

Ethernet Mobile Backhaul:

- A wavelength with Ethernet all the way to the cell site

Have you selected Ethernet as the technology of choice for increasing capacity in your mobile backhaul? If so, you should look into Transmode's Ethernet Mobile Backhaul solution. Being built on the Native Packet Optical architecture it provides virtually unlimited capacity, scalability and flexibility in addition to best in class synchronization, ultra-low latency and zero jitter. And, if required, it can easily transport your TDM traffic too, with the same cost benefits as with Ethernet.

Introduction and executive summary

With the introduction of HSPA+, WIMAX and ultimately LTE, the need to backhaul Ethernet traffic from the cell site increases dramatically. In addition to cost; synchronization, latency and jitter are three key issues in Mobile Backhaul and these also need to be carefully addressed.

Transmode's Ethernet Mobile Backhaul solution transports Ethernet traffic cost efficiently over a single wavelength all the way to the cell site. It is ideal in mobile backhaul for several reasons. First it provides a capacity increase based on Ethernet and WDM technologies, both of which are well known for their scalability and flexibility characteristics. To add capacity you simply use the integrated Layer 2 Ethernet capabilities to increase the capacity to the node or for larger capacity increases you can add another wavelength. Add to this the flexibility of Transmode's WDM solution such as support for both CWDM and DWDM, both single fiber and fiber pair and finally the multi-service capabilities for the optional transport of TDM services over the same cost efficient network.

Second reason to why it suits mobile backhaul so well is the unparalleled synchronization, latency and jitter performance. To take synchronization first; the Ethernet Mobile Backhaul solution is designed to fully support Synchronous Ethernet (G.8262 SyncE) technology. Transmode's implementation of this technology

significantly outperforms synchronization in SDH/SONET networks, which traditionally has been regarded as a benchmark in this area. Add to this the impressive holdover capabilities of the solution and you have a robust platform for now and the future.

Furthermore; ultra-low latency and zero jitter are additional key characteristics of the Ethernet Mobile Backhaul solution, which all in all makes it so well suited in mobile backhaul networks.

In short the solution provides:

- Cost-efficient transport of Ethernet traffic all the way to the cell site
- Full scalability and flexibility enabling easy build out of capacity
- Industry leading synchronization capabilities, ultra-low latency and zero jitter
- Optional transport of TDM traffic over the same cost efficient WDM network using Transmode's Multi-Service capabilities

This whitepaper describes how Transmode's Ethernet Mobile Backhaul solution can be used in a mobile backhaul network, and how it can benefit mobile operators.

The Ethernet Mobile Backhaul solution – the best way to transport Ethernet

Mobile backhaul is a demanding environment with specific requirements that make it well suited to a Layer 2 Ethernet approach. Each cell site requires a fine granularity of traffic with a few 100 Mbit/s per cell site rather than a full Gigabit Ethernet. In addition operators will ultimately migrate from 3G data offload over best effort Ethernet to full LTE backhaul with many levels of Quality of Service requirements. These factors favor a Layer 2 Ethernet approach to the problem although this then opens up the question of how best to implement Layer 2 within a backhaul network.

Transport Ethernet - Optimized for transport

One approach would be to take the full Carrier Ethernet approach and to deploy full Ethernet switches in the access and aggregation points of the network and to use standard Layer 1 transport solutions to interconnect these. This would undoubtedly address the requirement for finer service granularity and for varying quality of service but it adds considerable cost and complexity over a purely Layer 1 approach. Careful consideration of the exact traffic matrix is required to determine if the complex Layer 2 approach actually saves money over a simpler but higher capacity approach of using Layer 1 to provide a full Gigabit Ethernet circuit to each site.

An alternative approach is to use just the functionalities and attributes of Carrier Ethernet switches that are required to aggregate and backhaul Layer 2 traffic and to integrate these into the optical layer. If done correctly this has the potential to add Layer 2 capabilities to the access network at a lower cost than both the full Carrier Ethernet approach and the higher capacity Layer 1 approach. Furthermore by focusing on adding the necessary Layer 2 functionality such as aggregation, service demarcation etc but avoiding implementing a full Ethernet switch it is possible to create a network with superior technical performance, particularly in the areas of synchronization and latency, both of which are extremely important in a mobile network. This approach is often referred to as Transport Ethernet.

Transmode's Ethernet Mobile Backhaul solution is built on the Transport Ethernet capabilities addressing Layer 2 Ethernet networking in metro and regional networks. The illustration below shows how the Ethernet Mobile Backhaul solution relates to Transport Ethernet as well as to the Native Packet Optical architecture.

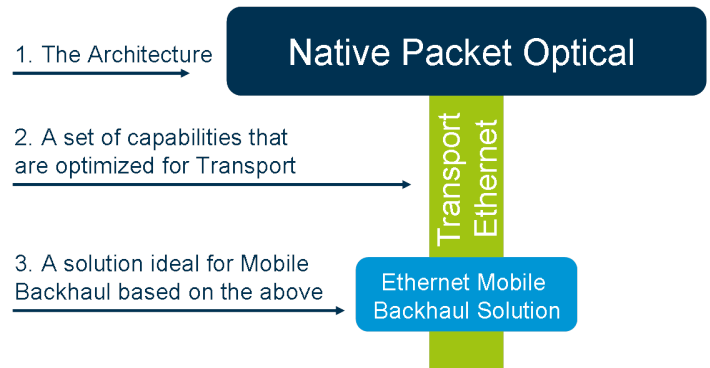


Figure 1.

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

The Layer 2 aggregation and backhaul components of the Native Packet Optical architecture are focused on one thing - Transport Ethernet - requiring an optimization based on cost. This allows the use of recent innovations in component design that utilize fair adaptive dynamic memory and output queued switch architectures. It enables the system designers to focus on the attributes that are important to Transport Ethernet such as low delay/latency, no jitter, synchronization, simple QoS model, classification, OAM FM and PM and Ethernet Service delivery. Overall this enables the design to use fewer components which impacts size, power consumption and to also integrate the aggregation function with the transport function. All these aspects help reduce total cost of ownership (TCO).

A business case based on a simple 3 node ring shows a TCO reduction of up to 35% when Transport Ethernet is deployed:

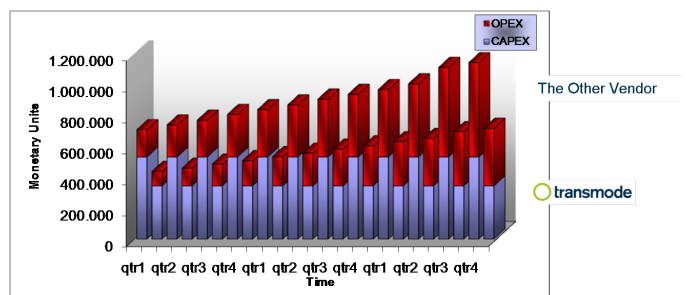


Figure 2:

An example showing a Total Cost of Ownership reduction of up to 35%. The main reason for the saving is that switchports used in the full Carrier Ethernet approach are too expensive.

Industry leading synchronization

In addition to the basic economic advantages of Transmode's Ethernet Mobile Backhaul solution, the design on which it is built provides a number of advantages over the full Carrier Ethernet architecture. One of these is support for Synchronization within the network. Synchronization is very important in mobile backhaul networks due to the unique situation where users move from one location to another and expect or even demand an uninterrupted service.

Currently the industry is divided on how to support synchronization in next generation LTE and 4G networks. Some operators plan to use 1588 v2 based synchronization and others plan to use Synchronous Ethernet. It is important that any transport solution, either Layer 1 or Layer 2, supports both. There are a number of reasons for this. Firstly the transport solution is likely to remain in place for a considerable period of time and should therefore not already restrict the options available to the operator. Secondly a lot of fiber based mobile backhaul will be in the form of wholesale services from a fiber owner to the mobile operator or operators. Therefore the wholesale operator needs to keep their options open and support any customer request. In the wholesale case it is also important that the transport solution supports multiple Synchronous Ethernet signals to support multiple mobile networks and operators over the same infrastructure.

Transmode's Ethernet Mobile Backhaul solution supports multiple Synchronous Ethernet signals and provides a transparent, low latency and jitter free transport of 1588v2 signals in order to provide optimal and flexible network synchronization. By focusing on the transport aspects of Layer 2 aggregation and backhaul rather than developing a full Ethernet Switch, Transmode has been able to develop a platform that has significantly better performance than alternative solutions. In terms of performance against standards, the solution provides orders of magnitude better performance than the G.813/G.823 SDH/SONET standards and the G.8262 Synchronous Ethernet standard.

A further related consideration is holdover performance, which again makes Transmode's Ethernet Mobile Backhaul solution ideal in mobile backhaul networks. Holdover is the ability of a network to still keep the clock rate if the connection between the clock source and receiving clock is broken, without losing any bits. Transmode's solution has only 1 ppb (parts per billion) which is about 70 times better than the ITU-T recommendations (G.8262) and is enough for very demanding mobile applications.

This industry leading performance provides operators with the reassurance of a very high quality synchronization signal from the backhaul network. Furthermore when this signal is used to provide timing to a portion of the access network that uses microwave backhaul then this superior quality signal can allow the microwave network to extend to a greater number of hops than would previously be possible.

Ultra-low Latency and zero Jitter

A further technical advantage that is possible when the Layer 2 integration is focused on Transport Ethernet is ultra-low latency and zero jitter. These characteristics are increasingly important as operators upgrade to LTE networks as LTE specifies multiple levels of Quality of Service from best effort for services such as email and basic internet access to high quality traffic for streaming high quality video. These high QoS services are latency sensitive and could become an issue if latency isn't considered in the backhaul network design. This is also an advantage for operators who choose to deploy 1588 v2 synchronization, which requires very low latency and zero jitter.

As previously mentioned, Transmode's Ethernet Mobile Backhaul solution adheres to the Native Packet Optical architecture, and is built with Transport Ethernet. This enables the system design to excel in support for ultra-low latency with performance that is 2-3 times better than typical Carrier Ethernet switches and to have almost zero jitter. This is important in mobile backhaul due to the cumulative effect of jitter across the network as traffic passes through many nodes – for example, within access rings, aggregation networks and also the core.

Flexibility and Scalability

The Ethernet Mobile Backhaul solution allows flexibility and scalability in 2 network layers. As the Native Packet Optical architecture, on which the Ethernet Mobile Backhaul solution is built, is based on Ethernet it allows operators to flexibly deploy capacity with a very fine degree of granularity, as you would expect from any Layer 2 based architecture. However, 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 can ensure that the deployed assets are fully utilized.

Ethernet Mobile Backhaul solution - the Products

The Ethernet Mobile Backhaul solution comprises of 3 main functions – Ethernet Demarcation, Layer 2 aggregation and backhaul of Ethernet traffic.

The Ethernet Demarcation function is common to all Layer 2 based access and metro architectures, this is where services are provisioned and where Quality of Service is measured. Where Transport Ethernet and the traditional Carrier Ethernet architectures differ is in the Layer 2 aggregation and backhaul. As previously mentioned, the Carrier Ethernet approach uses full Ethernet Switches at each necessary location and these devices are over specified for a mobile backhaul network. They are multi-purpose with a very broad range of functionality.

The products included in Transmode's Ethernet Mobile Backhaul solution are:

- **Ethernet Demarcation Unit (EDU):**

The EDU provides seamless aggregation of Ethernet services into CWDM / DWDM networks. Available in three different 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 either demarcation of a single GbE client or aggregation and demarcation of up to 4 lower speed clients onto a single GbE line. The interface options are (see datasheet for more details):

- EDU/2PGBE-GE: 2x SFP Optical + 2xRJ45 Electrical
- EDU/5PGBE-TE: 2x SFP Optical + 3xRJ45 Electrical
- EDU/5PGBE-TES: 4x SFP Optical + 1xRJ45 Electrical

- **Ethernet Muxponder II (EMXP II):**

The EMXP integrates Layer 1 and Layer 2 functionalities into one unit optimized for transport of Ethernet traffic and Ethernet services over the CWDM / DWDM network. The EMXP is available as a 10 port and a 22 port unit, and have the following interfaces (see datasheet for more details):

- **10G interfaces (XFP):**

- 2 ports
- Uncolored Multimode and Singlemode
- CWDM up to 8 channels, DWDM up to 40 channels or Tunable XFP up to 80 channels

- **GE/FE interfaces (SFP):**

- 10 or 22 ports
- Uncolored Multimode and Singlemode
- CWDM up to 16 channels or DWDM up to 40 channels
- Single-strand fiber solution
- Electrical 10/100/1000BASE-T

In addition to Ethernet focused mobile backhaul, Transmode also provides the Multi-Service Mobile Backhaul Solution. This supplies base stations with Native E1/T1 TDM traffic in parallel to Native Ethernet, both with multiple synchronization domains, over the same fiber infrastructure without the issues associated with packetizing TDM traffic.

Please see our additional whitepaper(s) for more information regarding this solution, see link at the end of this whitepaper.

Conclusion

Transmode's Native Packet Optical architecture and specifically the Ethernet Mobile Backhaul solution is ideal in mobile backhaul networks. The key issues of synchronization, latency and jitter – issues which are so vital in mobile backhaul – are specifically targeted allowing the solution to have industry leading performance in these areas.

Furthermore, the Ethernet Mobile Backhaul solution provides a proven and successful combination of Layer 1 and Layer 2 functionality offering full flexibility and scalability. As traffic continues to rapidly rise, the solution allows operators to right-size backhaul capacity through the combination of smaller fine tuned bandwidth via Layer 2 with additional Layer 1 wavelengths for more significant capacity boosts.

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 get more!

For further reading:

For more information regarding Transmode's solutions for Mobile Backhaul, please take a look at two other whitepapers:

- "How to light up the base station"
- "Solving the Mobile Backhaul challenges"

For more information regarding Transmode's Native Packet Optical architecture, please take a look at this whitepaper:

- "Go Native with Native Packet Optical transport"