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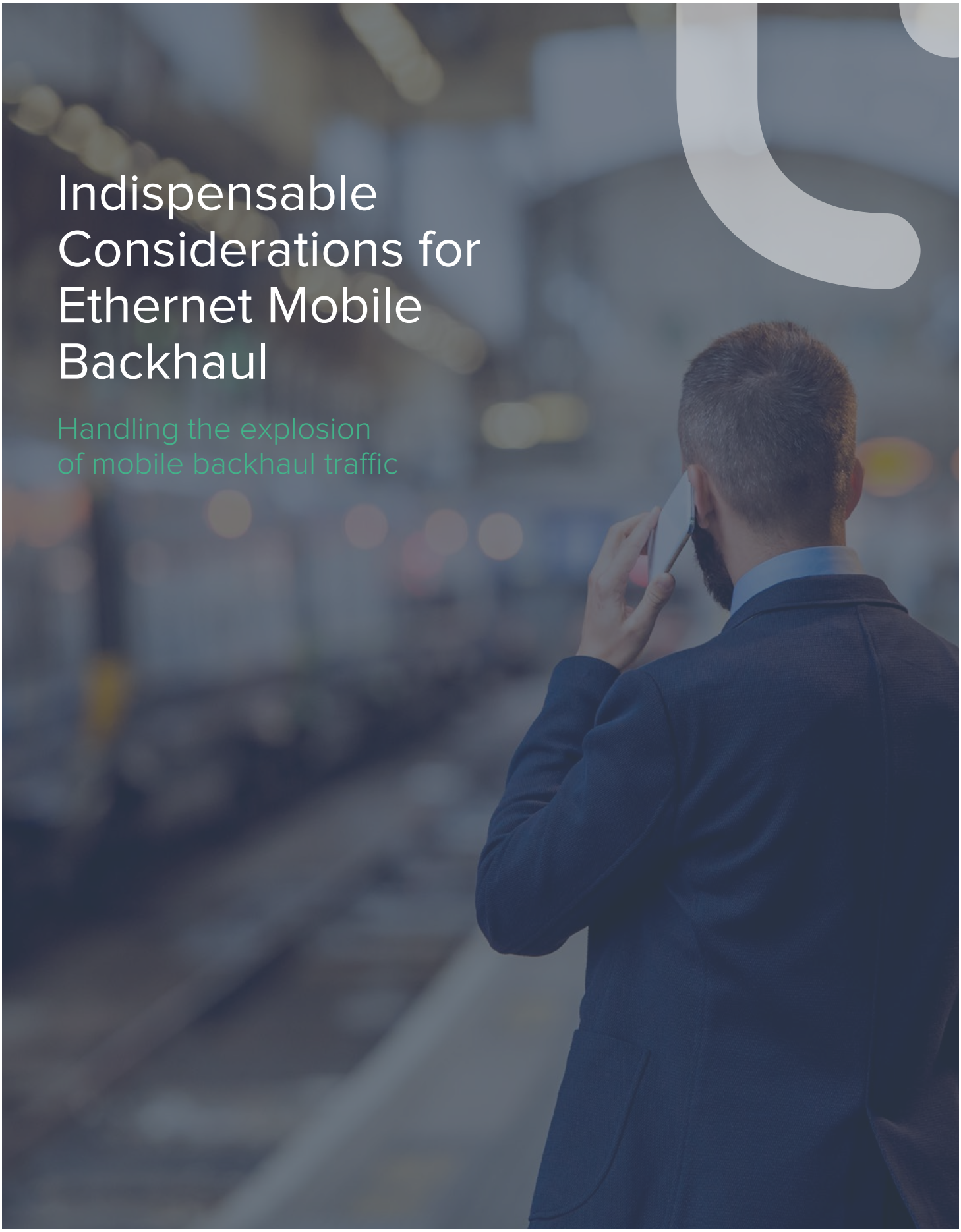


Indispensable Considerations for Ethernet Mobile Backhaul

Handling the explosion of mobile backhaul traffic

Content

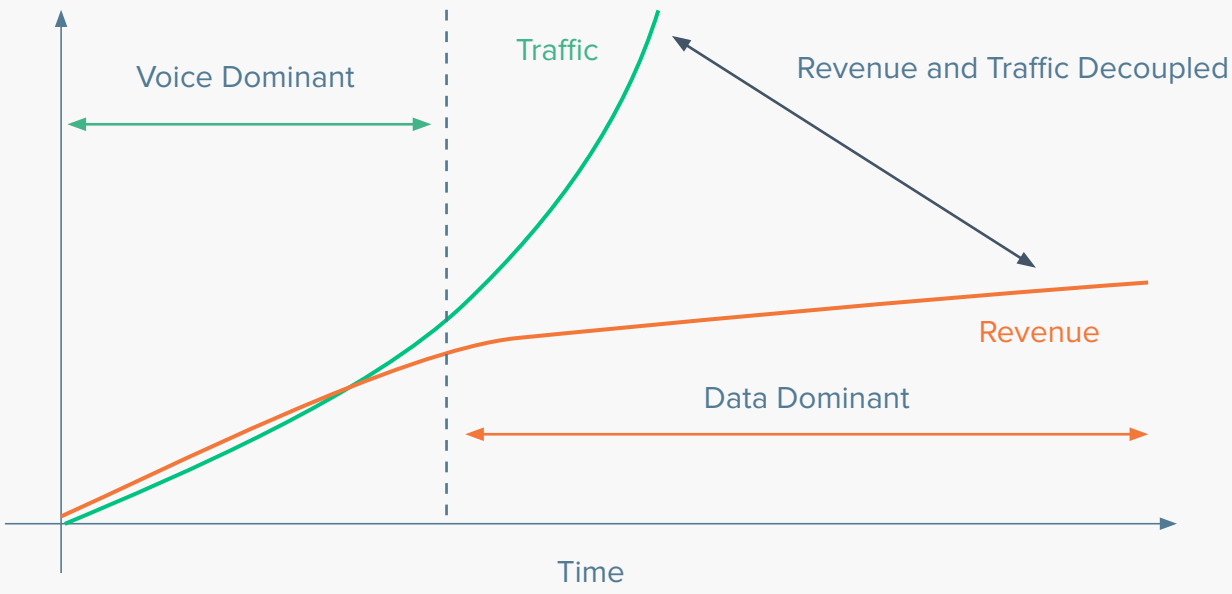
Executive Summary

With revenue from voice services flat or declining in mature markets worldwide, the growth of wireless data applications is conversely enabling mobile operators to increase revenue via the delivery of mobile data services. The impact of the iPhone on AT&T's business is a single, but powerful testament to this fact. However, while mobile data and content traffic volumes will continue to grow exponentially, revenue will not. This has led mobile operators and wholesale network infrastructure providers to look toward driving down "per-bit" costs for transporting data traffic. This basic business need has led to the choice of Carrier Ethernet technology as the transmission medium for handling the exploding volume of backhaul traffic—instead of traditional TDM, which simply does not scale in terms of cost benefits. Nearly every operator aspiring to launch long term evolution (LTE) services is thus first "preparing the ground" by deploying an Ethernet-based backhaul network.

However, the introduction of an Ethernet-based mobile backhaul network is a tricky affair. First, it is critical to appropriately size the infrastructure components that constitute the network—because not being able to do so defeats the whole purpose behind moving to a flexible and scalable technology: i.e., cost containment.

In a Carrier Ethernet environment, the traditional approach of oversizing your network infrastructure to meet growing mobile data traffic demands becomes counterproductive as it would defeat the purpose of Ethernet as a more cost-effective, alternative technology. Furthermore, rightsizing is not a one-time activity; it is an ongoing process to keep up with new traffic patterns that may result from disruptive business decisions (e.g., the introduction of iPhones) or user and demographic behavior (e.g., New York's Times Square on New Year's Eve.

Figure 1: Voice vs Data dominance
Source: Unstrung Insider



Rightsizing and QoS

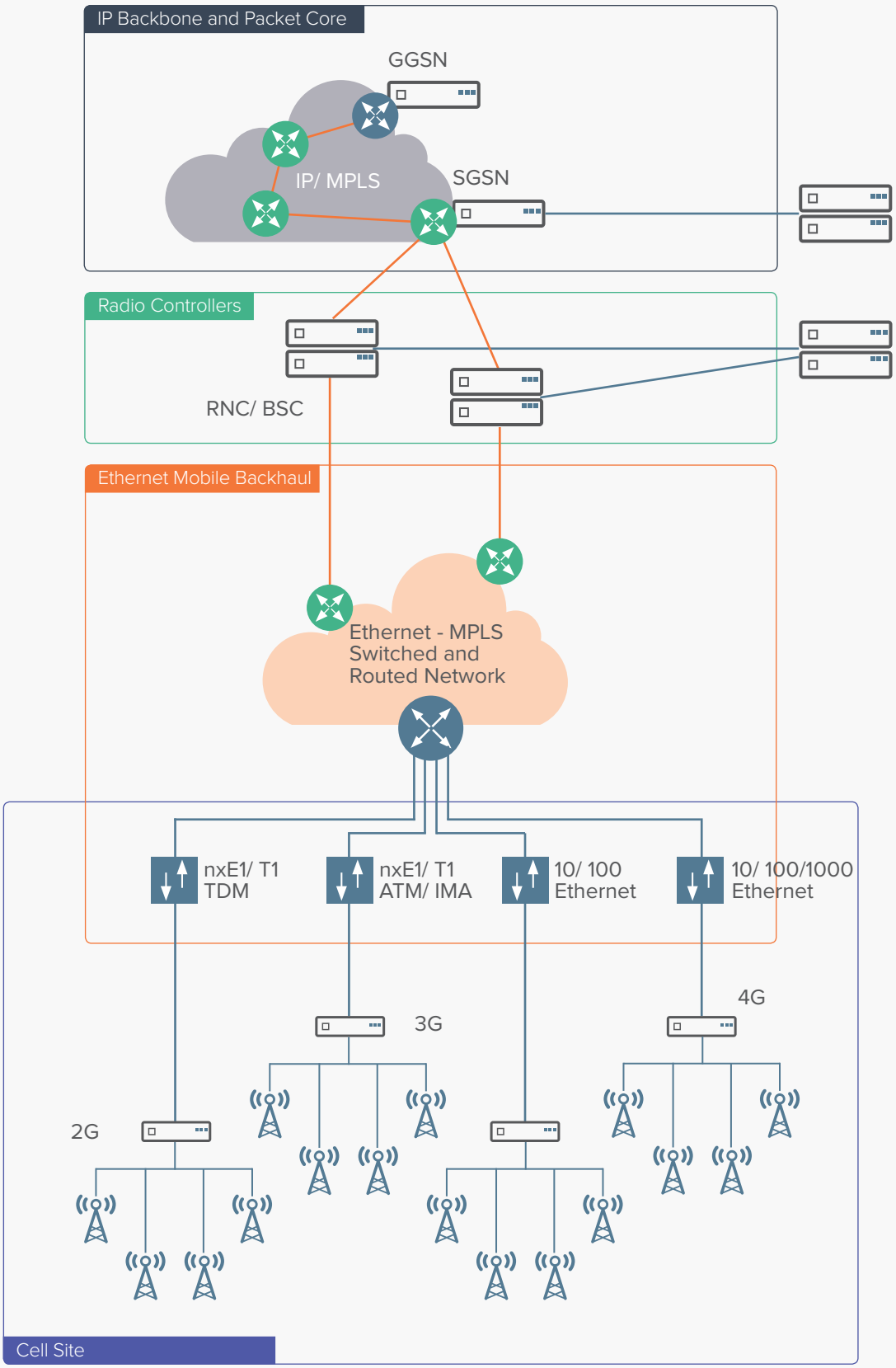
While rightsizing is important toward staying aligned with the objective of cost containment, the aspect that needs to be balanced in parallel is quality of experience. Customers who have signed up for expensive data service packages, especially those traveling on business, expect a certain quality of user experience. When they don't get it, they become a strong candidate for churn—and will likely switch to a competitor. What complicates the matter is that reduced infrastructure investment invariably leads to a degraded quality of experience for end users. So, not only is it important to perpetually rightsize the network infrastructure, but also to ensure that the appropriate quality of experience is preserved. Furthermore, there are stringent quality benchmarks imposed by packet-based synchronization standards, like IEEE 1588v2 or adaptive clock recovery, to carry out the basic functions of a cellular network, such as cell-to-cell hand-offs.

The radio access network (RAN) is critical to the delivery of voice and data services. Although operators embrace Carrier Ethernet to "future-proof" against explosive data growth and next-generation mobile networks (4G), they still have to support their legacy 2G and even 3G radio networks (e.g., UMTS, HSPA, and HSPA+), which use legacy transmission standards like TDM or ATM. This is where pseudowire or circuit emulation technologies are enabling operators to seamlessly support legacy transmission interfaces over a pure Carrier Ethernet network.

Nevertheless, transmission connections to individual cell sites are still prone to multiple problems ranging from weather to careless configuration changes. While the operations team traditionally managed the tools that tested the legacy connectivity, it now needs similar tools to assure the availability and quality of such emulated connections over Carrier Ethernet. Furthermore, the capability to troubleshoot transmissions to each cell site in real time is vital for comprehensive service management.

Last but not least, Carrier Ethernet, as compared with traditional TDM, brings more complex concepts like classes of service, VLANs, virtual circuits, and MPLS tunnels. Although operators entrust the assurance of the mobile backhaul to the same transmission teams that managed TDM backhaul, they need to ensure that those teams are also equipped with the right tools that can assure and engineer all these entities holistically.

Figure 2: The Ethernet Mobile Backhaul Architecture



Key Demands of Ethernet Backhaul Assurance

Rightsizing

With the need to rightsize the components of the Carrier Ethernet backhaul infrastructure comes a number of challenges. Data traffic patterns of mobile consumers are extremely temporal. For example, holidays and events have a deep effect on consumers' messaging and browsing patterns. Demographic factors further dictate variation in data traffic usage spatially—that is, mobile data usage in New York exceeds that of Arkansas. An accurate comprehension of traffic patterns is further complicated by the combination of time and demographics—for example, New Year's Eve at Times Square (New York City) could potentially mean thousands of multimedia messages being sent at the same time through a single radio network subsystem (RNS). Under these circumstances, the need for deep analytics of traffic utilization must be realized. Industry-proven concepts such as "busy day" and "busy hour" designations are crucial in determining the worst stress levels of the backhaul network. Furthermore, hourly baselines help the operator understand traffic patterns at specific time windows and further plan maintenance and engineering activities intelligently.

Engineering benchmarks like 95th percentile are critical to optimally engineer the network based on past traffic patterns. Finally, accurate traffic forecasts based on historical traffic usage are indispensable in achieving the objective of rightsizing the network for the future. Being able to do all of this down to every sub-element (interface, class of service, and VLAN) is important in determining the patterns of each traffic type. But it requires industry-grade assurance tools that demonstrate proven scalability and performance.

Quality of Experience to Retain Customers

In a world of fierce competition, mobile consumers are extremely susceptible to churn when they experience poor service quality. The mobile backhaul plays an important role in this regard. End-to-end quality degradations in the mobile backhaul lead to local market/regional issues that affect service experience for an entire population of mobile users. As operators look to push their top-line revenue, they are introducing more and more value-added applications that are streaming-oriented (e.g., video) and real-time (e.g., gaming). This puts stringent end-to-end quality demands on the operator, which must be prepared to measure and monitor at varied levels of traffic segregation.

Traffic Type	Service Requirements
Voice	✓ Minimal End-to-End Delay ✓ Minimal Jitter ✓ Virtually Zero Packet Loss
Video	✓ Reasonable End-to-End Delay ✓ Minimal Jitter ✓ Virtually Zero Packet Loss
Preferred Data	✓ Reasonable End-to-End Delay ✓ Reasonable Jitter ✓ Very Low Packet Loss
Best Effort Data	✓ No Delay Constraints ✓ Minimal Packet Loss

Timing and Synchronization Demands on End-to-End Quality

Mobile networks require highly accurate primary reference clocks (PRCs) to distribute timing across all network elements. If the synchronization is misaligned, the base station and mobile devices may lose contact and inter-cell hand-offs may fail, resulting in dropped calls.

While numerous techniques have been explored to address this within Ethernet backhaul, packet-based synchronization techniques have gained popularity because of their ability to interoperate with a wide variety of access transport layers including fiber, copper and microwave.

Packet-based synchronization techniques like IEEE 1588v2 or adaptive clock recovery involve distribution of timing information in the packet layer using a dedicated Ethernet stream. However, this technique is vulnerable to packet network impairments such as end-to-end delay, delay variation and frame/packet loss. T

iming and clock recovery mechanisms thus become weaker with degraded end-to-end quality issues such as high packet delay variation (jitter) and packet loss. This has further led standards bodies to dictate end-to-end transmission quality limits on Ethernet backhaul that operators should verify on an ongoing basis.

Approaches to End-to-End Ethernet Quality Assurance

The need to assure data service experience as well as the compulsion to adhere to strict timing synchronization requirements make it imperative to consider end-to-end quality assurance techniques even before rolling out the Ethernet backhaul network.

The recognition of this by the industry has led to the introduction of end-to-end Ethernet assurance standards like IEEE 802.1ag and ITU-T Y.1731, or more generically, Ethernet OAM.

Popular carrier Ethernet infrastructure vendors like Cisco, Alcatel-Lucent, ADVA and others have thus followed suit in introducing standards-based, “built-in” instrumentation within their offerings to measure end-to-end quality of Carrier Ethernet. Leveraging such instrumentation is inherently advantageous in that service providers can avoid the costs of deploying explicit probes (that may be expensive as well as intrusive) across the entire RAN backhaul.

Furthermore, if the Ethernet backhaul being deployed consists of multiple vendors, some of which may not be standards-compliant or may have legacy versions with proprietary instrumentation, operators need to be able to leverage the vendor instrumentation in a generic manner. This clearly implies the need for effective service assurance platforms that can leverage vendor-specific instrumentation to portray the end-to-end quality of the Ethernet backhaul using vendor-agnostic key quality indicators.

This aspiration must be compatible with the objective of being able to rightsize the Ethernet infrastructure, because containment of infrastructure components below certain levels invariably leads to degraded quality of experience for end users.

With rightsizing being an ongoing effort, the ability to continuously baseline end-to-end quality over long periods of time becomes necessary to ensure that the chosen infrastructure sizing can meet service quality expectations.

Ethernet Backhaul Quality Limits An MEF-Commissioned Survey	
Availability	5-9s
Latency budget for synchronization	3-5ms
Number of CoSs	3-4s
% who want Ethernet OAM (operations, administration and maintenance)	78%

Service Class Name	Example of Generic Traffic Classes mapping into Class of Service (CoS)		
	4 CoS Model	3 CoS Model	2 CoS Model
Very High	Synchronization	-	-
High	Conversational, Signalling and Control	Conversational and Synchronization, Signalling and Control	Conversational and Synchronization, Signaling and Control, Streaming
Medium	Streaming	Streaming	-
Low	Interactive and Background	Interactive and Background	Interactive and Background

Complex Engineering and Design Capabilities

The clear technology of choice for future-proofing the mobile backhaul infrastructure, Carrier Ethernet also brings complexities. While T1 backhaul brought only channelization, Ethernet Backhaul brings challenges such as the management of VLANs (for traffic separation), classes of service (for traffic prioritization), pseudowires, Ethernet virtual lines, Ethernet virtual LANs (for broadcast TV), and MPLS tunnels.

And although the same transmission-engineering and transmission-operations teams are being entrusted with a far more sophisticated transmission medium (Carrier Ethernet), they also need the right set of assurance tools to measure and report the performance of the aforementioned entities in a holistic manner.

Engineering an end-to-end connection between a cell site and the upstream controller using Carrier Ethernet requires an orchestration of all these entities; therefore, a modification of any one entity requires a deep and ongoing analysis of the other entities from a performance perspective.

Quality Obligations for Wholesale Operators

The inclination of mobile operators to build their own Ethernet mobile backhaul can vary by geography. Therefore, in many regions of the world, Carrier Ethernet infrastructure would be leased from wholesale providers (wireline or cable operators), which, for their part, have the obligation to monitor and sustain the quality of services that mobile operators deliver.

In this role, wholesale operators are likely to adopt the business practice of providing private online reporting, also known as customer portals, to their high-value mobile operator customers in addition to all the other service assurance considerations listed earlier. This practice has become popular with business VPN services, and such offerings help wholesale operators increase the value perceived by their end customers. It also helps them build trust and legitimacy with mobile operators.

Carrier Ethernet is an excellent choice as a transmission medium for mobile backhaul. But as mobile carriers—in concert with standards bodies—work toward accommodating basic benchmarks and standards (e.g., for timing synchronization), the considerations for service assurance should be viewed as indispensable in exploiting Ethernet backhaul's advantages. Service providers should back up their business decisions (and technological choices) with appropriate capabilities from an engineering and operations perspective. These service assurance considerations should therefore not be viewed as afterthoughts; but rather as basic pre-requisites for achieving the business objectives behind Ethernet backhaul.

Infovista's VistaInsight® for Networks is an assurance solution ideally positioned to facilitate the introduction of Carrier Ethernet backhaul. As a service assurance leader in the business services market, Infovista has the unique status of repeatedly delivering compelling assurance solutions for the Carrier Ethernet VPN market.

Furthermore, partnerships with most leading Ethernet vendors allow Infovista to deliver a multivendor solution that supports vendor-agnostic workflows and can be used to effectively manage transmissions to mobile cell sites. Infovista's VistaLink® for Alcatel-Lucent 5620 SAM is a relevant product in this latter context.

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