WHITE PAPER

Transforming Mobile Backhaul Networks: Using SDN to Securely Scale Backhaul for LTE and the Next Generation of Mobile Broadband Services

Sponsored by: Juniper Networks

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February 2014

INTRODUCTION

Global smartphone adoption, new LTE network rollouts, increase in OTT content, and higher subscriber data usage are all contributors to the explosive growth of mobile broadband data services. These factors combine to stress the capacity of mobile backhaul (MBH) throughput. Customer expectations for the mobile experience are also evolving. People expect a flawless experience, yet more video, music, business applications, and OTT content threaten to congest the backhaul network, ultimately affecting the quality of experience (QoE). How do mobile backhaul networks evolve to support all of these applications? And how can investment choices made today in new advances like small cells and LTE-Advanced affect the requirements of tomorrow's mobile backhaul networks?

To meet these requirements, the mobile backhaul network needs to transform from a static transport architecture to a more automated, scalable, and intelligent architecture capable of supporting virtualized services as the edge moves closer to the cell tower, creating value for subscribers and network service providers alike.

MARKET FORCES DRIVING MOBILE BACKHAUL CAPACITY

The rapid adoption of LTE data services in many markets is driven by a confluence of factors ranging from faster throughput than 3G mobile networks to the marketing of slick new 4G smartphones. In fact, IDC predicts that by 2017, global smartphone shipments will exceed 1 billion devices per year compared with 280 million devices in 2013. The adoption of LTE data services contributes to the overall network congestion because of higher data usage per subscriber. In fact, a 2013 GSMA market study, *Global LTE network forecasts and assumptions, 2013–2017,* noted that leading carriers like Verizon, Vodafone, and Telefónica found that LTE users consume 1.5GB of data per month on average — almost twice the average amount consumed by non-LTE users.

IDC predicts exponential growth in global mobile data usage, which will grow by 4.5 times to over 19 exabytes in the next two years, according to IDC's *Worldwide Internet Broadband Bandwidth Demand 2012–2015 Forecast* (IDC #232596). Consumers are increasing the consumption of high-bandwidth OTT video content applications (such as Netflix, Hulu, FaceTime, YouTube, and Dailymotion) over smartphones and tablets, which is contributing to the network capacity crunch.

Other contributing market factors at play are new and emerging business models such as AT&T's sponsored data advertising over 4G/LTE networks, which allows subscribers to access mobile content and apps without using the subscriber's data plan. This of course adds further traffic to the network because there is no cost to end users, although AT&T recoups monies from business sponsors. The implementation of QoE, security, and location-based service features could enhance top-line revenue but also add cost and complexity for metro Ethernet service providers and mobile operators of MBH. Finally, government broadband consumer initiatives and mandates, such those in India and Brazil to increase access to affordable, ubiquitous mobile broadband, will force operators to plan for MBH network upgrades or replacements to cope with inevitable demand.

LTE NETWORK REQUIREMENTS: TRANSFORMING MOBILE BACKHAUL

LTE network rollouts continue at a terrific pace, and IDC predicts that there will be over 260 additional mobile operators that deploy commercial LTE networks in the next one to three years as regulatory approvals take place in many countries and end-user demand for higher broadband data speeds goes unabated. The GSMA predicts that there will be 1 billion LTE connections by 2017 and that 1 in 5 mobile broadband subscribers will be on an LTE network. IDC research in developed Asia/Pacific markets such as Japan, South Korea, and Singapore indicates that LTE ARPU is about 7–15% more than 3G postpaid ARPU. In other developed markets, IDC notes that operators have found that LTE can generate a more modest ARPU uplift of 10–40%.

To cope with this larger demand for network data capacity, service providers have to develop a common network strategy for all IP networking services that include LTE. When considering LTE, the boundary between network domains can become blurred. In the case of LTE, 3GPP already specifies that IP transport is mandatory. LTE systems are based on entirely new packet-based architecture, including the use of Ethernet physical interfaces for interconnection between the various functional elements. 3GPP R8 standards also flatten and simplify the network architecture, resulting in adding more intelligence into the radios (eNodeB [eNB]).

Adding MPLS to the IP transport architecture fits with the service provider's requirements to reduce capex on infrastructure and for leveraging common access, aggregation, and edge network infrastructure solutions. The inherent quality-of-service (QoS) features, network resiliency management, and support for SLAs of an MPLS-based mobile backhaul enable service providers to support legacy 2G/3G services with the flexibility to also support dynamic new LTE-based services. For example, an MPLS-based mobile backhaul network would allow a carrier to offer IPTV, fixed broadband, and even enterprise services from the same platform with different QoS levels, generating further value from the network.

A key consideration for intelligent MBH solutions is an open, flexible software architecture that can enable automatic provisioning of additional MBH capacity during peak congestions loads. The ability to leverage network virtualization technologies, such as bandwidth calendaring, auto-redundancy, and shared MBH multitenant network elements, overcomes scalability limitations. Manual provisioning across different network domains can be costly in terms of increased opex because of encapsulation, QoS, and traffic management overhead, ultimately affecting end-user experience. Also, there is an increase in the operator's use of the X2 interface between the eNodeBs to ensure better handover performance and to coordinate transmission and reception among neighboring sites for LTE-Advanced. Even though most service providers plan to expand their macrocell network and develop small cells to improve coverage and capacity, they are faced with flat or slightly increasing capex budgets. It then becomes critical to implement a network virtualization strategy for the backhaul network, which can lead to improvements in overall network capacity utilization for both peak and off-peak scenarios.

NETWORKING CHALLENGES OF IMPLEMENTING AN ALL-IP LTE MBH SOLUTION

An IP-based LTE mobile backhaul solution presents some new networking challenges for service providers in terms of scaling capacity, provisioning, management, security, interoperability, and support for legacy 2G/3G services.

The economics of scaling network infrastructure including MBH capacity cost effectively will be one of the most critical challenges for service providers over the next five years. Service providers' capex investments to increase macrocell and small cell site density and also add more cell site locations for coverage will alleviate some of the problems with scaling mobile infrastructure. However, without the integration of intelligent software analytics, automated transport engineering tools, and the implementation of network virtualization technologies, service providers will likely spend more on opex and capex to reprovision and adjust capacity changes. IDC expects service providers will increase the access, pre-aggregation, and aggregation capacities of their mobile backhaul networks to 10G, 40G, and 100G over the coming years and will begin to deploy 1G interfaces to many cell sites.

Provisioning additional capacity within an MBH network is often a manual process that is slow and tedious because there can be multiple network management platforms, multiple network control software tools, and multiple network engineering teams involved. Service providers are challenged to implement automated provisioning solutions for MBH capacity changes and to automate many of the monitoring, troubleshooting, and traffic engineering functions in the MBH network. Service providers have the choice of internally developing these software capabilities to automate the control of thousands of network elements or employing third-party solutions from vendors that they can integrate into their OSS/BSS. The key challenge is to do this with open, software-based programmable platforms.

One of the most important functions performed by MBH is security, and since IP networks are inherently more vulnerable to physical and internal network security threats, service providers need to plan accordingly. From a security perspective, an LTE architecture is vastly different from a 3G architecture; whereas there is built-in encryption between NodeB and RNC in the latter case, for the LTE S1 interface between eNB and S-GW, there is no encryption. This open IP interface not only exposes data security and vulnerability for end customers but also creates potential attack points for service provider networks as another emerging vulnerability will be the use of small cells with easier public accessibility to potential hackers with port access.

Another goal for many service providers is designing a virtualized MBH network infrastructure to share backhaul network capacity on demand, based on peak congestion times, or location changes using new SDN and NFV technologies. This remains a challenge since many service providers are reluctant to implement SDN and NFV technology solutions that are unproven and not widely deployed.

Managing QoS policies in LTE MBH networks also becomes an important CSP consideration. A typical wholesale MBH network provider is supporting a shared multitenant service to a set of mobile operator customers. QoS can be used to support different SLAs and has to be actively monitored in this environment. QoS also becomes important for handling combinations of legacy voice and data services from 2G/3G networks along with more latency-sensitive 4G data and video traffic. QoS may also play a future role in determining new business models for OTT content, time-of-day SLAs, and on-demand pricing, which will have to be supported.

CSP CONSIDERATIONS FOR IMPLEMENTING SDN AND NFV FOR MBH FOR LTE AND SMALL CELLS

IDC believes that the combination of SDN and NFV will play an important role in tackling some of the challenges posed by new LTE MBH network deployments. For service providers, the implementation of a software-based virtualization strategy must also leverage their underlying MPLS transport network, which can alleviate the scaling capacity issue. Service providers using a single seamless IP/MPLS control plane from an access network to a packet core network with an automated single-label switch path can also help drive automation of provisioning and lower opex costs for MBH. This seamless MPLS control plane can be capable of scaling to hundreds of thousands of endpoints while reducing the number of service abstractions required across network domains. The need for a highly scalable control plane becomes essential with the introduction of small cells and HetNets (mix of macrocells and small cells), without which the potential impact to QoE is significant. The seamless MPLS control plane can accommodate a large number of endpoints and simplify management of backhaul networks.

As service providers plan their LTE rollouts, one emerging network consideration is having an MBH architecture that makes it much easier to deploy new services or change existing service offerings using a predefined "service template." The creation of a new service abstraction layer in concert with the MPLS control plane is an example of how service providers can abstract a specific service with its unique KPIs, service parameters, QoE, latency, and other traffic engineering requirements into a service instance. This approach facilitates network orchestration of resources that will automatically adapt to the changes to live network capacity and service requests. Service providers can leverage the combination of a seamless MPLS control plane and an open, programmable, SDN-based controller to optimize the MBH network. An architecture that enables open APIs is critical for this and allows the service provider to design an MBH network solution that employs best-of-breed networking hardware, data management plane software, and application software vendors. An SDN controller, in concert with this service abstraction layer, can facilitate service chaining, which allows the orchestration of MBH services and capacity adjustments and optimizes the use of the MBH network in response to network performance, amount of backhaul traffic, time of day, and latency conditions.

Service providers also have to support a number of important security requirements to maintain authorized access to the MBH network, including support for IPSec to limit accessibility to the MBH infrastructure. Other considerations include the use of port filtering to limit access to macrocell and small cell sites and IP address filtering to ensure that only authorized traffic is leaving off-net to the Internet. Service providers should also strongly consider whether there will be the flexibility to support value-added, NFV-defined services such as virtual firewall, NAT, intrusion detection, and other security services and how this will impact the MBH network. IDC recommends that service providers consider the vendors that can demonstrate expertise in the security domain and also practical experience with NFV-based deployments.

RECOMMENDATIONS FOR TRANSFORMING TO AN OPEN, SOFTWARE-DEFINED MBH NETWORK ENVIRONMENT

IDC recommends that service providers transform to an open API–based network operating architecture that will leverage a centralized, software-based SDN controller and enable support for service chaining in an NFV environment. An open, programmable network must also operate in concert with seamless MPLS to ensure scalability. Seamless MPLS leverages a single MPLS control plane, integrating access, aggregation, and core domains into a single MPLS domain. This is a critical requirement for service providers to incorporate into an LTE MBH strategy since it enables a flexible point-and-click provisioning of new end-to-end services and simplifies management of these services.

IDC believes that service providers have already invested billions of dollars in the implementation of MPLS technology and MPLS VPN solutions including the use of traffic engineering, QoS, and policy management. Vendors like Juniper Networks have further enhanced MPLS with additional features including path computation element (PCE), which automates and simplifies the service provider's task of traffic engineering all of the MPLS LSP connections. This becomes an essential component of LTE backhaul resource management to ensure more efficient use of network resources and backhaul links. Also, automated software-based capacity planning tools working together with PCE are all important considerations made today that will affect the economics tomorrow.

IDC believes that an SDN overlay approach, like the Juniper Contrail SDN controller, is easier to integrate with a service provider's existing MPLS network environment. The implementation of a seamless MPLS control plane and MPLS traffic engineering features like PCE to improve network optimization, control cell site router network elements, and manage MBH capacity in LTE networks can lower opex and improve service agility. A good SDN controller is one that implements an intelligent SDN control plane that allows the network to respond to dynamic traffic changes, extracts real-time data and analytics from the network, and then correlates this to a network policy engine, which then automatically orchestrates all of the necessary changes from the cell site router all the way to the core of the backhaul network.

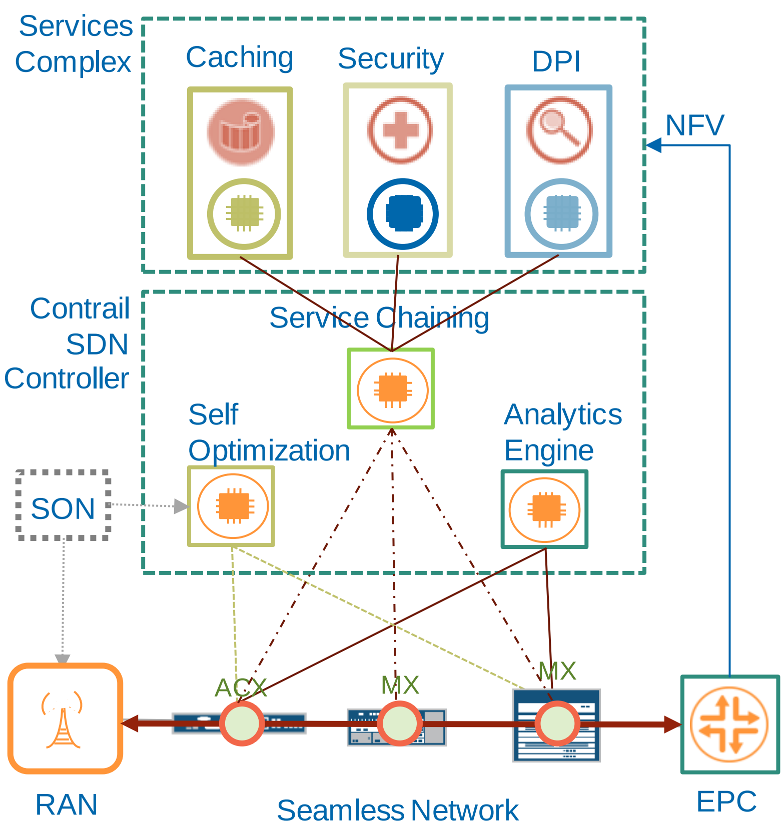
An SDN-based control plane adapts to the requirements of the applications deployed on the network. IDC notes that the current-generation networks and architectures are statically configured and vertically integrated. New-generation applications such as Hadoop, video delivery, and virtualized network functions require networks to be agile and to flexibly adapt to application requirements. An abstraction layer that maps applications and service parameters into service policies is another consideration for SDN controllers. A centralized SDN controller such as OpenContrail provides north-bound REST APIs for managing the network and exposing concepts at a much higher level of abstraction. These are APIs at the service layer instead of the technology layer. IDC predicts that in the next few years, most service providers' backhaul architecture will require some form of an SDN controller that communicates with all of the MBH network elements and network management systems and the OSS/BSS layer.

This integration or virtualization of network functions, or NFV, in LTE MBH networks presents service providers with a new opportunity to monetize virtualized services and applications. Juniper MX Series functions as an anchor for service chaining existing as well as new Juniper and third-party virtualized services. Open APIs on the Juniper Contrail SDN controller–enabled platforms will allow the use of service chaining to enhance service agility, enabling faster time to market. These APIs would allow the operator's ecosystem partners to enhance content delivery by, for example, caching at the edge of the backhaul network. The premium charged for these enhanced services will be shared by all of the ecosystem partners.

Figure 1 is an illustration of a software-defined mobile backhaul network.

FIGURE 1

Software-Defined Mobile Backhaul Network



Source: Juniper Networks, 2014

SDN- and NFV-driven service chaining can improve service providers' business models just by automating and simplifying the provisioning process. Service providers carry email, voice, video, and Web traffic and downloaded files over mobile networks, and each data type benefits from specific types of related services. With SDN and NFV, service providers can create service chains tuned to each application type, device type, and location to ensure the level of service quality each customer purchases as a result. Juniper's SDN and NFV service chaining capabilities can enable service providers to accelerate the time to revenue from new applications.

IDC believes that the combination of SDN, NFV, programmable networks, and service chaining enables service providers to more efficiently embed applications and related services in the network itself, placing them at an advantage over third-party OTT providers. It also enables service providers to easily build customized, self-defined services catering to the needs of individual enterprises, consumers, and wholesale environments. This open, programmable platform environment can help transform service providers to be able to easily add and offer new "apps" and also has the agility to respond to changing network workloads. It also presents new revenue opportunities in transforming today's mobile backhaul networks.

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