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INTRACOM TELECOM

White Paper

Driving Mobile Backhaul Networks toward LTE

Contents

1. Executive Summary

The explosion in demand for mobile broadband services, driven by the prevalence of HSPA+, mobile WiMAX and LTE technologies, put significant constraints on the backhaul network.

Wireless broadband carriers are forced to make new investments to evolve their transport networks to all-IP, in order to grow their customer base, achieve a fast ROI and increase their revenue.

Operators perceive the advanced Next Generation MW solutions as high-valued. Such solutions enable a smooth all-IP migration for existing legacy backhaul networks and allow flexible configurations at any part of the network, in an optimum and cost-effective manner.

A deployment case, which is presented hereinafter, demonstrates the significant savings from the incorporation of OmniBAS™ systems in a mobile operator's network. The OmniBAS™ end-to-end Next Generation MW offering from INTRACOM TELECOM fulfills the operator demands for a MW backhaul solution capable to pave the road toward LTE evolution.

2. The Challenge

Currently, mobile operators have to deal with the ever-increasing data traffic volumes, which resulted from the heavy usage of smart handsets and IP applications.

Market forecasts reveal an anticipated 40/60-fold increase in the wireless backhaul needs by 2015. This huge increase emerges severe bottlenecks for the backhaul network, and requires the immediate action from operators' side.

IP / ETH (Ethernet) is considered as the most appropriate underlying mechanism for backhauling the extensive mobile network traffic. This technology is future-proof, it provides significant cost / capacity / scalability advantages, and ensures strong benefits for all new wireless standards. In short, the IP / ETH technology enables the following:

- CapEx & OpEx-independent traffic growth
- Fine granularity of quality & availability of services
- Simplification of deployment and integration with IP/MPLS core networks
- Smooth migration of legacy systems towards all-IP
- Facilitation of evolving requirements to cater for LTE networks
- Full interoperability with existing IP / MPLS core backbone networks
- Powerful network management to handle all types of traffic flows

The transition from existing TDM-based to all-IP MW backhaul requires the seamless support of legacy services, to:

- Achieve a smooth evolution path
- Provide sufficient time to ensure that all technical challenges are met
- Maintain crucial TDM services
- Keep business running without interruption

For all the aforementioned reasons, operators seek competent end-to-end MW solutions that will meet their backhaul requirements, while effectively addressing their current and future IP issues.

3. The INTRACOM TELECOM Response

OmniBAS™ is a highly-flexible, native ETH / all-IP PtP MW solution that perfectly fits all topologies (tree, repeater, ring) within a typical backhaul network. This solution is easily incorporated into nodal aggregation or edge backhaul sites.

Backhaul of legacy services is carried out seamlessly through Pseudo-Wire Emulation, which encapsulates TDM traffic into packet frames.

OmniBAS™ is an indoor – outdoor system comprising:

- Indoor units (OmniBAS™-4W, OmniBAS™-2W) of small form factor (1RU) and modular architecture
- Complete family of outdoor radios (ODUs) covering a wide range of operating frequencies, from 6 GHz to 38 GHz
- Traffic aggregation and interworking indoor unit (OmniWAY™-2G)

The following table gives the technical details for the aforementioned indoor units:

OmniBAS™-4W	OmniBAS™-2W	OmniWAY™-2G
		
• Industry-leading modem density – up to four modems in 1RU • System configuration agility (1+0 / 2+0 / 3+0 / 4+0, 1+1 / 2+2 FD / SD / HSB) • 2 x GbE (optical or electrical) network interfaces • 16 x E1 interfaces	• Up to two modems • System configuration agility (1+0 / 2+0, 1+1 FD / SD / HSB) • Fits edge MW backhaul applications • 1 x GbE (optical or electrical) & 4 x FE network interfaces • 8 x E1 interfaces	• Compact (1RU) aggregation & interworking unit • 4 x GbE (optical or electrical) for traffic aggregation • 4 x STM-1 / VC-12 (optical 2+0 / 2+2) • 2 x STM-1 / VC-4 (optical 2+0 / 2+2)

For assured high availability, OmniBAS™ provides various hardware redundancy options and supports protected Ethernet rings, as per ITU-T G.8032 and IETF RSTP protocols. Its efficient timing capabilities include traditional synchronization (based on G.703) and Ethernet synchronization based on the Synchronous Ethernet standard and IEEE 1588v2.

4. Meeting the Challenge

The OmniBAS™ product line effortlessly meets the mobile operators' network evolution plans and effectively addresses their IP design & deployment challenges:

i. Breaking the capacity bottleneck

With 400 Mbit/s (per single link) and 1.6 Gbit/s (from a single 1RU unit) native Ethernet capacity, OmniBAS™ satisfies all current and future capacity needs. For such capacities, competition responds with larger form factors (2RU at least).

ii. Efficient bandwidth utilization through advanced techniques

OmniBAS™ utilizes statistical multiplexing to best allocate the available link capacity. It also utilizes hitless adaptive modulation – QPSK to 256QAM – to increase the availability of services, maintain the flow of critical services and maximize the throughputs at all weather conditions. Operation at 256QAM allows achieving the maximum capacity for all channel sizes (7 / 14 / 28 and 56MHz).

iii. No hidden costs

Compared to other MW solutions, OmniBAS™ offers full capacity and unrestricted hitless ACM without any OpEx ovehead. The operator is benefited from a reduced CapEx (in the range of 20 – 30%), and OmniBAS™ can be part of the low and high Radio Access Network (RAN) from day 1.

iv. Effective legacy traffic handling

OmniBAS™ seamlessly emulates traditional circuit-based services, using Pseudo-Wire (PW) technology, and delivers them with assured high quality.

Contrasted to legacy practices implemented by hybrid MW alternatives, the encapsulation of E1 streams into packets, prior to transmission, allows the finest of QoS granularity.

In practice, an E1 stream carrying voice from a 2G BTS would have a higher priority than an E1 stream carrying ATM or ML-PPP data from a 3G BTS. With OmniBAS™, legacy traffic prioritization becomes a reality.

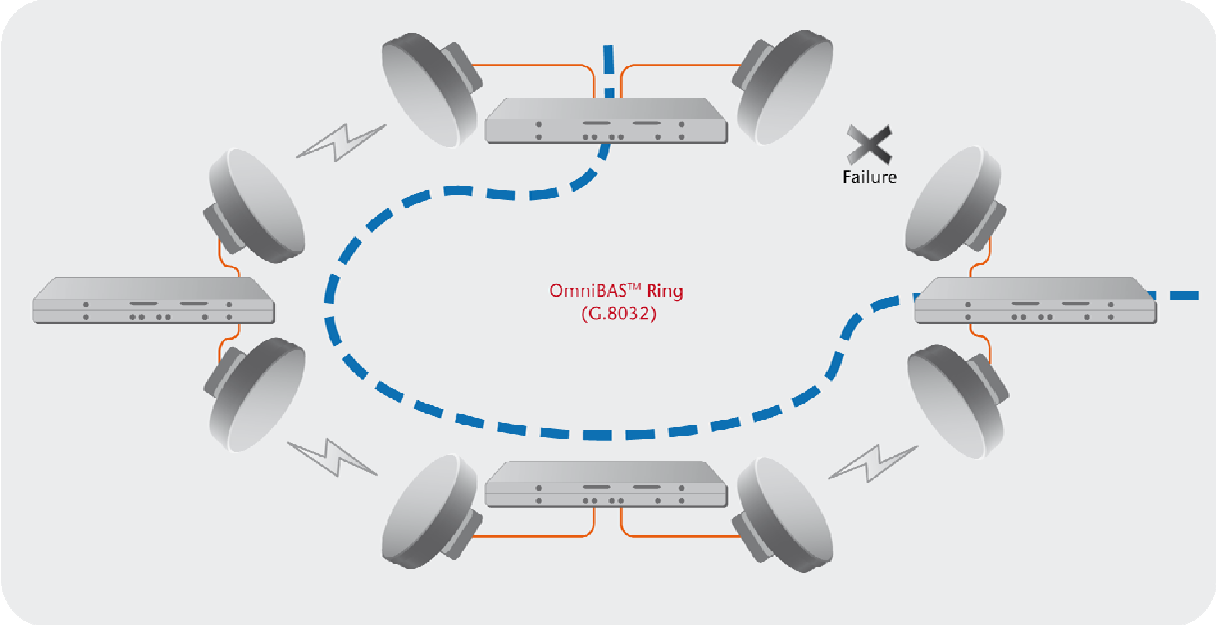
v. Reliability & service assurance

OmniBAS™ offers multiple redundancy options, at both link (1+1 / 2+2, HSB & FD) and module / interface level, to ensure the resiliency of the transmission network. It is the only ETH MW offering in the market that achieves an aggregate 800 Mbit/s capacity (on a single 56 MHz channel) and from a 1RU unit operating in full 1+1/XPIC protected mode.

In addition, the conformance to ITU-T G.8032 standard allows implementing protected Ethernet rings of assured low recovery switching time (much lower than 50 ms).

The OmniBAS™'s inherent L2 QoS capabilities support various classes of traffic to allow proper handling and prioritization of voice and IP traffic flows.

Fig.1 Protected Ethernet Ring Implementation According to ITU-T G.8032



vi. Highly-flexible IP Migration

Addressing the operators' approach to capitalize investments for legacy and hybrid MW systems, OmniBAS™ facilitates a staged introduction of IP technologies in the backhaul network. It enables a smooth transition to packet backhaul, while retaining the existing high quality of the legacy infrastructure.

In this smooth evolution process, OmniBAS™ maintains simplicity in the design and operation of the network, while encompassing future-proof IP concepts.

vii. Future-proof network

With a 400 Mbit/s capacity per single link, LTE traffic requirements (~100 Mbit/s) are effortlessly met. Furthermore, the utilization of advanced XPIC technology and Radio Link Aggregation (RLA) allows link capacities of up to 800 Mbit/s, thus offering the most efficient and resilient air link utilization.

viii. Full control over managed network & services

The uni|MS™ Unified Management Suite incorporates a powerful and complete set of features that enables the efficient end-to-end management of OmniBAS™ networks. Transition to IP is largely facilitated, while the QoS and network availability are ensured.

uni|MS™ allows the unified management of network resources through sub-networks. End-to-end circuit provisioning enables quick service implementation over multiple hops (A to Z sub-network connections), and not on a hop-per-hop basis. This significantly simplifies the operation flows during the configuration of the network.

The uni|MS™ advanced fault & performance functionality allows performing network troubleshooting and monitoring through intelligent automated procedures. Operators can gauge wireless utilization to proactively discover and address performance issues, which may affect the availability and health of the supervised network.

Circuit-based alarms and impact analysis provide direct visibility on services availability and performance. Historical reports, accompanied with graphs, can facilitate the localization and diagnosis of congestion and bandwidth problems. Fault localization is further aided by the uni|MS™'s embedded tools, which are responsible for alarm reduction, correlation, localization and notification.

5. Deployment Case

This section presents an actual deployment case that was carried out for a leading mobile operator employing edge technologies in its network. The scope of this case was the transformation and expansion of the existing backhaul network through the utilization of OmniBAS™ systems, in order to meet the customer's objectives for upgradeability, scalability and operational efficiency, within an optimum budget.

a. Input Data

Existing Backhaul Technology:	Hybrid PtP
Size of the Existing Network:	268 links
Air Capacity: *(Per Link)*	47 Mbit/s (3xE1s for TDM, plus 41 Mbit/s for packet data)
(Nominal, Whole Network)	6.786 Gbit/s
Assumptions:	• Channel size 14 MHz (on all links) • 18 GHz & 23 GHz frequency bands
Design Objectives:	• 16QAM and 99.995% availability – ensuring throughput of ~47 Mbit/s • 256QAM and 99.9% availability – ensuring a throughput of ~97 Mbit/s

b. Dimensioning of the Network

The redesign of the network brought a series of significant advantages to the customer. These are analyzed below:

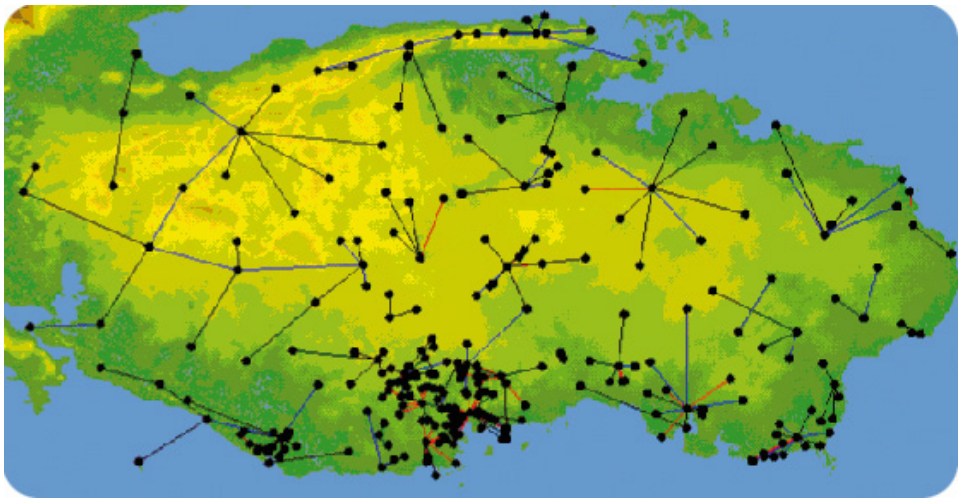
1. Reduced Number of Nodes

Using OmniBAS™-4W, a four-way nodal site can now be realized with five instead of eight IDUs (as required by conventional PtP solutions). This minimizes the total number of PtP links (from 268 to 240) as well as of network nodes, as depicted in the picture below *[see Fig. 2]*.

Benefits:

- More than 40% reduction in number of IDUs (i.e. from 536 to 323).
- 40% in CapEx savings.

Fig.2 *Representation of the new network topology*



2. Increased Capacity

OmniBAS™ dramatically increased the available capacity, thus giving unlimited capabilities to the backhaul network, now and in the future.

Benefits:

- 166% increase in nominal capacity (i.e. from 6.786 Gbit/s to 11.28 Gbit/s).
- 85.89 Gbit/s (= 240 links x 357.88 Mbit/s per link) maximum capacity available from day 1 – this capacity value achieved on a single 56 MHz channel, with ACM up to 256QAM.
- Almost 7 times excessive capacity available for future use.

3. Reduced Switching Needs

The unique nodal capabilities of OmniBAS™ allow reducing the total switching requirements – traffic switching can now be performed closer to the access links (in light nodal sites) than at the core.

Benefits:

- More than 60,000 € savings from the elimination of unnecessary Ethernet switches.

4. Simplified Operations

The uni|MS™'s inherent configuration and monitoring capabilities facilitate the management of the network, providing significant advantages to the operator.

Benefits:

- More than 90% OpEx savings from simplified network operations (e.g. end-to-end provisioning and monitoring).

5. Reduced Wiring Complexity

Traditional TDM / Hybrid PtP systems require enormous DDF wiring due to the increased requirements for E1 tributaries add/drop. This imposes certain limitations at the core (TN) site regarding the number of terminating E1 lines.

By encapsulating legacy TDM traffic into packet frames, OmniBAS™ allows reducing the wiring complexity (and associated maintenance costs) at the intermediate hop sites of chained PtP links.

Benefits:

- No need to drop TDM traffic of preceding nodes at every intermediate hop site.
- More than 50% OpEx reduction in infrastructure maintenance, as a result from the reduced DDF wiring complexity.

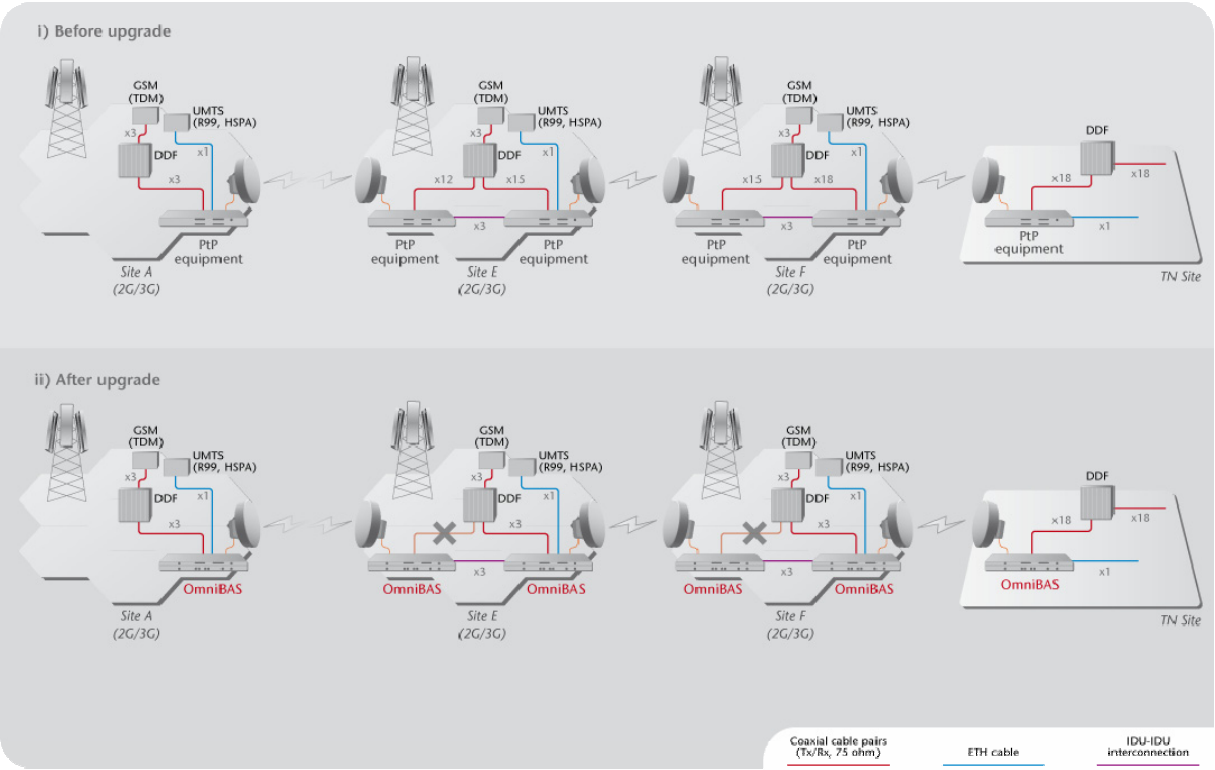
A Representative Example

Hereinafter, it is demonstrated how OmniBAS™ can remove the wiring complexity at the intermediate hop sites of chained PtP links, thus achieving significant savings.

Next schematic *[Fig. 3]* depicts a chain of six BTS / NodeB sites (Site A, … , Site F), each having similar backhaul requirements, which are:

- 3xE1, for GSM traffic and
- 1xFast Ethernet, for UMTS R99 / HSPA traffic.

Fig.3 *Local E1 wiring requirements, before (i) and after (ii) the upgrade*



Both GSM and UMTS traffic (from all hops) are forwarded to the core (TN) site. There, the aggregate packet traffic is provided at Ethernet interfaces (FE or GbE), while the aggregate TDM traffic is provided at eighteen (= 6x3) E1 interfaces.

i) Wiring requirements (before the upgrade):
At each intermediate hop site, the GSM traffic from all the preceding link partners is first dropped locally then added to the interconnected indoor unit through the DDF. In addition, local GSM traffic (3xE1) is forwarded to the interconnected indoor unit, also through the DDF. The closer a hop site is located to the TN, the more complex the local E1 cabling due to the E1 tributaries that need to be dropped and added to the next link hop.

ii) Wiring requirements (after the upgrade):
After the upgrade, there is no need to drop GSM traffic from preceding link partners. OmniBAS™ forwards the encapsulated TDM traffic to the next link hop through the IDU – IDU GbE interconnection, thus eliminating the need for local E1 tributaries drop.

The aforementioned example clearly demonstrates the benefits for a single chained link alone (composed of six cascaded hops). As the whole network comprises several such links, the benefits for the operator are multi-fold.

6. Conclusion

The fast-growing needs for data traffic backhaul are about to force mobile operators toward all-packet MW solutions. This will allow fulfilling their promises for high quality services at affordable prices.

The OmniBAS™ product line offers a series of unique characteristics, including:

- Excessive capacity
- Simplicity
- Deployment flexibility
- Advanced functionality
- Powerful management capabilities for end-to-end IP service control

OmniBAS™ meets and exceeds the operator requirements for backhaul network convergence at no extra cost. This product offering provides the foundation for building resilient LTE-ready backhaul networks today, while reducing the Total Cost of Ownership (TCO).

7. Glossary

ACM	Adaptive Coding & Modulation
BTS	Base Transceiver Station
CapEx	Capital Expenditures
DDF	Digital Distribution Frame
FD	Frequency Diversity
GSM	Global System for Mobile Communications
HSB	Hot Standby
HSPA	High Speed Packet Access
IDU	Indoor Unit
IETF	Internet Engineering Task Force
IP	Internet Protocol
LTE	Long Term Evolution
MPLS	Multi-protocol Label Switching
MW	Microwave
OpEx	Operational Expenditures
PDH	Plesiochronous Digital Hierarchy
PtP	Point to Point
PW	Pseudo-wire
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
ROI	Return on Investment
RSTP	Rapid Spanning Tree Protocol
TDM	Time Division Multiplexing
UMTS	Universal Mobile Telecommunications System
WiMAX	Worldwide Interoperability for Microwave Access
XPIC	Cross-polarization Interference Cancellation