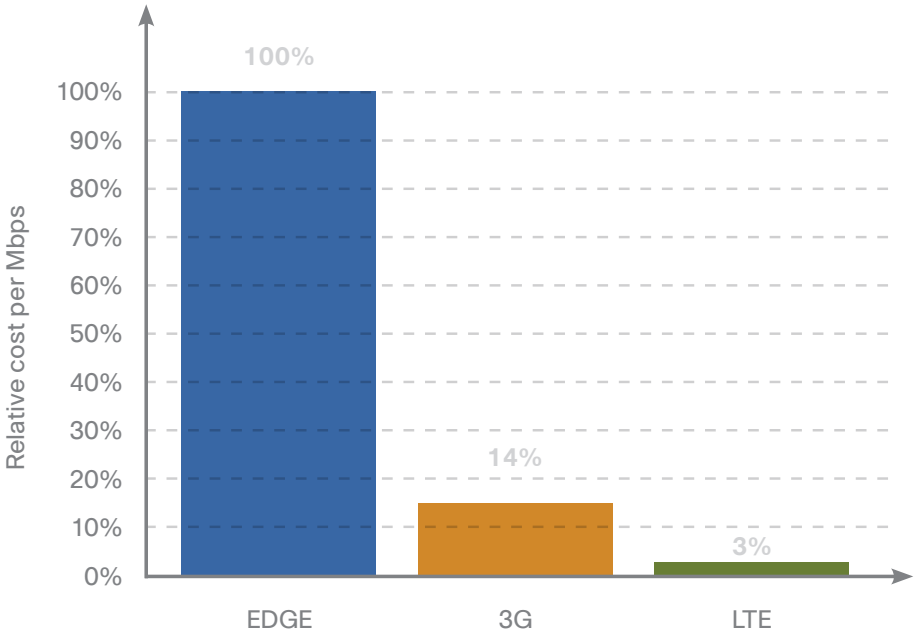
It also reduces indirect costs by simplifying factors such as:

- Decommissioning of legacy infrastructure
- Testing and training
- Operations, administration, and management
- Maintenance
- Energy
- Financing and insurance
- Network design costs .

Figures from Analysis, Booz & Company indicate that comparative costs per GB transported would be:

- 3G – 6 euros
- HSPA – 2 euros
- LTE – 1 euro.

LTE not only offers greater capacity, it is also significantly more cost-efficient.



Source: Booz & Company

As well as lowering costs, an IP-based infrastructure can also enhance revenue through faster deployment of new innovative services, greater ARPU, and a higher-quality customer experience that improves retention levels.

A European mobile provider has attracted more than a million subscribers to its IP-based mobile broadband service thanks to its ability to offer high-speed access to rich multimedia content and compete effectively with fixed xDSL services. Another provider is utilizing Mobile WiMAX over IP as a platform for next-generation, high-speed mobile video, gaming, and file transfer applications.

Migration Strategy

Cisco believes that it is important to have a clear migration strategy and to manage the transition at each stage. While the long-term vision of the mobile community is an all-IP infrastructure, operators can make the transition in stages. However, intermediate steps should be structured within an overall IP strategy.

As an example, while the ultimate vision embraced by many mobile operators and industry analysts is to replace TDM and ATM equipment and bring IP services over Carrier Ethernet to the cell site, a complete retrofit of infrastructure to make this possible would also incur huge capital costs. Instead, a growing number of mobile operators are deploying viable solutions based on Cisco MToP which requires minimal capital expenditures and can be quickly deployed to reduce operational expenses dramatically while boosting bandwidth to scale services profitably.

Cisco and its ecosystem of partners can support the transition with professional services at every stage to help operators migrate seamlessly without disrupting existing operations and services, accelerate the generation and delivery of new business opportunities and achieve CapEx and OpEx reduction. The services provide important support at every stage of the migration:

- **Advisory Services** help define new business and service models and deliver operational process transformation.
- **Advanced Services** help define, engineer, and optimize service delivery infrastructure to enable new service delivery and reduce costs. In doing so, Cisco Services provide end-to-end plan, design, deploy, test, and operate services for next-generation mobile Internet networks through our exceptional set of people, processes, tools, and partners. Cisco provides system integration and acts as a single point of contact for pre- and post-deployment support, including third-party products. Solution priming with SLA-backed assurance helps enable new business models faster.
- **LTE Readiness Assessment Service** is designed to help mobile service providers meet current 3G network challenges and prepare for deployment of LTE network services. Advanced Services has recently been awarded a consulting deal by a leading mobile service provider to (1) evaluate current mobile Internet readiness on key 3G/LTE planning metrics, (2) recommend IP RAN, gateway, and data center solutions, and (3) develop an implementation plan and 5-year vision for 3G-to-LTE network transition. The Advanced Services approach provides the service provider with a comprehensive review of network and business requirements and drives direct engagement with both technology and business decision-maker senior management.
- **Technical Services** provide traditional maintenance support plus proactive diagnostic capabilities to help assure higher availability, lower operational costs, and reduce risk.

Funding through Cisco Capital[SM] can help to protect capital while bringing forward investment and revenue opportunities. Financing from Cisco Capital simplifies access to the technology that can help operators elevate business performance. We can help from the outset by making funding available when and where there is a need to invest, at any stage in the budget cycle. As new technologies emerge, Cisco Capital can help operators upgrade or migrate. We protect investment through flexible end-of-lease options. And when operators move on to the next phase of technology-enhanced performance, we'll take on the burden of disposing of old equipment. By simplifying asset review and replacement processes, operators can more effectively manage equipment lifecycles, which independent analysts suggest can yield further savings of up to 20 percent in the total cost of ownership. To take advantage of Cisco Capital's dedication to business success, visit **www.cisco.com/capital/europe**.

A key element in the migration process is knowledge transfer. By working closely with internal teams, Cisco support specialists transfer knowledge, help boost the skills of operator staff, and reduce future risk.

Investing for the Future

Cisco has a depth of experience in IP and a clear vision of the future of mobile architecture that can help service providers invest in solutions that will support the future development of their networks.

A key area is mobile backhaul where research consultancy Heavy Reading reports that mobile operators recognize that migrating to lower-cost Ethernet backhaul is a critical factor in generating viable mobile business models. (source: Heavy Reading - Ethernet Backhaul Strategies and Opportunities, May 2007). Respondents also felt that operators building a single converged transport network will be the leaders in migrating cellular traffic onto Ethernet backhaul, although Ethernet and TDM solutions are likely to coexist for many years. Cisco's IP NGN can enable the transition for converged networks, as well as supporting legacy backhaul.

Another report by Heavy Reading (LTE/SAE Transition Strategies, June 2009) finds that the transition to 4G technologies will not happen overnight. Operators are likely to run 2G, 3G, and 4G networks simultaneously over a period of years, gradually migrating the subscriber base and tightly controlling the costs of parallel infrastructure. An IP NGN from Cisco will be a key element in the transition to 4G, but is also able to support legacy transport, offering different models that enable soft migration from legacy transport to LTE.

There are benefits of implementing Layer 3 routing into the IP RAN transport network. Perhaps the most obvious one is Direct Tunneling from the RNC to the GGSN allowing bearer data traffic to by-pass the SGSN. Direct Tunneling allows the operator to scale to meet ever-increasing demands on data usage while avoiding the cost of adding new SGSNs into the network.

An increasing number of mobile service providers are now seeing tangible benefits to deploying Layer 3 routers all the way out to the cell site and these benefits are proving critical to scaling their network requirements in a stable environment. Advanced IP intelligence that orchestrates QoS, buffering, and MPLS to provide fast rerouting of high-priority traffic around network congestion and failures has become an important capability. IP security suites incorporated at all routing points are especially important when leasing bandwidth from other network providers. Today, as mobile service providers move to full deployment and use shared networks, the benefits that are part of a Layer 3 IP RAN backhaul network are becoming more important. As service providers increase the mix of media-rich services to more end users, these benefits will be as appreciated in the RAN as they are today in the IP/MPLS core networks.

Cisco's comprehensive network-centric portfolio for mobile will also enable service providers to monetize the rapid flow of new applications and avoid losing revenue in the emerging mobile ecosystem, where developers and app store owners currently operate revenue-sharing arrangements. The network intelligence in Cisco's IP solutions enables service providers to meet the increasing user demand for personalized bundles of services, while reducing the cost and complexity of delivering those services.

Cisco believes that the key to success is to reduce the cost per bit transported and monetize opportunities by taking continuing advantage of the underlying technological changes taking place as the industry moves toward 4G. Many of the business and technology issues surrounding the transition period are discussed in the Service Provider Mobility section of Cisco Community Central **www.myciscocommunity.com/community/sp/mobility**. Please consider joining the discussions and giving your own views on the future of mobile architecture.

Partnership with Cisco

Mobile Internet will see the convergence of the Internet and the mobile world, and Cisco solutions can address the tremendous scaling and cost challenges. These solutions take full advantage of the scalability of IP along with some very compelling indoor radio solutions. Cisco focuses on standards compliance, interoperability, open systems, expertise in IP, and a strong worldwide footprint. Cisco expertise in all aspects of scaling data networks will be in great demand as the mobile Internet build-out accelerates in the years to come.

With the mobile infrastructure evolving to all-IP, Cisco is uniquely positioned to help mobile operators deliver what some analysts predict will be a 100-fold increase in mobile data traffic by 2013. Cisco is a global leader in IP networking with more than 20 years' experience and deployments worldwide:

- Leader in 3G IP infrastructure with 300+ operators
- Delivering mobile messaging to over 500 million subscribers
- 45,000+ cell sites IP-enabled by Cisco
- 10,000 Cisco 7600 Series Routers integrated in mobile networks.

The Cisco portfolio of solutions offers the mobile operator a complete end-to-end infrastructure from the core to the cell tower. While providing immediate cost reductions and bandwidth expansion, Cisco solutions offer features and capabilities truly unique in the industry. These capabilities provide unmatched traffic handling during peak hours, unrivaled security and resiliency, and the level of performance and scaling required both today and in the future.

As the undisputed IP leader, Cisco provides the technology, solutions, and expertise that mobile operators need as they transition to next-generation networks. Deploying solutions that deliver greater network intelligence, integration, and overall flexibility will not only give operators short-term benefits but ultimately will boost their competitive advantage.

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