

Growing mobile broadband adoption with future-proof backhaul networks

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A new approach to mobile backhaul infrastructure is needed to cope with the explosive growth in mobile data traffic. Any such approach must bridge the gap between legacy and next-generation networks and services. The traditional time division multiplexing approach to mobile backhaul networks has limitations that make it difficult to meet the evolving demands of mobile networks. Multiprotocol label switching, however, is a promising candidate to meet these challenges with flexible, scalable and economical backhaul networks.



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Mobile operators around the globe are experiencing a traffic boom in their networks. While voice continues to ramp up linearly, data is growing exponentially. It's easy to see why: consumers are demanding bandwidth-hungry mobile services such as Internet access, photo sharing and music downloads.

While a sizable proportion of consumers are still in the process of migrating from 2G to 3G, many operators are already exploring 4G adoption (LTE, mobile WiMAX) in a near term horizon. The 3G market for mobile handsets is growing at a compound annual growth rate (CAGR) of over 27 per cent, and

will supersede 475 million units (including HSDPA handsets) by 2010 (Source: 3G Market Forecasts to 2010). At the same time, the global market for LTE handsets is expected to grow from 50k units (2010) to 82m by 2014. Similar growth drivers are expected in other LTE consumer segments

such as netbooks (Source: ABI report on LTE - 2Q 2009).

So why is LTE so compelling? Long Term Evolution (*LTE*) offers high data rates at a reduced price per bit, better spectrum efficiency and lower latency. In the LTE environment, expected throughput is in the range of 100Mbps (peak data rate for 20 MHz spectrum allocation) and latency should be less than 10ms. This can offer a rich user experience for consumers, comparable to what they have at home today with fixed connections, and mobility will be an added advantage. LTE will enable new business models around emerging services such as real-time online gaming, HD video streaming, video blogging and peer2peer file exchange.

The rapidly increasing consumer adoption of smartphones and USB modems is the primary driving factor behind mobile broadband penetration. Increased traffic should reflect higher revenues, although the average revenue per megabit for data service is far lower than for traditional voice and text messaging, yet consumers are demanding mobile broadband services at affordable prices. Due to the significant cost of providing mobile data service, mobile data tariffs today are still relatively expensive compared to fixed line broadband pricing.

This phenomenon has created an imbalance in mobile operator's balance sheets as well as their network capacity planning. To support the traffic growth, mobile operators are scrambling to build out their networks faster than ever before.

Mobile backhaul is a crucial part of the mobile network that links the radio access network and the mobile core network. In the end-to-end mobile infrastructure, no area of the mobile network feels the strain more than backhaul networks (from the viewpoint of scalability, performance, cost and ease of migration from previous generations to the next. i.e., 2G to 3G, or 3G to 4G).

A new approach to mobile backhaul infrastructure

Cell sites are getting increasingly complex as operators rapidly adopt 3G technologies such as high speed packet access (*HSPA*) and evolution data optimized (*EVDO*) and are already looking ahead to 4G technologies. Even as they migrate to these next-generation services and architectures, operators realize that the new 4G technologies (IP/Ethernet) and emerging 3G (Asynchronous Transfer Mode - *ATM*) services will need to coexist

with existing legacy 2G (Time Division Multiplexing - *TDM*) for quite some time. Operators and transport providers must maximize their investment in infrastructure and are always reluctant to take out and replace existing technology. In addition, voice and text are still the dominant revenue generators, and it is hard to justify the expense and disruption of moving subscribers to new handsets.

Cost is a dominant factor in the design of the next-generation backhaul infrastructure. According to Infonetics Research, mobile carriers now spend as much as 30 per cent of their operating budgets on backhaul. As traffic for high-bandwidth data services continues to grow, this cost will increase exponentially. Operators must find a way to reduce the cost of mobile backhaul.

A vast majority of US mobile operators currently use leased T1/E1 lines for their mobile backhaul networks. In Western Europe and the greater part of Asia-Pacific, microwave (TDM encapsulations) based backhaul is widely deployed. Although TDM is known for its high reliability, this legacy approach is expensive and does not scale easily, since the carrier must add an additional full T1/E1 line when existing capacity is exceeded.

Clearly mobile operators need a new approach to cost-effectively scale their mobile backhaul networks. This new approach, in addition to being highly scalable and reliable, must bridge the gap between legacy and next-generation networks and services - providing the flexibility to support both.

The Broadband Forum's initiative for next-generation mobile backhaul networks

The Broadband Forum, a global standards organization focused on end-to-end IP network optimization, is tackling these backhaul challenges via its MPLS Mobile Backhaul Initiative (*MMBI*). The initiative proposes a framework for the use of IP/Multiprotocol Label Switching (*MPLS*) technology to transport radio access network (*RAN*) backhaul traffic over access, aggregation and core networks as shown in Figure 1. It describes possible deployment scenarios and provides recommendations on how to deploy MPLS in each of these scenarios to design flexible, scalable and economical backhaul networks.

The Forum has already published the MMBI Framework and Requirements technical

specification and currently the Forum's members are working together to define standards-based, interoperable architecture frameworks for 1) 2G and 3G networks and 2) LTE networks.

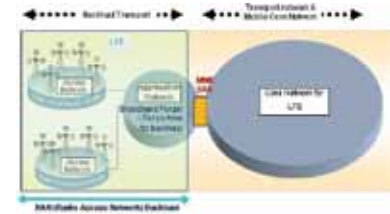


Figure 1: Scope of MPLS in mobile backhaul initiative

The mobile networking industry is recognizing an increasing role for IP/MPLS as the best strategic solution for backhaul. IP/MPLS offers the combination of cost, scalability and flexibility that mobile operators need to leverage existing investments while building out capacity for the burgeoning data traffic. IP/MPLS supports features such as:

- co-existence of TDM (2G), ATM (3G) and Ethernet (4G) transport using pseudo-wire technology;
- strong ATM-like Quality of Service (*QoS*) and traffic engineering techniques;
- rapid service restoration after failure detection by leveraging fast-reroute, operation administration and maintenance (*OAM*) and failure troubleshooting tools; and
- future-proof investment for migrating from 3G to all-IP based 4G/LTE.

Many mobile carriers have adopted IP/MPLS in their core network, as it is a familiar and proven technology that can be easily extended to the cell site. The transition to IP in the backhaul network is already taking place and will track with the accelerating growth of data-based services. Moving to IP/MPLS is simply a logical extension of a technology already in use in many mobile cores.

Many equipment vendors offer MPLS features within their products; however the lack of commonly agreed frameworks, architectures and deployment scenarios often results in additional avoidable costs in deploying MPLS services. To address this, the Broadband Forum also offers a certification programme for vendors that enables service providers to choose standards-based, deployment-ready products

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for their backhaul solutions, which empowers them to deploy backhaul solutions quicker.

Evolving the network from 2G/3G to 4G (LTE)

Broadband Forum is defining two architecture frameworks, one for 2G/3G and the other for 4G/LTE, corresponding to the 3rd Generation Partnership Project (3GPP) work. In 2G/3G RAN, base transceiver stations (BTS) or simply base stations handle the radio interface with the mobile station and the base station controller (BSC) manages one or more base stations to provide control functions such as radio-channel setup and handovers. A hub-and-spoke topology enables communication from base station to controller and controller to base station, as shown in Figure 2. The topology in 2G/3G RAN is also known as centralized topology. In this architecture, T1/E1 connections (TDM for 2G and ATM for 3G) between BTS and the BSC are carried over IP/MPLS based packet backhaul using pseudo-wire technologies.

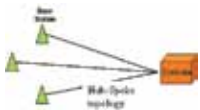


Figure 2: 2G/3G RAN topology

In LTE RAN, the base station itself includes controller functionality and communicates with another base station directly via any-to-any topology. LTE base stations communicate with access gateways (aGW) via a star topology, as shown in Figure 3.

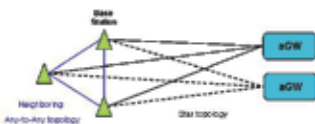


Figure 3: All-IP LTE RAN topology

Coexistence, interoperability, roaming, and handover between LTE and existing 2G/3G networks and services are inherent design goals, so that full mobility support can be given from day one. In LTE networks, IP is the only protocol used to support connectivity between the different mobile nodes as defined by 3GPP. To achieve any-to-any topology for LTE backhaul, the Broadband Forum has recommended leveraging Layer 2 virtual

private networks (L2VPN) and Layer 3VPN based solutions (such as virtual private LAN service (VPLS) and border gateway protocol (BGP)/MPLS based VPNs).

Hybrid IP/MPLS and TDM backhaul architecture for 2G/3G

In a hybrid model, carriers can build out capacity to accommodate data traffic growth without having to re-engineer the voice network (leave voice on existing TDM networks). Mobile operators can leverage cost-effective alternatives such as metro-Ethernet networks or existing assets to support data traffic (for example, using the DSL infrastructure in Western Europe to offload the data traffic from the cell site). Deploying a hybrid model allows operators to develop greater familiarity with IP/MPLS technology and integrate voice traffic into the packet-based infrastructure at a later date.

Timing synchronization

Synchronization is critical to maintain good voice quality, reduce interference and manage call handovers between base stations. There are several approaches to achieving this timing synchronization, including synchronous Ethernet, adaptive clock recovery and IEEE 1588 v2. Network architects must consider which of these methods to use, and must also ensure that their equipment vendors provide the necessary support while migrating to packet based backhaul.

To assist in this area, the Broadband Forum is assessing various requirements for supporting clock distribution to the base stations, including frequency, phase and time synchronization. The Forum is looking at different clock distribution scenarios over the mobile transport network, and provides recommendations in the context of QoS, resiliency, and efficient distribution based on topology (point-to-point or point-to-multi-point).

Matching SONET/SDH type reliability with IP/MPLS

Synchronous optical networking (SONET) and synchronous digital hierarchy (SDH) is known for its high reliability and fast

recovery from failures, and therefore, carriers expect that new packet-based backhaul will match that level of resiliency. IP/MPLS has already proved itself to be as reliable as SONET/SDH in many carrier deployments. The combination of functional recovery routine (FRR) and carefully engineered primary and secondary label switched paths (LSP) allows IP/MPLS-based network to recover in tens of milliseconds - on a par with SONET-based networks.

Managing and troubleshooting IP/MPLS-based networks

In the past there was an impression that IP/MPLS was difficult to manage and complex to troubleshoot, resulting in higher operating expenses. Carriers have been understandably reluctant to move to a new transport technology unless they were confident in its OAM tools.

However, today the management capabilities of IP/MPLS are extensive. With years of successful service provider deployments around the world, IP/MPLS now includes a robust set of standards-based OAM tools that greatly reduce troubleshooting time, such as MPLS Label Switched Path, ping, trace route, virtual circuit connectivity verification (VCCV) - test pseudo-wire state as well as bidirectional forwarding detection (BFD) - a hello protocol to connectivity, amongst others.

The traditional TDM approach to mobile backhaul networks has limitations that make it difficult to meet the evolving demands of mobile networks. However, IP/MPLS has proven itself over the years in fixed-line service providers as well as in mobile core networks. By transitioning mobile backhaul infrastructures to standards-based IP/MPLS solutions, operators can evolve from 2G to LTE, reduce operating expenses, scale efficiently, and most importantly, position themselves to compete effectively for the coming tidal wave of data-rich mobile services. ●