

Ethernet mobile backhaul delivers new services with higher performance and lower costs

Fiber to the cell site provides operator advantages

Have you selected Ethernet as the technology of choice for increasing capacity in your mobile backhaul? The Transmode Ethernet Mobile Backhaul solution provides virtually unlimited capacity, scalability and flexibility for metro and regional networks. Best in class synchronization, ultra-low latency and zero jitter define a unique approach for new service offerings. Based on Transmode's Native Packet Optical architecture, the Ethernet Mobile Backhaul solution provides a future proof way to prepare for LTE advanced networks.

The bandwidth challenges faced by wireless operators today are driven by trends that have been well publicized, and driven by the explosion in mobile data traffic. Mobile operators are rapidly increasing wireless network capacity, both in the wireless and backhaul networks. Operators often consider structural architecture changes, including the migration to fiber based backhaul, in response to the pressures of traffic, mobility and cloud services.

Mobile backhaul is a demanding application with changing requirements, making it well suited to an Ethernet based approach. Packet data is outgrowing voice data in the mobile network, which supports a scalable protocol like Ethernet instead of TDM. Cell sites currently support a range of <100Mbps up to 1Gbps, and operators need to deploy an infrastructure capable of supporting

1Gbps to 10 Gbps for future requirements. The migration from 3G data offload over best effort Ethernet to full LTE Advanced backhaul will require a network that supports many levels of Quality of Service (QoS) and a more flexible architecture. This migration is ideally suited for implementing Ethernet within a backhaul network.

The way networks are built and managed is changing, bringing new business opportunities. Recent market research forecasts wholesale mobile backhaul revenues growing from \$14.0 billion in 2009 to \$17.3 billion in 2016. Wholesale mobile backhaul providers will be chosen based on the classic characteristics of reliability, performance and cost. There is wide variance in how different suppliers meet these needs, which will have a direct impact on the success of individual operators.



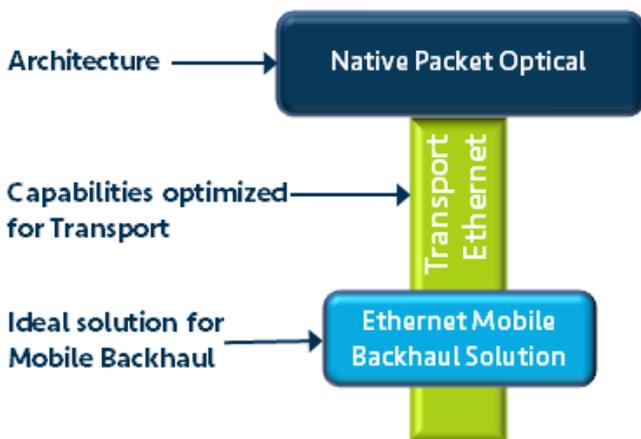


Figure 2 - The Ethernet Mobile Backhaul Solution adheres to the Native Packet Optical architecture and is built with the Transport Ethernet set of capabilities.

Transport Ethernet - optimized for services

One implementation approach for Ethernet mobile backhaul is to use Carrier Ethernet, the Metro Ethernet Forum (MEF) standard, developed to bring the simplicity and cost model of Ethernet to the wide area network. Meeting the stringent needs of the network core, Carrier Ethernet supports a wide range of enhancements, including those not used for transport networks. When implementing a mobile backhaul network using Carrier Ethernet, richly featured, Layer 2 Ethernet switches would be deployed in the access and aggregation parts of the network, interconnected by standard Layer 1 transport solutions. This approach would address the requirements for finer service granularity and for varying quality of service but adds considerable cost and complexity over a pure Layer 1 approach.

The most cost effective option is to use the Carrier Ethernet subset required to aggregate Layer 2 traffic and to integrate only these features with a Layer 1 solution. If well implemented, this option adds Layer 2 capabilities to the access network at a lower cost than full Carrier Ethernet or a pure Layer 1 approach. Focusing on aggregation and service demarcation enables the creation of a network with superior technical performance, particularly for synchronization quality and latency, which are extremely important in a mobile network. This approach is often referred to as Transport Ethernet.



Transmode's Ethernet Mobile Backhaul solution is a Transport Ethernet implementation, addressing metro and regional networks. It is built on Transmode's Native Packet Optical architecture, which enables efficient transport of Ethernet traffic in fiber networks. Standard Ethernet framing is used at the network edge instead of encapsulating it within an OTN "digital wrapper." Transport capacity is utilized much more efficiently as the overhead is minimal and maximizes the revenue-generating payload traffic.

The Transmode solution implements Quality of Service(QoS) functionality compliant with the MEF Carrier Ethernet 2.0 initiative. While the use of a single class of service as supported by Carrier Ethernet 1.0 is a viable way to get started, supporting multiple classes of service as enabled by CE 2.0 provides substantial Operating Expense(OpEx) savings for mobile operators. Implemented using Transport Ethernet, the multi-CoS solution will result in equivalent or better quality, as experienced by the mobile subscriber, than traditional solutions. MEF 22.1 and MEF 23.1 Implementation Agreements and MEF best-practices papers provide mobile operators with information to effectively implement the capabilities of Transmode's Transport Ethernet solution.

Cost savings through focus

Transmode's Transport Ethernet approach leads to cost savings for network operators in addition to the performance advantages. Transmode system designers focus on key performance characteristics, developed on Transport Ethernet and Transmode's Native Packet Optical architecture, including low delay/latency, jitter, synchronization, QoS, classification OAM FM and PM, and Ethernet Service delivery. This focus enables the design to be implemented with fewer components, simplified, and to have size and power consumption reduced. Recent innovations in component design utilizing fair adaptive dynamic memory and output queued switch architectures also contributed to systems with a high QoS feature set at low cost and power. These aspects help simplify architecture and reduce total cost of ownership (TCO).

Industry leading synchronization

Synchronization is critical to mobile backhaul networks as users move from cell site to cell site and expect uninterrupted service. In mobile backhaul networks, multiple technology generations are often delivered simultaneously on the same network. While supporting similar services to the end user, these technologies have different synchronization requirements. Figure 3 shows the requirements for the most common mobile technologies.

In addition to the economic advantages of Transmode's Ethernet Mobile Backhaul solution, the implementation provides performance advantages over both Carrier Ethernet and TDM. One distinct advantage is improved support for synchronization within the network. Transmode's Ethernet Mobile Backhaul solution supports Synchronous Ethernet (SyncE) signals and transparent

Mobile Technology	Frequency Sync	Time-of-day/Phase Sync
GSM	± 50 ppb	
UMTS-FDD	± 50 ppb	
LTE-FDD	± 50 ppb	
UMTS-TDD	± 50 ppb	2.5 µs
LTE-TDD	± 50 ppb	3 µs/10 µs
TD-SCDMA	± 50 ppb	3 µs

Figure 3 - Synchronization requirements for mobile technologies

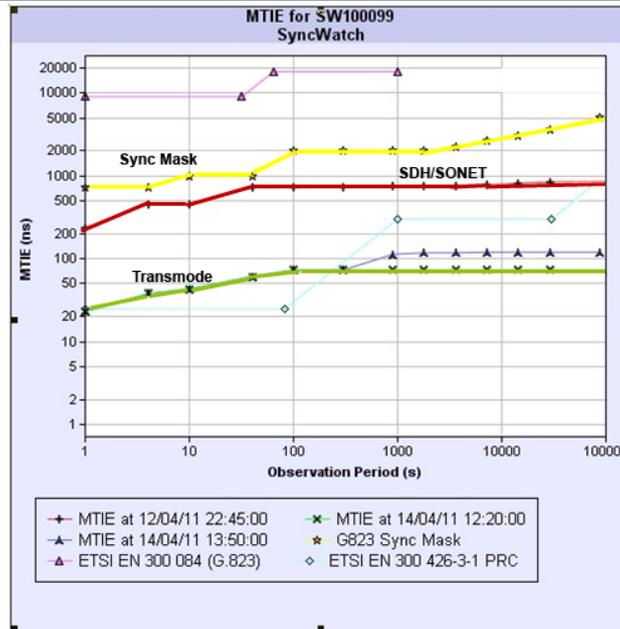


Figure 4 – On this 200 km live network, running at 100% throughput, Transport Ethernet Sync performance was 70-100% better performance with zero packet loss. Measurements taken over 30 days.

transport of 1588v2 signals for optimal flexibility. SyncE is the ability to provide frequency distribution through an Ethernet port. SyncE provides optimal synchronization performance, but also requires each device in the path to be SyncE-capable. 1588v2 is a packet-based synchronization method that can provide time and phase synchronization where the synchronization requirements are less stringent, see figure 3. It can also potentially work over existing infrastructure without requiring specialized equipment. However, 1588v2 has limitations which concern network operators, including network behavior, scalability, and efficiency. It is also sensitive to network performance, and performs best in a low latency and jitter environment. SyncE does not suffer from these limitations, and can be used in a hybrid system with 1588v2 to reduce Total Cost of Ownership.

It is important that mobile backhaul transport solution supports both synchronization methods. The transport solution is likely to remain in place for a long period of time and should not restrict options later available to the operator. Fiber based mobile backhaul will often be packaged as wholesale services from an operator that owns the fiber to another mobile operator or operators. The wholesale operator needs to keep their options open and support varying synchronization requests.

By focusing on a Transport Ethernet implementation and further simplifying wherever possible, Transmode delivers a platform that significantly improves performance versus alternative solutions. Based on network testing, the solution provides orders of magnitude better performance than G.8262 Synchronous Ethernet standard or G.813/G.823 SDH/SONET, previously considered the best standard for synchronization performance.

This industry leading performance provides operators with the reassurance of a very high quality synchronization signal from the backhaul network. This performance provides increased capabilities now and in the future. For example, this signal provides timing to a microwave backhaul access network, further extending geographic reach. Bigger cell site radiuses could be supported, as well as additional hops, important for LTE Advanced networks with stricter synchronization specifications.

Ultra-low latency and zero jitter

The combination of the Transmode Native Packet Optical architecture and Transport Ethernet allows the Transmode Ethernet Mobile Backhaul solution to excel, with 2-3 times better latency performance than typical Carrier Ethernet switches and almost zero jitter. Latency and jitter have a cumulative effect on the network as traffic passes with high volume through many nodes - in access rings, aggregation networks and the core. Latency should be stable, not varying with throughput or packet replication, see Figure 5. Managing latency and jitter is difficult without the Transmode solution.

These characteristics are increasingly important as operators upgrade to LTE Advanced networks. LTE Advanced networks support multiple QoS levels from best effort for services such as email and basic internet access to stricter levels for traffic streaming high quality video. QoS services are latency sensitive and should be considered in the backhaul network design.

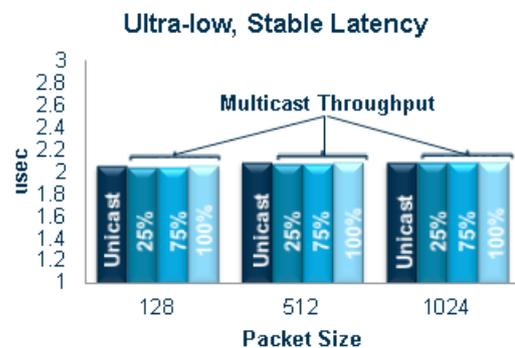


Figure 5– The Transmode Mobile Backhaul solution delivers stable, ultra low latency at varying throughput and packet replication levels.

Flexibility and scalability

The Transmode Ethernet Mobile Backhaul solution enables flexibility and scalability in 2 network layers. The Native Packet Optical architecture allows operators to flexibly deploy capacity with a very fine degree of granularity, as you would expect from a Layer 2 based architecture. As the architecture combines the best of Transport Ethernet with the best in optical networking, the operator can seamlessly add additional capacity at the optical layer. By combining the 2 layers within a single platform with a single management system the operator ensures that the deployed assets are fully utilized.

Service aware management

Enlighten is Transmode's multi-layer management suite for managing Transmode networks such as Ethernet Mobile Backhaul networks. With a modular design and standard open interfaces, Enlighten can scale from a few nodes to tens of thousands of nodes via clustered servers and integration into higher-level Operational Support Systems (OSS).

As operators move to Ethernet networks, supporting similar OAM techniques as the widely deployed SONET/SDH networks is required. With Enlighten, OAM features reduce the time that technical engineers need to spend on site and save OPEX. Enlighten understands the layers building up services and correlates problems on any layer to an impacted service. Integrated MPLS-TP management enables operators to configure MPLS-TP tunnels and services in a similar way to the paths and services that are used in ROADM-based optical networks.

Visibility and control of the services delivered is key for the operator delivering the services and the customer consuming them. Enlighten provides tools for assuring service availability through quick diagnosis and restoration. It also provides visibility of the service levels through Enlighten Ecosystem applications. The Enlighten Ecosystem of best of breed technology partners provides a broader and richer solution to address each operator's unique needs.

Ethernet mobile backhaul solution

The Transmode Ethernet Mobile Backhaul solution supports several capabilities – backhaul of Ethernet traffic, Layer 2 aggregation and Ethernet demarcation. The solution includes:

TM Series: The TM-Series is a family of carrier-class WDM optical transport products that provide the transport of any service between 100Mb/s and 10Gb/s in multi-reach transport applications. The TM-Series supports the Transmode Flexible Optical Network, incorporating state of the art ROADM technology, innovative concepts in planning, management and automation.

Ethernet Muxponder (EMXP): The EMXP integrates Layer 1 and Layer 2 functions into one module optimized for transport and aggregation of Ethernet traffic and Ethernet services over a WDM network. The EMXP provides 10G, GbE and FE interfaces, in several configurations. The EMXP is supported in the TM-Series 10U, 3U or 1U chassis.

- E-LINE, E-LAN or E-TREE services
- Flexible network resilience options through ring protection and point-to-point protection
- Tunable optics on line side for maximum flexibility
- Low Power Design ensures low total cost of ownership

Ethernet Demarcation Unit (EDU): The EDU provides aggregation of Ethernet services into WDM networks. Available in multiple modes and interface combinations, it provides operators with a clear demarcation point between the operator and customer owned network. The EDU also provides options for demarcation of a single GbE client or aggregation and demarcation of up to 3 GbE clients onto a GbE line with redundant network interfaces.

Conclusion

The Transmode Ethernet Mobile Backhaul solution, based on the Native Packet Optical architecture, is ideal for mobile backhaul network providers. The key demands for synchronization, latency and jitter are targeted and addressed, allowing the solution to have industry leading performance.

A proven and successful combination of Layer 1 and Layer 2 functionality is featured, offering full flexibility and scalability. As traffic continues to rise, the solution allows operators to right-size backhaul capacity. The network is ready for LTE Advanced in the future.

Transmode's Ethernet Mobile Backhaul solution is deployed in networks across the globe and helps operators lower the cost of their mobile backhaul traffic while also providing superior network performance – the ultimate in price-performance improvement – pay less and gain more!

For further reading:

For more information regarding Transmode's Ethernet Mobile Backhaul solution and Native Packet Optical architecture please take a look at:

- Solving the Mobile Backhaul Challenges Whitepaper
- Native Packet Optical Whitepaper