White Paper

Mobile Backhaul

Challenges and Opportunities

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Introduction

Leasing or self-building backhaul networks is a key strategic decision that mobile operators have to take – even more so in the mobile broadband era when EV-DO, HSPA, Mobile WiMAX and LTE promise to drive backhaul bandwidth demand at some urban cell sites to up to 50 Mbps within five years.

This paper presents a brief overview of the mobile backhaul market, illustrates the unique challenges facing mobile operators and backhaul transport providers and describes various strategies for commercially viable transport of multi-generation mobile technologies over fiber, fixed wireless and TDM/SONET/SDH infrastructures. In particular, this paper stresses the performance criteria that mobile operators expect if they are to trust their backhaul network to third parties.

Mobile Backhaul

The mobile communications industry continues to grow at a significant pace. Industry sources report the following figures:

- The number of worldwide mobile subscribers hit 3.3 billion in 2007 and will grow to 5.2 billion by 2011*
- 2.9 million backhaul connections worldwide in 2006, growing to 4.8 million by 2009 *
- Two out of every three towers already have more than one mobile operator on it
- Evolving backhaul requirements per cell site: 2-16 T1/E1s in 2006; 2-8 T1/E1s and 10-30 Mbps Ethernet in 2010
- Mobile operators pay incremental charges for 2x to 10x bandwidth*
- Legacy backhaul networks are prohibitively expensive. In the U.S. alone, mobile operators' transport costs are expected to skyrocket from $2 billion in 2006 to $16 billion in 2009
- Fierce competition is squeezing margins while new data and video appliances such as Apple's iPhone, Samsung's Instinct and LG's Voyager are driving demand for more bandwidth
- Growing dependence on mobile connectivity
- Exponential traffic growth in parallel to flat or low growth of average revenue per user (ARPU)
- The bandwidth increase will primarily be on Best Effort data user services and driven by 'flat fee business models'**
- More technologies need to be supported: 2G/GSM, 2G/CDMA, 3G/UMTS, 3G/EVDO, HSDPA, WiMAX and LTE
- Evolution towards Ethernet and IP-based backhaul solutions.

  * *Infonetics Research Mobile Backhaul Equipment, Installed Base & Services, 2007*

  ** *Lightreading.*

A closer look at these statistics reveals several warning signals. From 2006 to 2010, the number of mobile phone users is expected to grow by only 30%, while backhaul expenses will skyrocket due to an exponential increase in bandwidth required for video and multimedia applications as well as the need to support multiple technologies. Moreover, the average revenue per user (ARPU) is not likely to grow much, even for new data services, with competition from fixed line offerings keeping a lid on pricing. For example, AT&T charges $10 a month more for the iPhone 3G's data plan than it did for the original 2G/EDGE iPhone's plan, but this relates more to the subsidized verses unsubsidized price of the phone. On the other hand, a quick search on the Internet reveals that complaints are mounting about 3G data service speeds not meeting the promised performance and being inconsistent with inadequate coverage. If mobile operators are to reach profitability targets while providing untarnished performance, they must improve the efficiency of their networks by dropping the cost per Mbps of bandwidth. Because backhaul is one of the major contributors to the high costs of building out and running a mobile network – estimated to be about 25-30% of total operating expenses – it is critical that mobile carriers optimize their networks and/or find lower cost and more scalable cell-site backhaul solutions from alternative wholesale transport providers. To ensure customer satisfaction, these optimized, scalable backhaul solutions must be in place as new wireless applications and multimedia services, such as music downloads, mobile video and gaming, are rolled out.

In this paper we will focus on the business and technical challenges that the transport providers and mobile operators face as they evolve their networks to Ethernet, IP and MPLS.

Mobile Operators vs. Wholesale Transport Providers

Transport providers see a large opportunity to generate incremental revenue by focusing on the rapidly growing backhaul market. To be successful, they need to offer mobile operators less expensive and more scalable backhaul options than today's typical T1 or E1 connections. Importantly, the wholesale services must meet or exceed the performance criteria required by the mobile operators with respect to timing, packet loss, delay, jitter, availability, OAM, and diagnostic capabilities to support the various 2G, 3G and 4G cellular protocols. The shift to packet-based technologies provides additional challenges: Where lower-cost Ethernet-based facilities are used for backhaul, the challenge is to deliver TDM services to interface with the T1 and E1 ports on most installed base radios. This can be accomplished using TDMoIP®/Pseudowire technologies over Ethernet, IP or MPLS (fig. 1). Where TDM-based facilities are used for backhaul, the challenge is to deliver Ethernet to support data/video services. This can be accomplished using bridging and circuit bonding technologies (fig. 2).

Business Challenges

Mobile Operators	Wholesale Transport Providers
Improve customer experience: • Fewer dropped calls • Higher data rates • Smoother transition between 2G, 3G, 4G, and WIFI.	Generate incremental revenue: • Wholesale backhaul services • Business services
Enhance performance: • Add bandwidth • Improve QoS mechanisms.	Expand service offering: • TDM leased line services e.g., pseudowire for 2G/3G backhaul services over Ethernet networks • Carrier Ethernet services e.g., circuit bonding for 3G/4G backhaul services over TDM/SONET networks.
Expand coverage: • Many markets underserved, especially for 3G/4G services.	Extend footprint: • Revenue generating backhaul services help justify network expansion to more cell towers • Two of every three towers already has more than one mobile operator • Reach more customers and mobile operators.
Keep backhaul costs in line with revenue generated: • Implement more efficient network topologies • Optimize network by moving best effort data services to cheaper facilities • Take advantage of lowest cost, highest bandwidth wholesale transport networks.	Capture share of rapidly growing backhaul market by offering mobile operators: • Less expensive backhaul options than today's typical T1 or E1 connections • Scalable bandwidth for unpredictable needs.

Technical Challenges

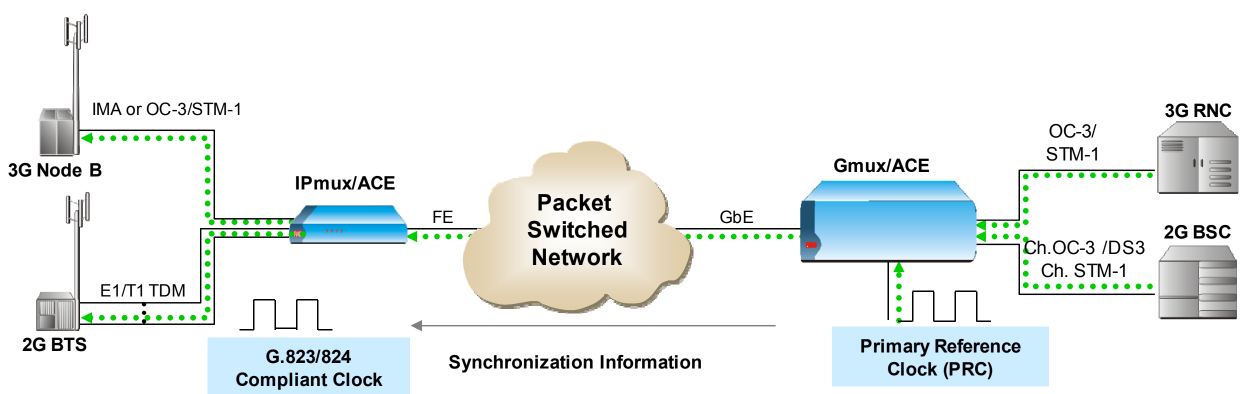
Mobile Operators	Wholesale Transport Providers
Define performance criteria and ensure that their self-built or alternative transport provider network meets the requirements.	Build a transport network that delivers TDM and Ethernet services that exceed the mobile operators performance criteria.
Research wholesale transport networks available in each region and take advantage of the lowest cost, highest bandwidth ones.	Design the network to support multiple mobile operators per tower that share the same network facilities.
Optimize usage of expensive access links: • Idle flag suppression and dynamic bandwidth allocation (DBA) • Statistical multiplexing of services • Intelligent oversubscription • Abis optimization • Per VC switching of voice and data.	Sell bandwidth "pipes" on a per T1/E1 or per Mbps Ethernet basis: • Deliver quality service i.e., committed information rates (CIR) with low latency, jitter and packet loss • No optimization • Transparently support any mix of cellular protocols with TDM, ATM and Ethernet interfaces.
Accurately regenerate timing	Accurately regenerate timing per mobile operator to ensure they each get timing from their own clock source.
Monitor performance to ensure SLA guarantees are met.	Support standards based Ethernet and pseudowire OAM for connection fault management and performance monitoring.
Detect faults and network degradation (excessive latency, jitter, etc.).	Provide diagnostic tools to operator, such as in-band facility loopbacks.
	Find hardened units for use in compact outdoor cabinets.
Migrate to Ethernet, IP and MPLS for more bandwidth at lower costs.	Provide services over available access infrastructure (fiber, microwave, bonded T1/E1 circuits, SONET/SDH, DSL, etc.

Key Backhaul Challenges

Synchronization over Packet-Switched Networks

Synchronization is a crucial factor in any network, but particularly in mobile backhaul, and probably the most challenging capability to be supported over packet-switched networks. In a TDM network, clock is transported natively over the network, but with a packet-based transport network that is asynchronous in nature, it is a necessity to develop a dedicated mechanism to transport the clock in a very accurate and reliable manner with minimum bandwidth consumption and the ability to overcome packet-based network issues, such as varying delay, jitter and packet loss.

In the diagram below we show how a primary reference source or PRC is provided to Pseudowire aggregation equipment at the BSC/MSC and then distributed over packet networks to the Pseudowire gateways at the BTS and Node B locations.



Backhaul solutions should ideally offer options for synchronization to be dependent or independent of PWE3 connections. When dependent, no additional bandwidth is required to carry the timing. When independent, a fractional unicast or multicast dedicated timing distribution PWE3 or alternatively a timing distribution protocol, such as IEEE 1588v2, minimizes bandwidth consumption. It is also convenient to have system clock input and output via an external clock port to accept GPS timing or provide timing to elements at the BTS or Node B.

For synchronization over packet networks, it is important to have both a precise and accurate clock. When a base station clock is not accurate, it measures each second just a little shorter or a little longer than a second actually is. In general, such a frequency inaccuracy might cause mobile handhelds to disconnect or experience bad handoff behavior. Moreover, in CDMA or UMTS TDD networks, where accurate transmission phase (time) is crucial, this clock will therefore lose phase accuracy the longer it runs, and as a result the base station will begin transmitting before or after it is the base station's time slot. The greater this error, the earlier or later the base station will transmit until it overruns another base station's time slot, causing undesired inter-cell interferences. Precise timing is also important since a clock that is accurate but not precise will lead to similar contentions between channels. With accuracy and precise timing, base stations can coordinate their transmissions to maximize effective bandwidth, reduce dropped calls/connections, and increase operating revenue.

Frequency Reference Accuracy

Cellular base stations of any generation (2G, 2.5G and 3G) require a highly accurate frequency reference because they may derive transmission frequencies from this reference. If clocks are not sufficiently similar, there could be lengthy synchronization procedures between cells during hand-off.

The pseudowire gateways clock recovery mechanisms should conform to G.823/G.824 Traffic or Sync Interface using G.8261-defined scenarios (depending on the base station's local reference clock and clock 'cleaning' algorithm quality). For macro base stations, frequency accuracy should be better than 50 ppb (parts per billion) when locked to a PRC (stratum 1) or SSU (stratum 2) master clock and frequency accuracy in holdover should at least conform to STRATUM 3. Sometimes, in order to guarantee the 50 ppb frequency accuracy on the air interface, a lower 16 ppb frequency accuracy is required in the clock input interface to the base stations.

2G/2.5G/3G require accurate frequency reference:

- GSM (50 ppb), UMTS (50 ppb) CDMA (uses GPS receivers)
- Holdover of at least STRATUM 3
- Recovered clock at the cell site should conform to ITU-T G.823/G.824 Sync or Traffic Interface MTIE* mask using G.8261-defined scenarios
- Multiple timing domains helps transport provider support multiple mobile operators at the same tower
- System timing with master and fallback sources for added reliability.

* *Note that in the case of mobile backhaul over packet networks, only MTIE masks are relevant. TDEV masks are relevant in SONET/SDH networks.*

Cellular Protocols

The MSCs, BSCs and BTSs need to be synchronized to insure slip-free interconnection.

In addition, the BTS' need to be synchronized with one another to ensure adequate frequency stability on the air-interface (RF). Different types of cellular mobile networks have different synchronization requirements. For example,

CDMA requires a frequency accuracy of 50 pbb and has stringent time accuracy requirements, but supporting CDMA over packet networks is relatively straightforward since CDMA uses GPS receivers at each cell site. Therefore each base station is effectively self-synchronizing with master clocks in the GPS Satellite network.

GSM, Wideband CDMA and UMTS base stations rely on a recovered clock from the T1/E1 leased line or microwave link to which they are connected. They require less than 50 parts per billion of frequency error to support the GSM handoff mechanism as mobile stations wander from one cell to the other

With UMTS in TDD mode, there is also a phase (time) accuracy requirement of 2.5uS between neighboring base-stations.

Primary Synchronization Methods

Firstly there is adaptive clock regeneration where the clock is distributed over the packet network as a TDM stream and is adaptively recovered solely using time-of-arrival information. The format of the clock stream is a standard pseudowire flow, so interoperability with third-party vendors is simplified. In this case timing is recovered independently of the physical layer. Pseudowire solutions, such as RAD's IPmux, Gmux and ACE products, equipped with advanced adaptive clock recovery mechanisms, already exist and meet the stringent GSM/UMTS requirements.

Next there is IEEE 1588v2, which is basically a time and frequency distribution protocol based on timestamp information exchange. In this way it is similar to NTP. If the packet network elements do not support 1588, then 1588 and adaptive deliver the same frequency recovery performance. It is important to note that 1588 merely defines the packet format and does not denote the slave clocks recovery algorithm, which is critical for good time and frequency recovery and which is not standardized as in NTP. IEEE 1588 solutions are now starting to become available and RAD has recently announced that the company's ACE-3220 cell site gateway fully interoperates with Symmetricom's grand master clock supporting IEEE 1588v2 to ensure the highest level of synchronization over Next Generation Networks.

Also important is the ITU G.8261 standard, which defines how synchronous clocks are distributed and extracted from the physical layer. This method is also known as Synchronous Ethernet. In this case the physical layer of Ethernet is used for accurate frequency distribution in the same manner in which timing is distributed in SONET/SDH. As such, Synchronous Ethernet is unaffected by higher layer network impairments such as PDV and Packet-loss.

Quality of Service (QoS)

QoS enables better service to certain flows over others. For example, control, signaling and voice traffic are prioritized over best effort data. Similarly CDMA traffic should be prioritized over best effort data to minimize delay and dropped calls during soft handoff.

To ensure QoS we need:

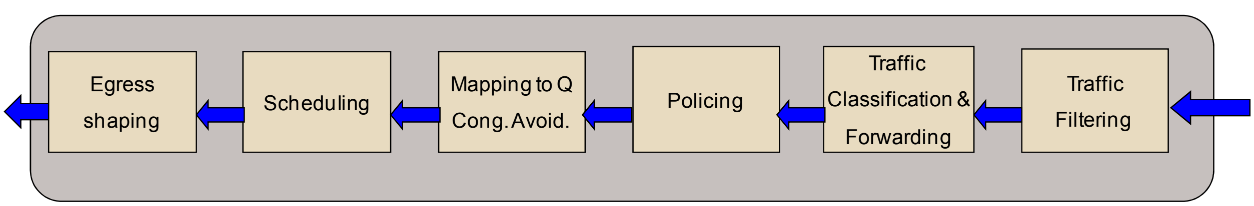
Traffic Classification: Identify traffic requiring preferential service based on port, C-VLAN, P-bit, ToS, DSCP, etc.

Policing (rate limiting): Discard traffic that exceeds CIR/EIR rates.

Mapping to queues: Congestion avoidance mechanisms such as WRED ensure that high priority traffic is not dropped.

Scheduling: Strict priority queues are handled first and WFQ thereafter.

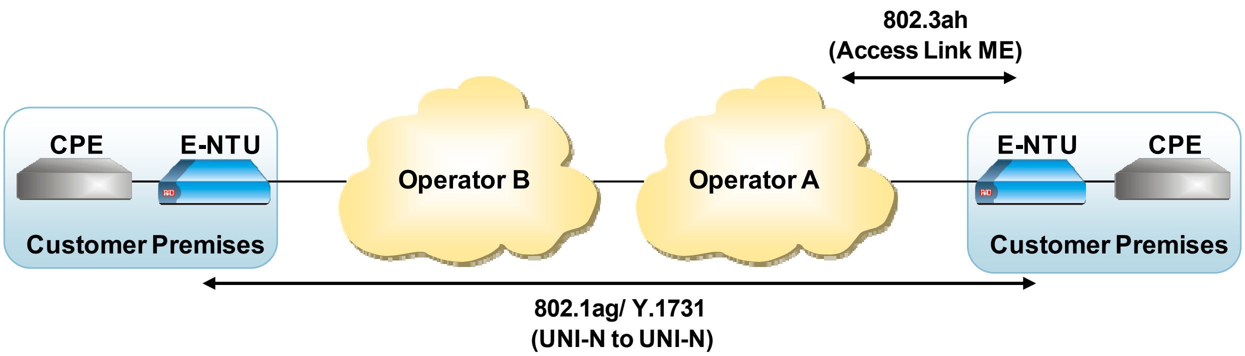
Shaping: Conform egress traffic to a specific line rate.



QoS is especially important in mobile backhaul applications and is critical to ensure acceptable T1/E1 backhaul services since it helps minimize network latency, jitter and packet loss. In situations where some packet loss is unavoidable, the pseudowire solutions should have mechanisms to minimize the effect by compensating for lost and out of-sequence packets. In addition, to minimizing network and pseudowire-induced latency, it is important to packetize only at network ingress and egress points.

Operations and Maintenance (OAM)

OAM is used to monitor the health of a network and diagnose problems without maintenance truck-rolls. OAM is required for connectivity verification, especially in the case of connectionless protocols such as Ethernet (otherwise when there is no traffic, there is no verification of connectivity). Ethernet OAM standards, 802.1ag and Y.1731 provide mechanisms for monitoring the connections (CFM) and measuring performance (PM).

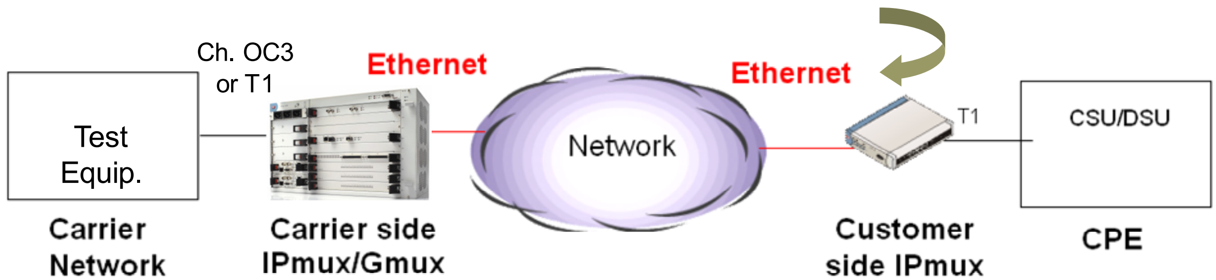


Pseudowire and ATM-based OAM mechanisms are also very important for mobile backhaul. Primary OAM functions include:

- End-to-end fault detection (e.g. packet/cell loss and remote status)
- Validation of end-point configurations (e.g. configuration mismatch)
- Diagnostics (e.g. inband facility loopback based on ANSI T1 403)
- Performance monitoring (e.g. delay and delay variation)
- Pseudowire bundle redundancy and alarm relay to the network for self healing functions, such as failover of traffic to redundant link.

In-Band Facility Loopbacks

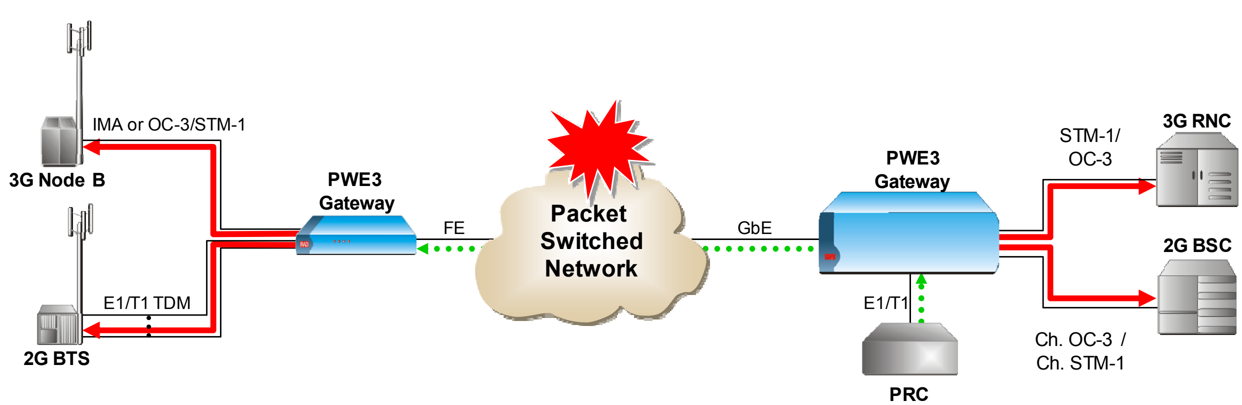
Mobile operators expect that the T1 circuits provided by the wholesale transport provider are equivalent to traditional T1 circuits. This includes support for inband facility loopback based on ANSI T1 403. This can be achieved either by configuring the pseudowire connection to transparently pass the facility codes through as data and then to place smart jacks after the pseudowire gateways, or to incorporate the smart jack capability into the pseudowire gateway, as follows:



1. Facility loopback request initiated by the carrier network.
2. Carrier side IPmux/Gmux is configured to intercept loop-up and loop-down codes, such as FAC1, FAC2 and NI.
3. IPmux/Gmux then sends an out-of-band OAM message to the remote IPmux requesting that it perform the loopback function.
4. Especially useful when remote IPmux is also used as a carrier NTU (network terminating unit) with no smart jack.
5. The IPmux/Gmux can be configured for CSU or DSU and framed or unframed modes.
6. Loop activation code conforms to ANSI T1 403 (i.e. Activation pattern 10000 deactivation pattern 100).

Fault Propagation

Fault Propagation is activated when a defect state is detected on a port or connection. In the figure below we see an example of how a fault in the packet-switched network can be detected by the pseudowire gateways; for example, through persistent jitter buffer under runs and propagated to the BTS and BSC via the TDM port sending a red alarm indication (RAI). Similarly the 3G node B and RNC could learn of the failure through ATM OAM (F4/F5).



Mobile Backhaul Solutions

Delivering TDM and Ethernet to Multiple Mobile Operators over Packet-Based Infrastructures

Many Cable MSOs and alternative carriers are taking advantage of packet economics to build efficient, easily managed metro Ethernet networks. In this application, the backhaul transport provider can take advantage of pseudowire equipment with integrated Ethernet switching and OAM capabilities to provide both Ethernet and T1/E1 services to mobile operators over their Ethernet, IP and MPLS networks. The pseudowire equipment should be capable of precisely reconstructing the original traffic timing and should be able to service multiple mobile operators, each with their own clock source (i.e. support for multiple timing domains). In the ideal case, we would have fiber-based Ethernet access rings traversing a cluster of towers to deliver these services with sub-50 ms failover times if the primary path is damaged. RAD's IPmux pseudowire gateway units can support point-to-point, ring and daisy chain topologies over fiber, T3 circuits or fixed wireless connection and are available in environmentally hardened format for use in outside cabinets.

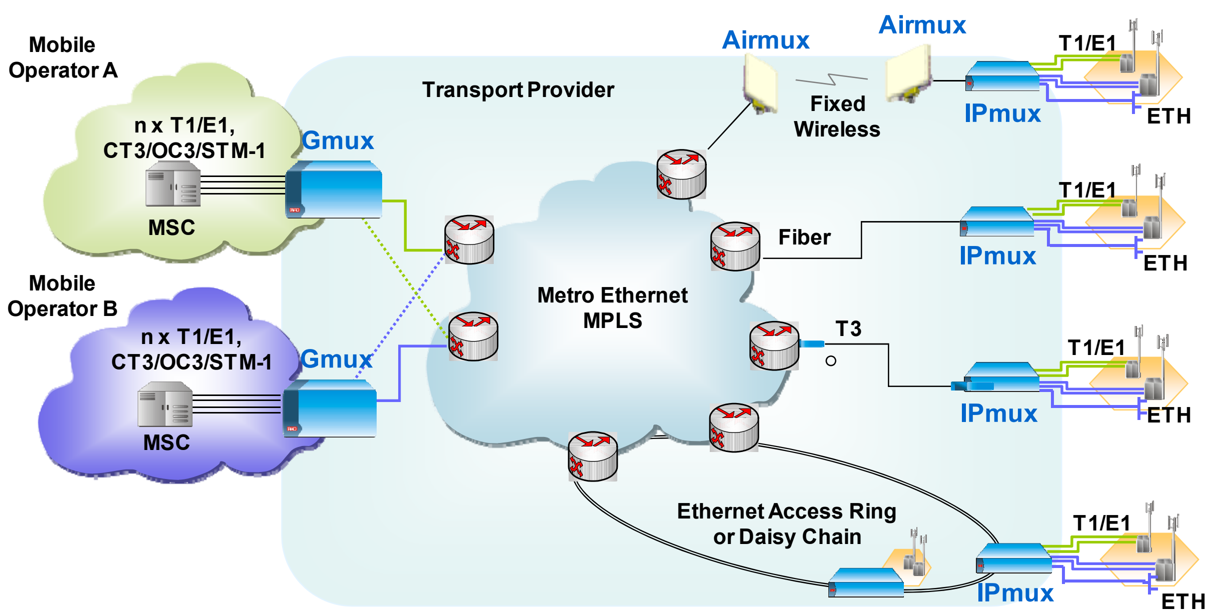


Fig 1. TDM and Ethernet Services over Metro Ethernet Infrastructure

Delivering TDM and Ethernet to Multiple Mobile Operators over TDM/SONET Infrastructures

Many legacy transport networks have an abundance of T1, T3 and SONET capacity available. In this application, we see how the transport provider can take advantage of the networks to deliver Ethernet and T1 services to multiple mobile operators.

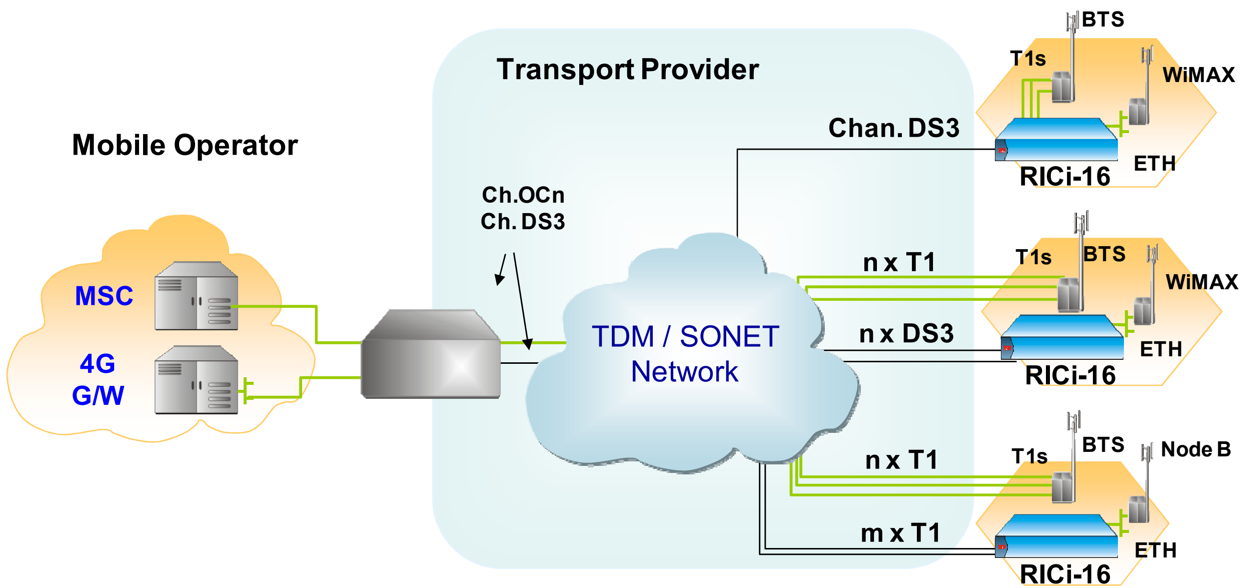


Fig 2. Ethernet Services over TDM Infrastructure

Circuit bonding of multiple T1/E1 connections is a simple way to leverage these ubiquitous services to deliver Ethernet to towers; for example, RAD's RICi-16 product line makes it possible to bond up to 16 T1/E1 circuits for a total aggregate bandwidth of ~24/32 Mbps Ethernet. The RICi-16T1 with DS3 option is very flexible in allocating DS3 bandwidth efficiently. For example:

- Bonding up to 28 x DS1 into multiple VCGs to support multiple mobile operators on a single channelized DS3 (~43 Mbps Ethernet).
- Mapping up to 16 DS1s from a channelized DS3 to T1s (M13 MUX functionality) while bonding the rest of the DS1s into larger Ethernet pipes to support multiple mobile operators with T1s and circuit bonded Ethernet pipes.
- Any mix of T1 and Ethernet services (0-16 T1; 18-42 Mbps Ethernet)
- Also supports Ethernet over single or bonded T3s (~45/90Mbps Ethernet)

RAD also offers the RICi-155/622, which supports single or bonded OC3/OC12s for up to 1.2 Gbps of Ethernet bandwidth.

Ensuring and Monitoring SLA Performance over Third-Party Transport Networks

In the USA today, only about 10% of towers are accessible over fiber, however, cable MSOs often have fiber facilities nearby and can build short spurs to the towers to deliver native Ethernet backhaul service. In order to ensure that this Ethernet service delivers the availability, reliability and scalability that wireless operators require, it is critical that the mobile operator can verify the SLA. Fig. 3 below shows an example of how mobile operators can assure consistent levels of service across multi-tier networks by monitoring both the end-to-end and segment QoS with Ethernet demarcation devices such as the RAD ETX. Ethernet OAM helps monitor each service in terms of availability, frame loss and delay. In addition, a threshold can be defined for each service and, if it deviates from the SLA, the ETX can send notifications to warn of degradation in circuit quality.

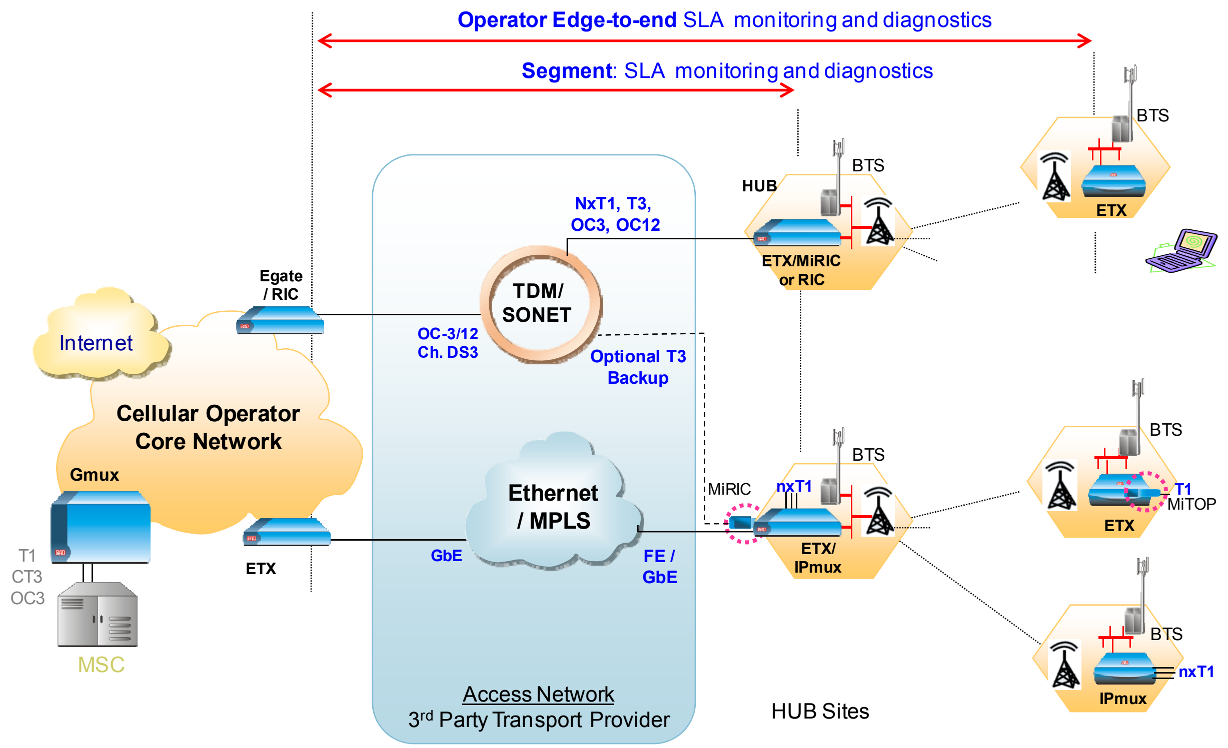


Fig 3. Ensuring and Monitoring SLA Performance over Third Party Transport Networks

WiMAX Backhaul over Ethernet

Reliable WiMAX backhaul requires a solid underlying infrastructure with strict QoS mechanisms and the capability to monitor SLAs, especially across multi-tier networks. To ensure a consistent, high quality level of service with notification of any network degradation, service thresholds should be defined to send traps when the service deviates from the SLA. On a TDM network any discontinuity is immediately identified and delay is hardly an issue. But since Ethernet is a connectionless technology, Ethernet OAM helps monitor each service in terms of availability, frame loss, delay, and delay variation.

Major functions of an Ethernet demarcation device at WiMAX cell towers are:

- Traffic classification, policing, scheduling, shaping
- OAM for non-intrusive monitoring of connections (CFM) and performance (PM)
- MAC swap loopbacks for diagnostics tests and performance monitoring.

At hub locations, the Ethernet demarcation devices also provide oversubscription and shaping features to conform to the third party network's CIR/EIR.

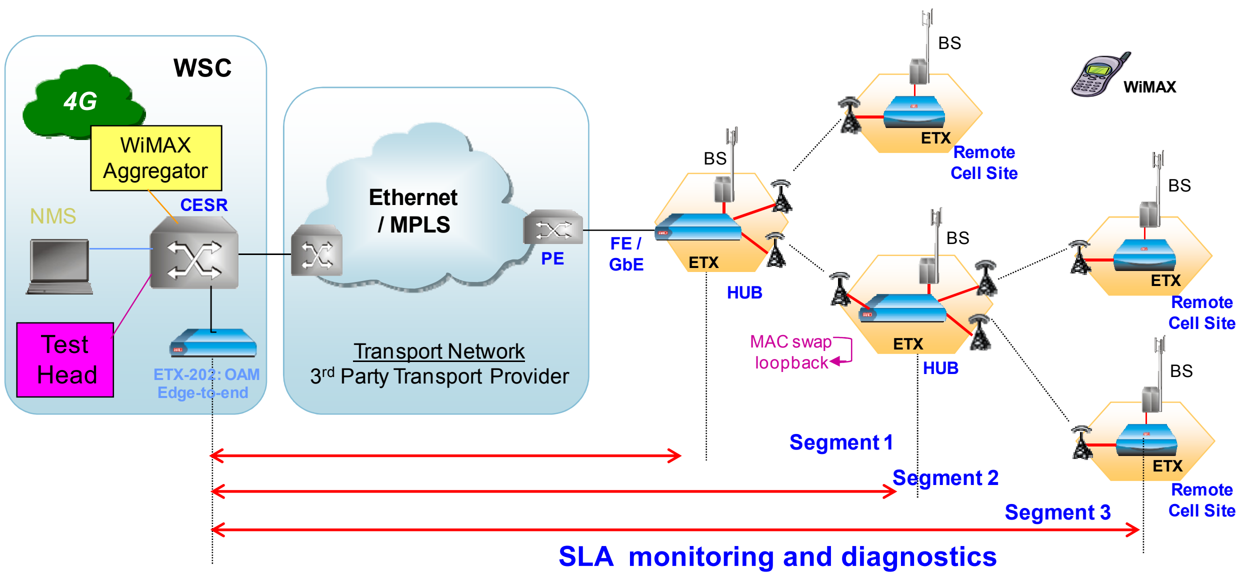


Fig 4. WiMAX Backhaul over Multi-Tier Packet Switched Networks

Backhaul over Microwave / Ethernet Access Infrastructure

Since backhaul services are very sensitive to latency, it is recommended that conversion from TDM to Ethernet occur only once at the ingress point and then the traffic should be kept in packet format as it traverses multiple microwave links and Ethernet networks. In this way, delay is minimized because you have only single instances of TDM packetization delay and jitter buffer delay. The solution is also more scalable than TDM-based microwave alternatives since there is no need for TDM configuration and cabling at intermediate points whenT1/E1s are added at remote cell sites.

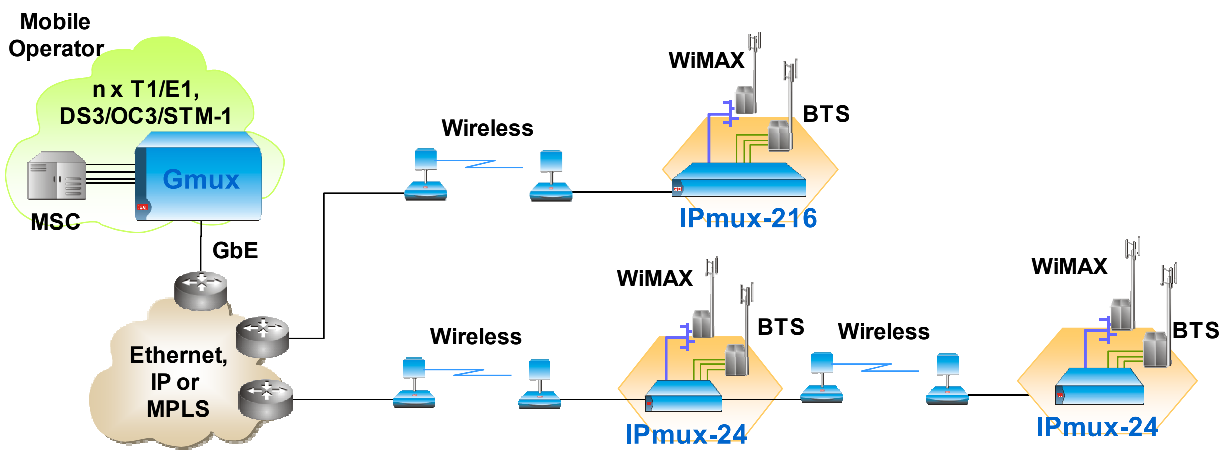


Fig 5. Backhaul over Microwave / Ethernet Access Infrastructure

Benefits:

- Inexpensive, rapid deployment, efficient multi-hop (daisy chain)
- Convergence of 2G/3G/4G over a common wireless access network
- Scalable solutions with T1/E1 at remotes and channelized OC-3/DS-3 aggregation
- QoS ensured through traffic classification, policing (rate limiting), scheduling to queues and shaping of egress traffic to a specific line rate.

Optimized Backhaul Solutions for Mobile Operators

RAD's ACE and IPmux/Gmux product lines help to reduce transport costs by optimizing bandwidth and supporting more efficient network topologies. Bandwidth optimization is achieved by deploying idle flag suppression, Abis optimization, statistical multiplexing, idle cell removal, and per-VC switching to offload data traffic from expensive links. RAD's Vmux voice compression gateways allow operators to dramatically reduce the cost of MSC-to-MSC transport for both voice and voicemail applications while our Airmux radios provide high quality Ethernet and T1/E1 backhaul over microwave links.

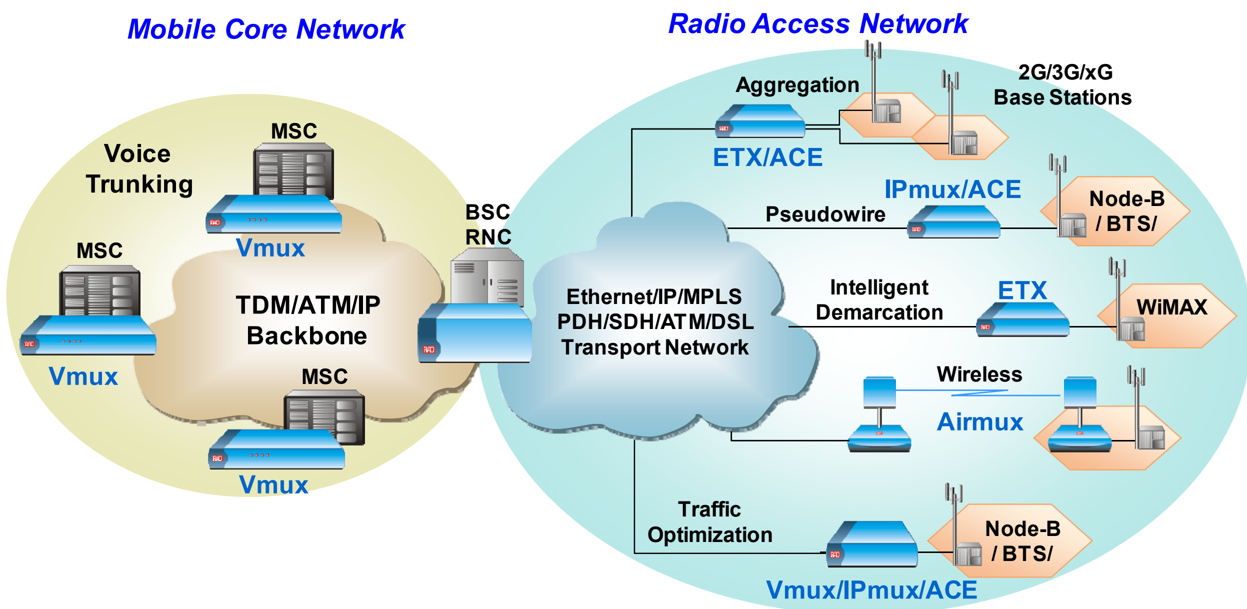


Fig 6. Optimizing Backhaul over TDM, ATM, Ethernet or Limited Bandwidth Networks

RAD's ACE product line is particularly flexible and uses standard circuit emulation and pseudowire techniques to transport TDM and ATM traffic over TDM, ATM, Ethernet, IP, MPLS, or DSL networks. In situations where high priority traffic needs to traverse one network while low priority traffic must traverse another, the ACE also supports per-VC ATM switching. This provides HSDPA segregation over hybrid ATM and Ethernet networks so that data traffic can be offloaded to cheaper DSL, fixed wireless or cable modems while only the latency sensitive voice traffic will traverse the ATM or TDM networks.

As with other RAD pseudowire devices, such as the IPmux, it is important to note that the ACE cell-site gateways and RAN concentrators are able to reconstruct the original traffic timing over packet switched networks with a frequency accuracy of better than 16 ppb, a jitter mask according to G.8261, and a holdover accuracy of 1 ppb per 24 hours. For a more comprehensive discussion on precise timing over packet networks, please refer to RAD's TDM Timing white paper.

RAD's Pseudowire and Carrier Ethernet Leadership

RAD focuses on building innovative access solutions that bridge the gap between customer applications and the transport networks they run over. RAD's broad product portfolio includes solutions that support legacy applications, such as TDM voice and data, as well as ATM, IP, Ethernet, and 2G/3G/4G cellular traffic over any mix of traditional and emerging transport networks. Some highlights include:

TDM, ATM and HDLC pseudowire solutions

- Greater than 60,000 ports sold since product introduction in 1998
- Clock recovery conforms to G.823/G.824 sync interface using G.8261-defined scenarios with frequency accuracy that is better than 16 ppb.

Comprehensive SLA support

- End-to-end OAM capabilities over Ethernet and TDM networks
- Traffic classification, policing, scheduling, and shaping
- Extensive statistics, threshold notifications and diagnostics
- Uplink redundancy, fault propagation and Time Domain Reflectometry (TDR)
- standards leadership
- Pseudowire: SAToP, TDMoIP, CESoPSN, HDLCoIP, ATMoPSN
- Carrier Ethernet: IEEE 802.3-2005 (formerly IEEE 802.3ah), IEEE802.1ag, ITU Y.1731, MEF 9 & 14
- EANTC interoperability tests in collaboration with MEF and IP/MPLS forums:
  - Sep 06: Only RAD demonstrated Y.1731-based performance measurements
  - Jan 08: ACE demo of PW interoperability with Cisco 7600 and Nortel 15K
  - Jan 08: ETX demo of Ethernet OAM interoperability with IXIA, Telco and MRV

Comprehensive product offering

- Ethernet over anything and anything over Ethernet
- Extensive interface options (e.g. Fast Ethernet, Gigabit Ethernet, serial, analog, T1/E1, T3/E3, OC3/STM-1, OC12/STM-4)

Summary

Although mobile backhaul transport providers have very different needs than mobile operators, their interests dovetail when it comes to efficient and optimized multiservice backhaul networks.

Mobile operators are experiencing numerous challenges moving to Triple Play and 3G/4G. They need much more bandwidth, but at a much lower cost per bit. There are a wide variety of technologies involved and they must ensure that the old and new work seamlessly and economically together. They can buy TDM services from the transport providers, but then they need Ethernet bridging and circuit bonding for emerging services. Alternatively, they can buy Ethernet services, but then they must verify their SLAs and utilize pseudowire technology for legacy TDM and ATM requirements. On the other hand, the mobile backhaul transport providers need to utilize Ethernet networks to provide Ethernet and TDM services to multiple operators at the same tower to justify the expensive fiber construction costs. Packet switching is required to ensure scalable solutions for unpredictable bandwidth needs and packet economics is needed to ensure a compelling business case.

The end result: lower backhaul costs for mobile operators, higher revenues for mobile transport operators, and the promise of increased profitability for both.

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