

# How to light up the base station

Native Ethernet and TDM traffic, with support for multiple individually synchronized domains delivered over a single wavelength that stretches all the way to the base station. Is this possible? Yes – and at unprecedented low cost!

## Introduction and executive summary

Mobile data traffic is soaring. Examples show mobile operators experiencing huge increases – up to nine-fold in only three months\*. The reason? Today's highly connected users around the globe are hungry for ever greater flows of mobile media.

Presently, the number of mobile broadband users has already passed the number of fixed broadband users and is expected to pass 1 billion in just a few years. With the introduction of even higher data rates through technologies such as HSPA+, WIMAX and ultimately LTE, the pressure is on to quickly expand the bandwidth to more than a billion users.

The problem is that conventional backhaul networks cannot affordably scale to meet this demand. In addition, the handling of synchronization issues quickly becomes highly complex and expensive.

From a technical point of view the ultimate destination is a backhaul network carrying voice and data services natively, individually synchronized, over a cost-efficient all-Ethernet network.

How best to enable mobile backhaul networks to handle this huge demand and help operators profit from the potential it brings? Transmode's Multi-Service Mobile Backhaul Solution offers transport of native TDM and Ethernet traffic simultaneously over a single wavelength. To this can be added the possibilities that come with limitless expansion using WDM (Wavelength Division Multiplexing) in optical fiber networks.

Transmode is taking advantage of the general trend towards using more fiber in Mobile Backhaul (projections from Infonetics, see graph below) by pushing its Intelligent WDM (iWDM™) technology all the way to the base station.

In this approach, TDM and Ethernet traffic is transported with individual synchronization, thus eliminating the need for a separate synchronization network, which is typically highly complex and demanding of capacity.

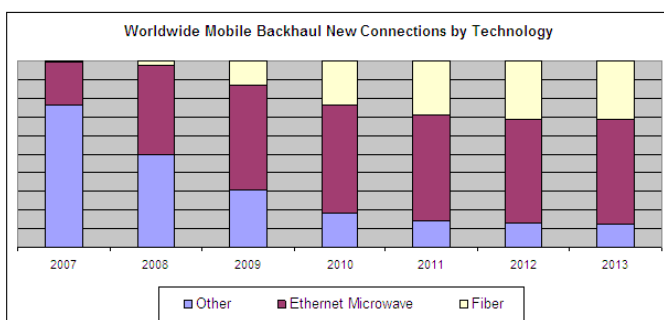
The result is a network ensuring the quality of service and the cost-efficient scalability needed for the capacity increases to come.

With a significant number of base stations installed, operators want simpler and more affordable architecture. This is what Transmode is offering in the Multi-Service Mobile Backhaul Solution.

The solution provides:

- Cost-efficient increase of Mobile Backhaul capacity by pushing iWDM all the way to the base station.
- Multi-Service mobile access capabilities optimized for mobile networks.
- Delivery of native TDM and Ethernet transport with individual synchronization over a single wavelength, through an innovative iWDM transport solution.

This whitepaper describes how Transmode's Multi-Service Mobile Backhaul Solution can be used in a mobile backhaul network, and how it can benefit mobile operators.



Source: Infonetics July 2009

Figure 1. The number of base stations connected by fiber is expected to grow rapidly.

\*Source: Light Reading.

## Backhaul challenges

E1/T1 has been the gold standard for the transport of voice, data and synchronization, but E1/T1s lack the bandwidth and reliability needed for today's explosive demand in broadband data. Mobile operators migrating to 3G or 4G cellular networks are off-loading their broadband data onto high-bandwidth Ethernet backhaul. However, they are also leaving E1/T1s in place for voice services and synchronization, while they search for a way to get all the bandwidth and cost advantages of Ethernet without jeopardizing the benefits and performance of E1/T1s for voice and physical layer timing.

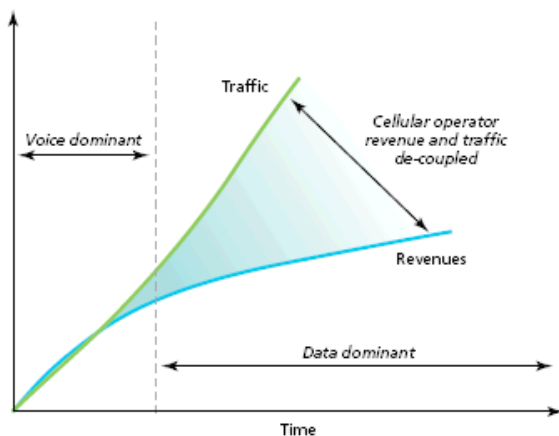


Figure 2. Increased data traffic and reduced revenue per bit.

In today's data-dominant market, E1/T1 leased lines cannot solve this challenge – they lack the economics and robustness to meet mobile-operator demands.

## Synchronization challenges

Mobile operators and network designers understand that synchronization is crucial for smooth handovers between sites and is therefore key to mobility. Today, the issues are even more complex as a single site can contain 2G, 3G and 4G base stations. In addition, operators often share sites, so any transport solution connecting a site should be able to support the cost-efficient synchronization of multiple networks.

## The benefits of Transmode's Multi-Service Mobile Backhaul Solution

Transmode's Multi-Service Mobile Backhaul Solution features immediate synchronization via a resilient, high-quality timing mechanism. In addition, it provides fundamental elimination of jitter and bit-error multiplication, thus ensuring a synchronization signal that meets E1 and T1 standards as well as multiple synchronization domains, for both E1 and T1 as well as Ethernet.

Achieving efficient utilization of the backhaul network requires consolidation of TDM and broadband data traffic onto a single backhaul facility. Transmode's solution achieves this by handling TDM traffic natively – retaining all of the requisite native TDM attributes and physical layer timing delivered by E1/T1s as well as native Ethernet.

With Transmode's Multi-Service Mobile Backhaul Solution, the service provider reaps the benefits of TDM for synchronization and voice, while achieving the bandwidth and economic returns of Ethernet. In addition, the solution eliminates the problem of stranding bandwidth through static allocation of traffic streams due to its high bit-rate performance.

## Simultaneous native traffic on one wavelength

The Transmode solution offers flexible, resilient transport of both Ethernet and TDM traffic by delivering native TDM traffic simultaneously with native Ethernet traffic over the same wavelength. The technology helps operators grow by smoothly transitioning their mobile backhaul networks from Time Division Multiplexing (TDM) to Ethernet – all while providing customers with the bandwidth they need and the line quality they expect. The solution delivers any mix of native TDM and native Ethernet over fiber and is an alternative or complement to PWE3 (Pseudowire Emulation Edge to Edge) transport.

## Replacing and/or complementing Pseudowire?

Pseudowire is a solution used by some mobile operators for transport of voice and data services over the access networks, as well as the optical packet core. Transmode's Multi-Service Backhaul Solution overcomes the limitations of pseudowire access and core networks by:

- Creating a fiber connection that carries TDM traffic and Ethernet traffic.
- Transporting TDM natively, i.e. avoiding the "packetization" effect that can occur when TDM is re-packaged into IP or Ethernet packets, which may affect traffic quality.
- Transporting Ethernet natively.
- Maintaining transparent separate synchronization for multiple TDM and Ethernet accesses.
- Eliminating the need for extensive introduction of new OAM systems.

The Transmode Multi-Service Mobile Backhaul Solution can be regarded as a replacement for pseudowire but also works with pseudowires, and/or as a transport for pseudowires. It can also complement pseudowire over high-capacity fiber-optic transport. The solution offers a flexible bandwidth multiplier for resilient transport of both Ethernet and TDM traffic over fiber, and delivers the ultimate bandwidth required for a carrier's typical suite of mobile, DSLAM backhaul, Wi-Fi and WiMAX backhaul applications.

## Optimized for mobile voice and data traffic

Carriers will be able to prioritize and dynamically allocate bandwidth to a changing mix of voice and data traffic on their aggregated backhaul transport facilities. As a fiber-based technology, a significantly bigger pipe is provided, with enough flexibility, capacity and resiliency to meet service demands, now and in the future. The Transmode Multi-Service Mobile Backhaul Solution is optimized for 2G, 2.5G or 3G for NxE1/T1 TDM and Asynchronous Transfer Mode (ATM)/TDM backhaul networks, enabling a seam-

less transition to all-Ethernet RAN and 4G networks. As carriers evolve their networks from TDM-based 2G networks to all-Ethernet 4G, they will require optimized performance and a seamless transition. The Transmode solution allows a mobile operator to tune its TDM-versus-Ethernet requirement at any stage of the migration process. The operator thus gains complete control of the TDM to packet evolution, realizing immediate economic gains.

With Transmode's Multi-Service Mobile Backhaul Solution, 100 percent of the bandwidth on the backhaul facility is available at all times, regardless of the traffic mix currently on the network. Operators can use proven TDM timing and synchronization while also carrying Ethernet traffic natively. The ability to handle Ethernet in native format is a key benefit, since the data backhaul capacity can be upgraded to multiple GbEs.

## Key differentiators

### Transparent transport of TDM

The Transmode Multi-Service Mobile Backhaul Solution enables a fiber connection to carry TDM traffic and Ethernet traffic using only one wavelength. The TDM bits are transparent and thus cannot be interfered with by Ethernet traffic. That means the delay and jitter of TDM remain constant, regardless of what else is happening in the network. TDM never has to wait in queue behind other (potentially many and potentially large) frames.

The absence of "packetization" effect results in first-rate performance with regard to latency and jitter and makes the Transmode solution superior for transporting TDM in the access network. This advantageous approach is well suited for mobile network backhaul as these networks have strict requirements on latency and jitter for each part of the network. The cumulative effect that the above mentioned phenomena have on a mobile network is substantial, particularly when combined with the restrictions mobile networks have in timing budgets. Transmode's solution stands out in its unique ability to successfully address these tough challenges.

### TDM quality synchronization

The synchronization and timing-recovery aspects of pseudowire are relatively unspecified in the standards and are typically left to the implementations where some proprietary form of adaptive or differential timing is used. Both adaptive timing and differential timing have some disadvantages in the network and therefore pose a common challenge for implementations.

The quality of the pseudowire synchronization signal is affected by many things, including the availability of a reliable, high-quality reference clock over the packet access and the amount of jitter/latency on the pseudowire stream. Transmode's Multi-Service Mobile Backhaul Solution overcomes these limitations by allowing the use of all E1/T1 and Ethernet signals as a timing source.

The solution has the ability to multiplex and transport E1/T1 and Ethernet signals while maintaining synchronization transparency. This Layer-1 multiplexing technique ensures the highest quality clock signal by fundamentally eliminating latency and jitter on Ethernet traffic. Furthermore, it allows multiple Ethernet signals, with different high-quality references, to share the same wavelength channel. With this approach, the T1/E1 and Ethernet carry a physical-layer synchronization signal transporting a Stratum clock. The immediate synchronization provided by the resilient, high-quality timing mechanism, ensures a synchronization signal that meets E1 and T1 standards, while fundamentally eliminating jitter and bit-error multiplication.

## The Multi-Service Mobile Backhaul Products

The Transmode Multi-Service Mobile Backhaul Solution is comprised of three parts:

- Access: for collection of E1/T1 and Ethernet signals from Mobile Base Stations and co-located DSLAMs.
- Hub: for aggregation of E1/T1 traffic from Access nodes into STM-1/OC-3 signals and hand-off of collected Ethernet signals.
- Backhaul: for further transport of SDH/SONET and Ethernet signals up to switching centers via Layer-1 and/or Layer-2 solutions.

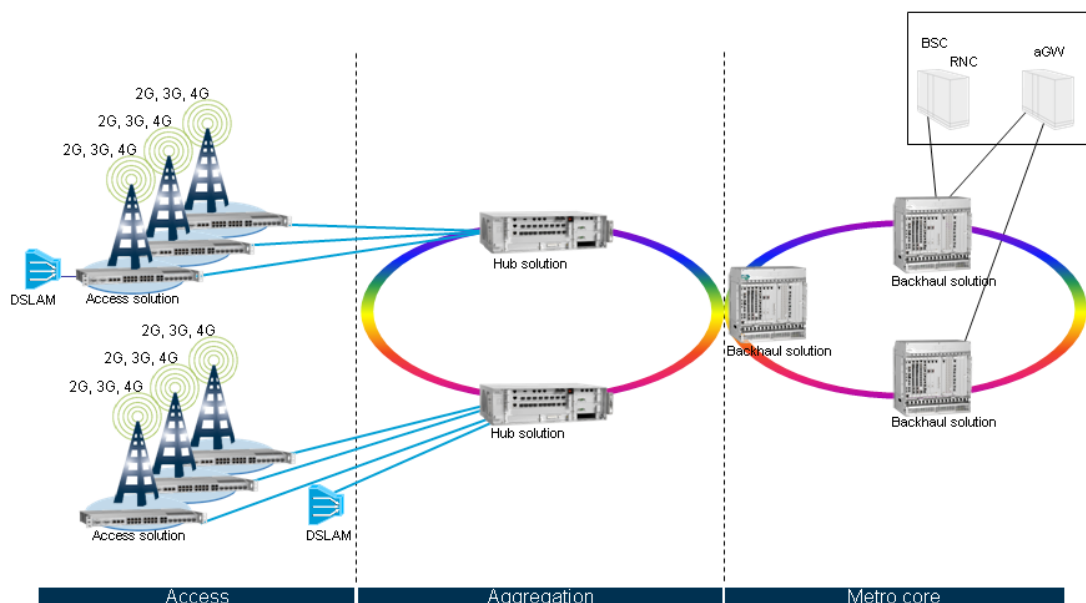


Figure 3. Transmode's Multi-Service Mobile Backhaul Solution.

## Access - Collector nodes

A number of collector nodes are provided, each designed for various requirements on capacity as well as number of E1/T1 and Ethernet interfaces. One of the collector nodes is available in a hardened version supporting an extended temperature range.

Currently the following versions are offered:

- Multi-Service Access Collector (MBA/1). Collecting 8xE1/T1 and 2x Ethernet traffic.
- Multi-Service Access Collector (MBA/2). Collecting 16xE1/T1 and 4x Ethernet traffic.
- Multi-Service Access Collector (MBA/2e) - hardened. Collecting 16xE1/T1 and 4x Ethernet traffic.
- Multi-Service Access Collector (MBA/3). Collecting 4x Ethernet traffic.
- Multi-Service Access Collector (MBA/4). Collecting 24xE1/T1 and 4x Ethernet traffic.

All collector nodes are 1U-high and have two line interfaces to enable 1+1 protection configurations towards the hub.

The line interface of the MBA/1 can operate at 1Gb/s or 2.5Gb/s, depending on collected capacity. The line interface of MBA/2, MBA/3 and MBA/4 can operate at 2.5Gb/s or 4Gb/s, depending on collected capacity.

## Hub

The Hub unit has the ability to collect traffic from up to eight unprotected collector nodes or four protected. This is a plug-in unit that is inserted in a Transmode TM-3000 or TM-301 chassis. The hub unit maps the E1/T1 signals into STM-1/OC-3 signals for further transport up to switching centers. The Ethernet signals from the access nodes are provided synch and data transparent for further transport over a Layer-1 or synchronous Ethernet network. Two hub units can be interconnected to enable better utilization of the STM-1/OC-3 signals.

## Backhaul

The Backhaul includes both Layer-1 and Layer-2 technologies. The Transmode Layer-1 Multi-Service Muxponders provide synchronized transparent transport of multiple STM-1/OC-3 signals and GbE signals over a single line signal. One of the advantages of Transmode's Multi-Service units is their ability to carry signals with independent synchronization sources. Multiple GbE signals with independent synchronization sources can share the same line signal, which differs from a synchronous 10Gb Ethernet solution, for example, where all GbE flows will have the same synchronization source.

An alternative to the Multi-Service Muxponder for Ethernet transport is Transmode's Layer-2 Ethernet Muxponder (EMXP), which can be used for Ethernet transport and aggregation in the packet optical network. The EMXP supports GbE, 10GbE as well as synchronized Ethernet.

## Cost savings

The Transmode Multi-Service Mobile Backhaul Solution delivers more bandwidth than E1/T1 and lets carriers address a larger market at lower expense. The cost synergies of using a single transport facility for all backhaul traffic are realized, and there is no need to physically reconfigure the network. Any mix of TDM and Ethernet traffic can be supported on Transmode's solution, with all bandwidth on the backhaul facility available at all times, regardless of the traffic mix.

The abilities of the Transmode solution to help carriers control both capital expenses as they enter into a service situation, and operational expenses as they continue to serve the growing needs of their backhaul customers, are compelling arguments. Since the Transmode solution does not put TDM into IP or Ethernet packets, or Ethernet packets into TDM, the management costs and headaches of packetization delays are eliminated.

## Conclusion

With the growing demand for new applications and service content in fixed and mobile networks, the bandwidth required for today's services is exploding. As a result, core networks have begun the migration from traditional TDM-based networks to service-rich IP/MPLS networks, thus ensuring lower CAPEX and lower OPEX.

To fully capitalize on the potential revenue and cost benefits of next-generation networks, operators must leverage true packet infrastructure. By supporting native Ethernet and native TDM in the access network it is possible to lower cost, simplify deployments and migrations, and gain a more flexible network for new services, such as VoIP. To satisfy these demands, Transmode is offering a Multi-Service platform tailored for the future of mobile access.