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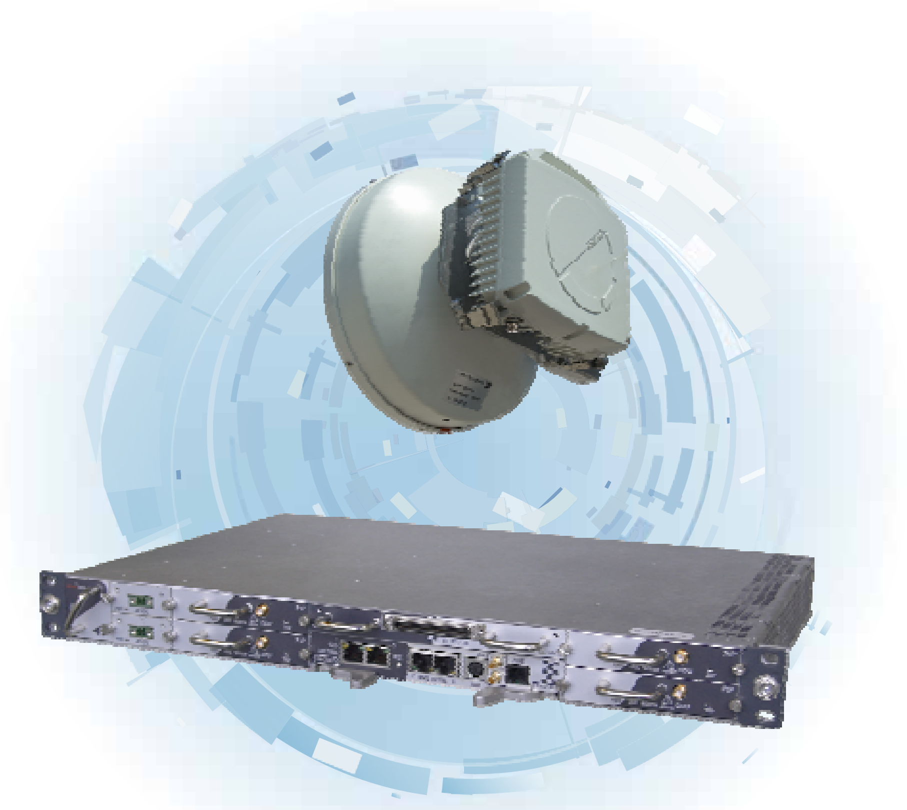
omniBAS

Next Generation Ethernet Microwave Backhaul Solution



GDC-002/30

System Description

Edition 2.0

Confidential

Printed in Greece.

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Document Revision History

Revisions

- Previous Edition: 1.1
- Current Edition: 2.0 *(concerning OmniBAS Release 2.0)*

Reasons of change

The following table lists the changes effected in relation to the previous edition of the OmniBAS System Description document:

Reason of change	Paragraph	Page
Typical OmniBAS configurations are modified.	3 Typical OmniBAS Configurations	12
Description of OmniBAS indoor equipment is modified (description of OmniBAS-2W front view is also added).	OmniBAS Indoor Equipment (OmniBAS-4W/ 2W)	22
Interconnection between OmniWAY-2G and OmniBAS-4W subracks is modified.	OmniBAS/ OmniWAY-2G interconnection	32
Information concerning the Local Craft Terminal is modified (OmniWAY-2G is added).	6.1 Local Craft Terminal	33
Networking specifications are modified (Ethernet and L2 Bridging Modes).	7.1 OmniBAS System Specifications > Networking	47
Specifications of ODU-CF models are modified.	Specifications per ODU-CF Model	51
Radio & Modem Performance are modified.	7.4 Radio & Modem Performance	56

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1 System Overview

Operators today needs

The emergence of mobile broadband and multimedia services, the enhancement to the air interfaces (HSPA+, LTE, CDMA EV-DO, WiMAX) and the upcoming saturation of ARPU for voice, shape today's mobile market and technology landscape. Operators are faced with increased capacity demands, which put stress on their transport / backhaul networks. To overcome, they have to either spend on expanding their existing networks, or spend on new, more efficient solutions. Most preferable is the second choice with solutions that are cost-efficient and future-proof, while supporting the current TDM, ATM and Ethernet services. In recent years, transport technology has evolved from native PDH / SDH, to hybrid PDH / SDH & Ethernet / MPLS. Today, all experts agree: the future of transport belongs to native Ethernet / MPLS technology. Regarding the transport and backhaul costs, microwave has proved to be the most cost-efficient technology having the lowest cost per bit.

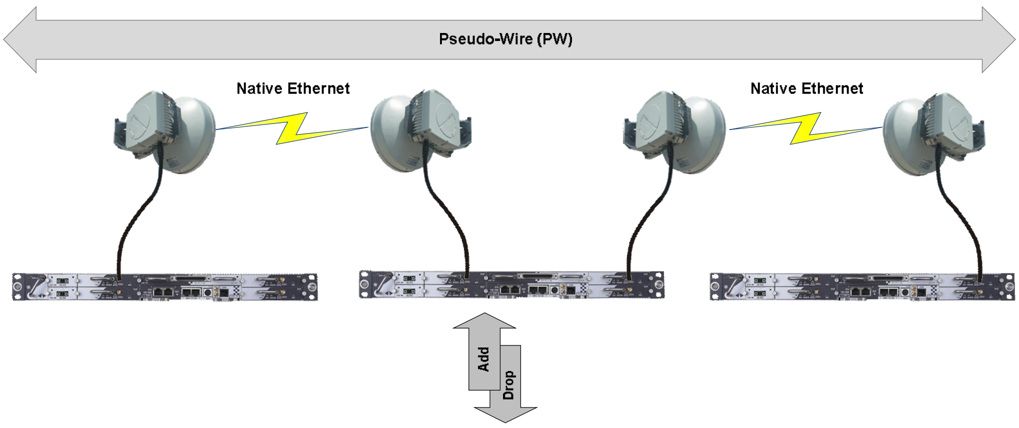
OmniBAS Overview

OmniBAS™ is a native Ethernet wireless backhaul platform employing latest microwave technology. It achieves traffic throughputs of up to 400 Mbit/s over a single link (or up to 800 Mbit/s with XPIC) with channelization up to 56 MHz.

OmniBAS™ incorporates statistical multiplexing for best optimization of the available link capacity, and adaptive modulation – QPSK up to 256QAM – for increased service availability at all weather conditions.

OmniBAS enables operators to take an evolved approach and smoothly migrate to all-IP, for delivering new compelling services along with serving more customers without additional expenditures. Incorporating highly efficient traffic handling mechanisms and bandwidth utilization techniques, OmniBAS assures carrier class service delivery with highest availability.

Backhaul of legacy services is carried out seamlessly through Pseudo-Wire (PW) functionality and through the utilization of E1, STM-1 (VC-12 and VC-4), and Gigabit Ethernet network interfaces.



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System Overview, Continued

OmniBAS composition

OmniBAS™ is offered in split indoor – outdoor (OmniBAS-4W / 2W – ODU-CF) form, with the OmniBAS-4W combining industry-leading modem density – up to four modems – for system configuration agility (1+0 / 1+1 / 2+0 / 2+2 / 3+0 / 4+0, FD / SD / HSB) and flexible network deployments. A complete family of outdoor radios covers a wide range of operating frequencies, from 6 GHz to 38 GHz, while the antennas can be either integrated to ODU-CF units or standalone.

With regard to protection capabilities, OmniBAS™ provides various redundancy options (ODU-CF, modem, Gigabit Ethernet), also allowing the implementation of Ethernet protected rings (as per ITU-T G.8032). OmniBAS™ efficient timing capabilities include traditional synchronization based on G.703, as well as Ethernet synchronization based on Synchronous Ethernet or IEEE 1588v2 standards.

Features

- Native ETH-based Point-to-Point radio with statistical multiplexing
- Up to 1.6 Gbit/s from a single 1RU chassis
- QoS to fully support all classes of traffic
- Up to 256 QAM adaptive modulation for optimum bandwidth utilization and lower CapEx & OpEx
- High full-duplex throughput over a single channel: up to 400 Mbit/s, up to 800 Mbit/s with XPIC
- Pseudo-Wire (PW) over ETH for multiservice transmission
- Nodal configurations with four radios
- ETH ring protection (ITU-T G.8032)
- Intuitive graphical management (SNMP)
- Optimized transmission capacity of Ethernet-based services

---

2 Typical Applications

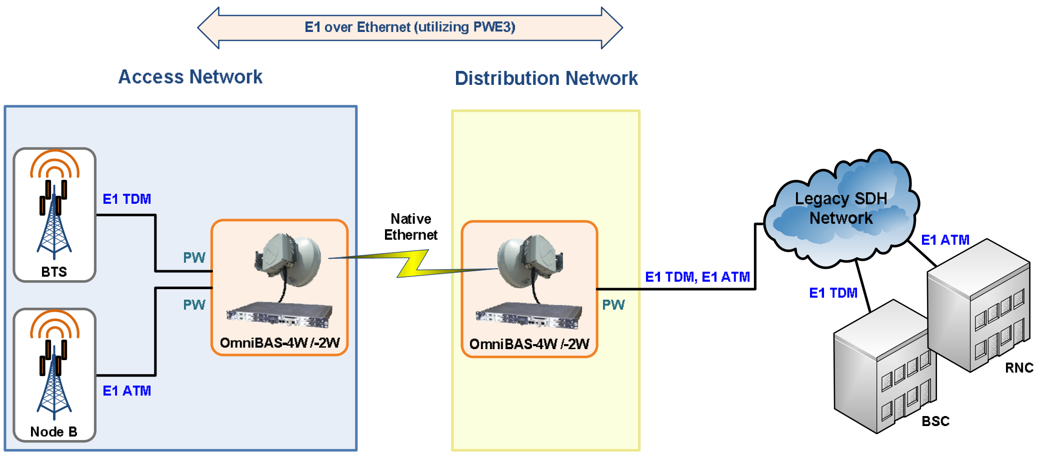
This chapter describes the OmniBAS typical applications:

Mobile 2G/ 3G Backhaul

Market requirements

Mobile (2G/3G) operators need a contemporary solution for their demanding, capacity-hungry backhaul applications, which will enable business growth, increase ARPU and deliver new compelling services to existing customers.

Application schematic



Description

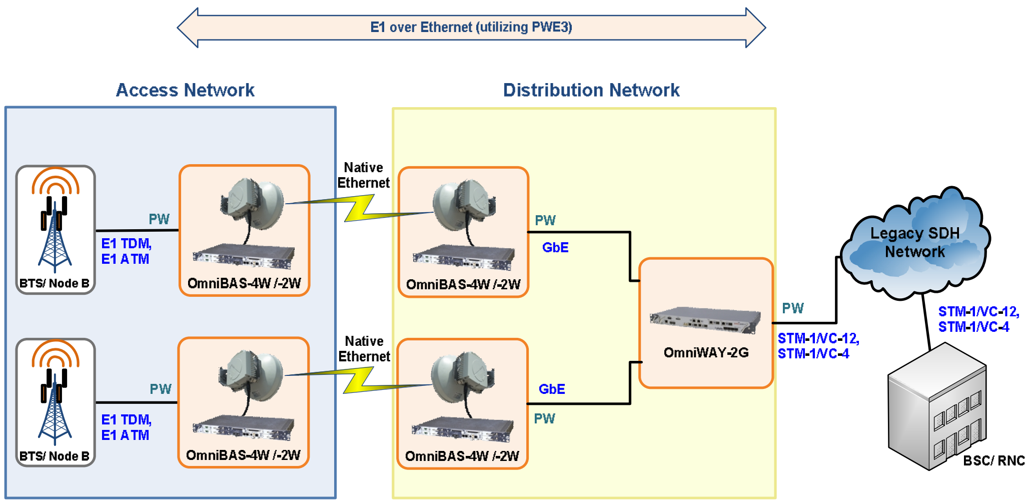
OmniBAS is a future-ready platform allowing smooth migration to all-IP in a cost-effective manner. OmniBAS incorporates latest microwave technology, advanced capacity handling features, while it utilizes Pseudo Wire (PW) for transporting legacy TDM and ATM traffic.

Mobile 2G/ 3G (R99) Backhaul (with Aggregation)

Market requirements

Mobile (2G/ 3G) operators with low traffic aggregation needs at small and medium hub sites, seek for a solution offering aggregation capabilities in a compact ant cost-effective solution.

Application schematic



Description

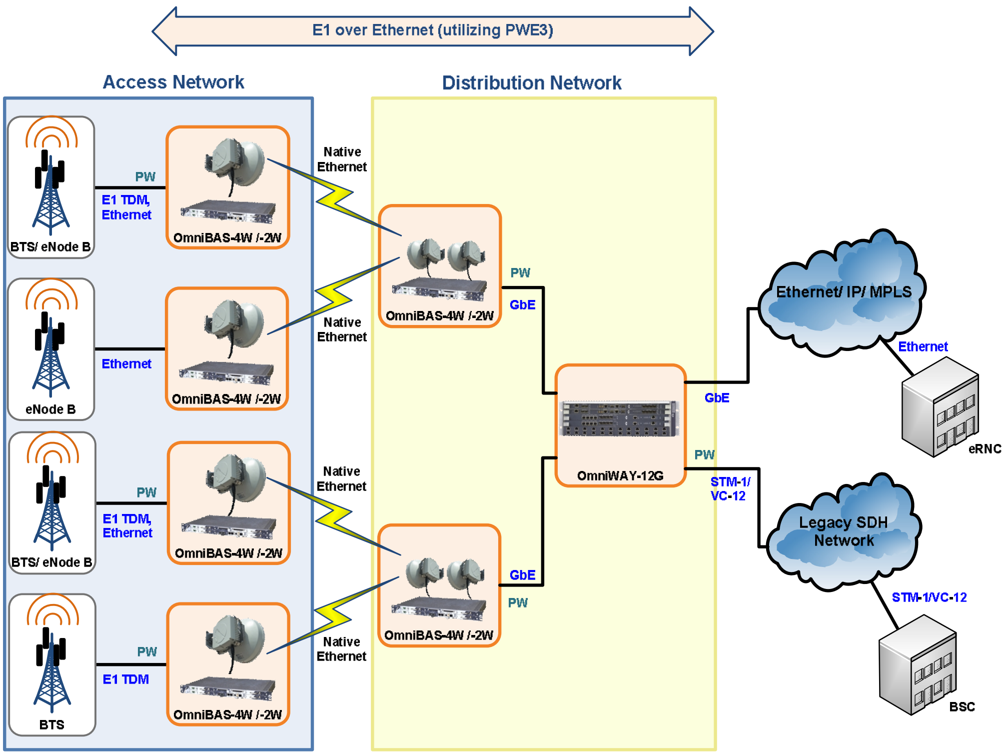
OmniWAY aggregation platform fully complements OmniBAS PtP product family. OmniWAY-2G aggregates packet-based traffic from OmniBAS systems and provides connectivity toward the legacy SDH network, through STM-1 (VC-4 and VC-12) interfaces.

Mobile 2G/ 4G Backhaul (with High Aggregation)

Market requirements

Mobile operators with increased traffic aggregation needs at medium and large hub sites, seek for a solution offering high transport capacity, advanced aggregation capabilities, and high flexibility.

Application schematic



Description

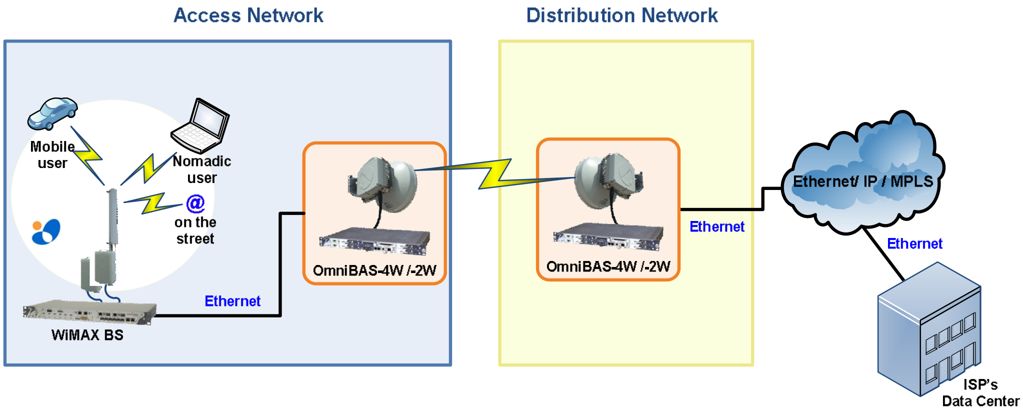
OmniWAY aggregation platform fully complements OmniBAS PtP product family. Mobile operators can implement nodal configurations for aggregating packet-based traffic from multiple OmniBAS systems and provides connectivity toward the Ethernet network (Ethernet/ IP/ MPLS), through GbE interfaces, or toward the legacy SDH network, through STM-1 (VC-4 and VC-12) interfaces

WiMAX Backhaul

Market requirements

WiMAX operators need a contemporary solution for their demanding, capacity-hungry backhaul applications, which will enable business growth, increase ARPU and deliver new compelling services to existing and new customers.

Application schematic



Description

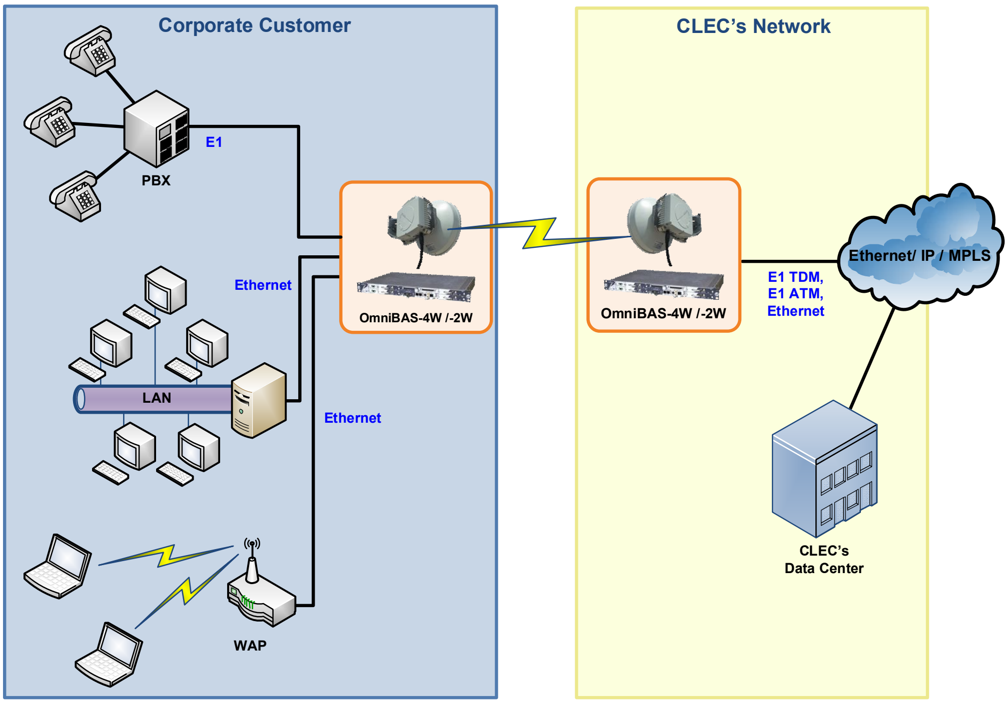
OmniBAS is a next generation Ethernet microwave backhaul solution for the demanding WIMAX operators seeking for a technologically-advanced solution for their transport network and last-mile backhaul.

Leasing Services for CLECs

Market requirements

Competitive Local Exchange Carriers (CLECs) with own network infrastructure seek for an effective way to exploit their available capacity for generating new revenue streams.

Application schematic



Description

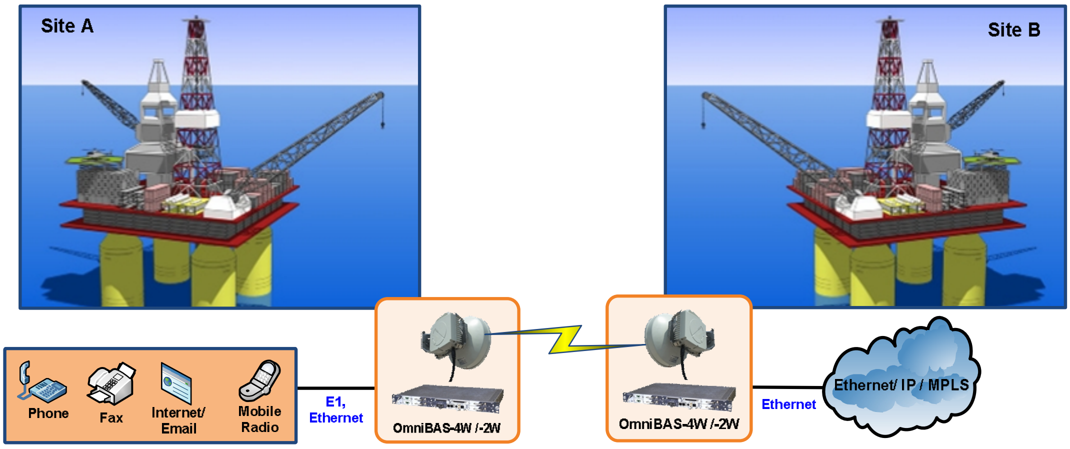
OmniBAS incorporating efficient bandwidth handling mechanisms allows excessive bandwidth to be leased to corporate customers needing economical high-capacity permanent connections.

Resilient Network Infrastructures

Market requirements

Utility companies, involved in the energy sector (oil, natural gas, electricity, water, etc.), and with own facilities at high-risk locations (where natural disasters – flood, forest fires or hurricanes – occur on frequent basis), are developing disaster recovery plans to mitigate the risk from such situations.

Application schematic



Description

OmniBAS is a cost-effective solution for utility companies needing to rapidly deploy main/ backup networks through the utilization of reliable microwave technology coupled with high throughput capacity and inherent Ethernet connection capabilities.

3 Typical OmniBAS Configurations

This chapter describes the following typical OmniBAS configurations:

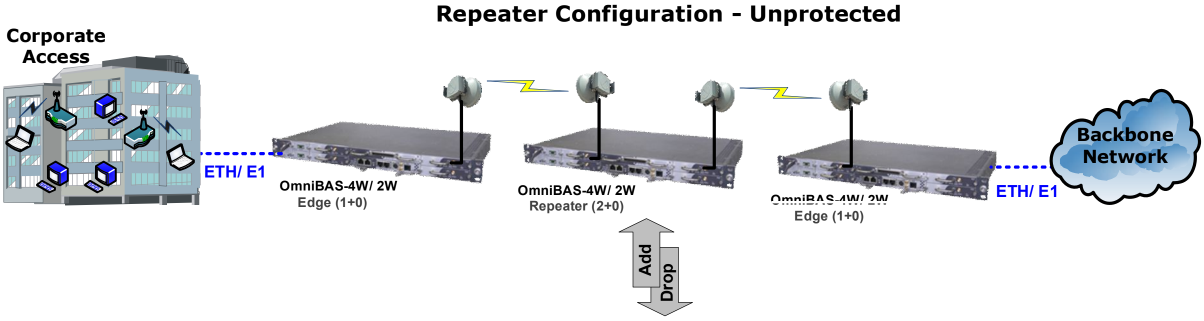
- Link Configuration
- Nodal Configuration
- Ring Configuration

Link Configuration

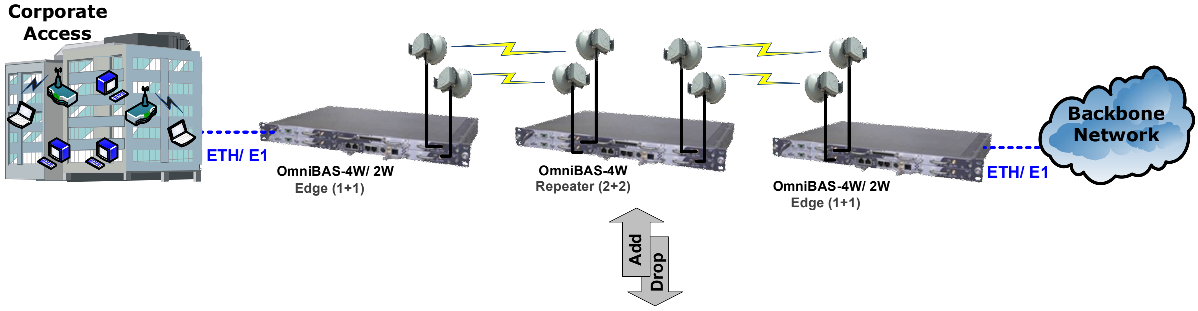
Link configuration schematics

A typical OmniBAS configuration example is the repeated PtP link where a repeater station is used for extending the effective range of the link.
The following schematic shows how a single OmniBAS handles repeater configuration, protected and unprotected.

Repeater Configuration - Unprotected



Repeater Configuration - Protected



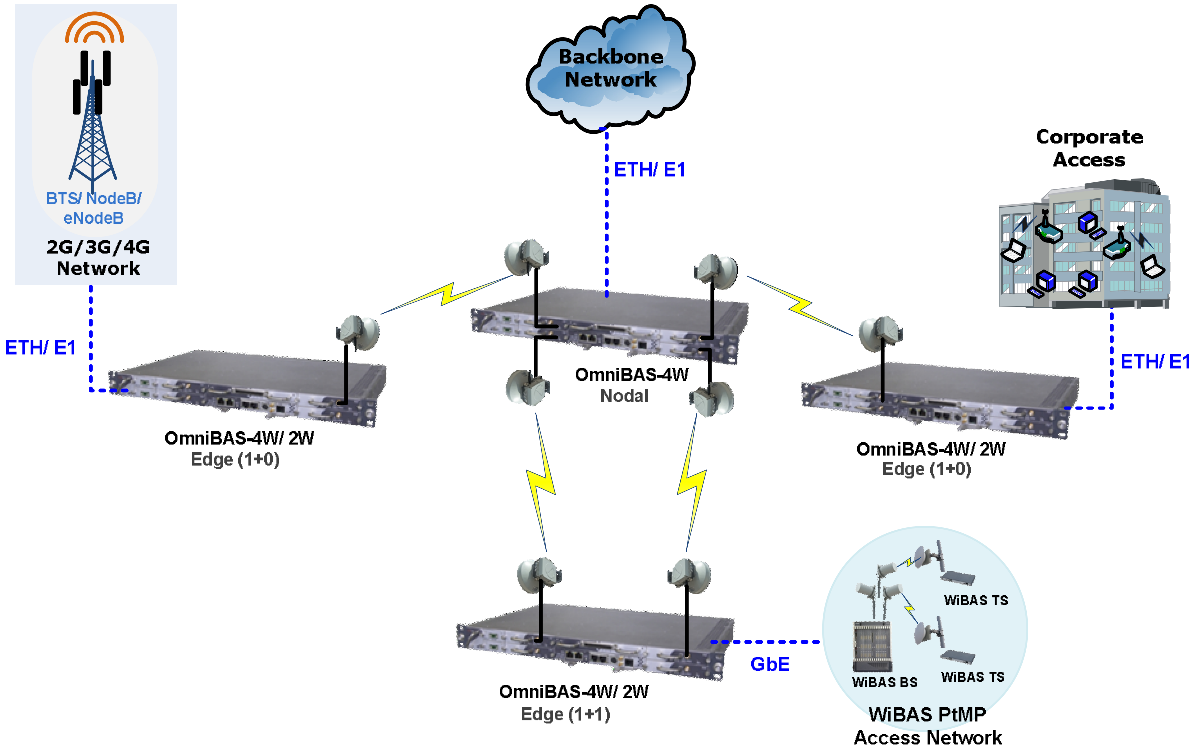
Description

Both repeater configurations (unprotected and protected) of the above examples, depicts three OmniBAS systems that are used to transport legacy E1 and Ethernet traffic from a corporation toward the backbone network.
In the *unprotected repeated configuration*, the two OmniBAS-4W/ 2W systems at the edges of the link are configured for 1+0 operation, while the third OmniBAS-4W/ 2W system at the repeater station is configured for 2+0 operation.
In the *protected repeated configuration,* the two OmniBAS-4W/ 2W systems at the edges of the link are configured for 1+1 protected operation, while the third OmniBAS-4W system at the repeater station is configured for 2+2 protected operation.

Nodal Configuration

Schematic of typical nodal configuration

The following schematic shows a typical nodal configuration for mobile 2G/ 3G/ LTE network:



Description

In this example, three OmniBAS-4W/ 2W systems (at the edges of the network) and one OmniBAS-4W system (at the nodal station) are used.

The nodal OmniBAS aggregates TDM/ ATM/ Ethernet traffic from a BTS/ NodeB/ eNodeB site, a PtMP access network and a large corporation, and forwards it toward the Ethernet and legacy networks.

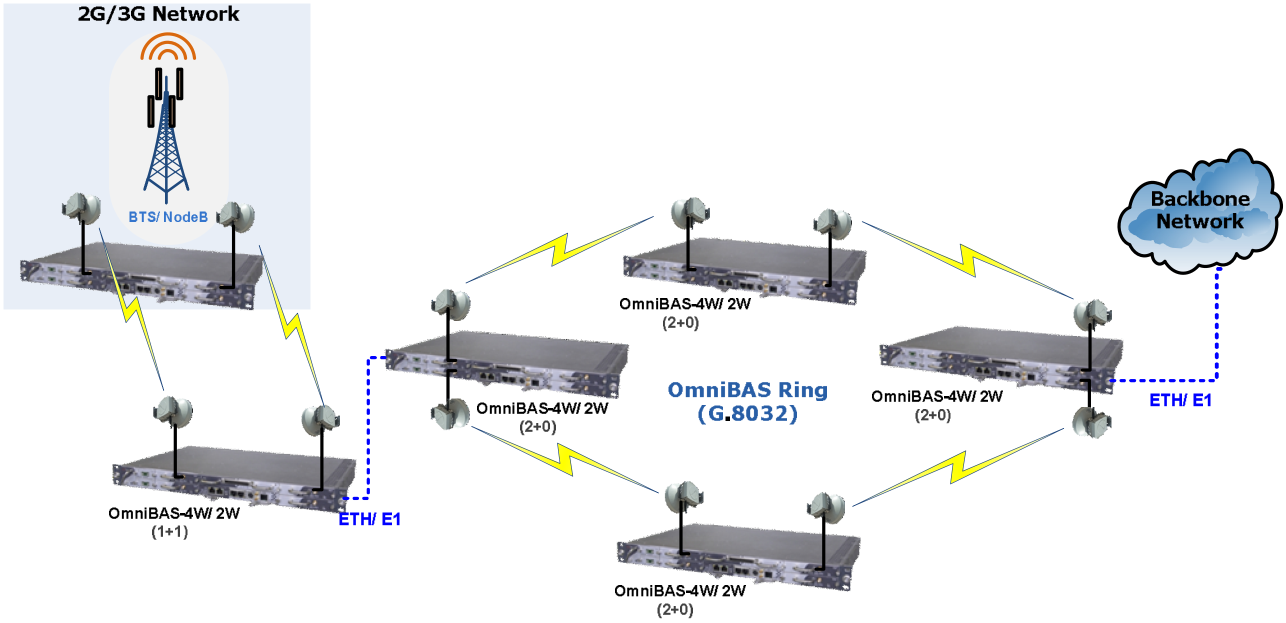
As the schematic shows, two edge OmniBAS systems are configured for 1+0 unprotected operation and the third edge OmniBAS system is configured for 1+1 protected operation. Thus, the nodal OmniBAS is configured for 2 x (1+0) and 1+1 operation.

At the nodal station, several indoor units can be stacked to serve higher nodal requirements.

Ring Configuration

Schematic of typical ring configuration

The following schematic shows how the OmniBAS-4W/ 2W systems implement a native Ethernet protected ring, according to ITU-T G.8032:



Description

With regard to protection capabilities, OmniBAS allows the implementation of Ethernet protected rings (as per ITU-T G.8032) assuring a protection recovery switching much lower than 50 ms.
In the above example, each OmniBAS-4W/ 2W system is configured for 2+0 protected operation, while one of them (the one shown at the right) is used for forwarding traffic toward the backbone network.

Features complied with Rec. ITU-T G.8032

- Protection and recovery switching within 50 ms
- Efficient bandwidth utilization of ring traffic
- Automatic reversion mechanism upon fault recovery
- Frame duplication and reorder prevention mechanisms
- Loop prevention mechanisms
- Use of different timers (WTR timer, Hold-off timers) to avoid race conditions and unnecessary switching operations

4 Description of OmniBAS Key Functions

This chapter provides the description of the following OmniBAS key functions:

- Ethernet Functionality
- Adaptive Modulation & Coding

4.1 Ethernet Functionality

This section presents the Layer 2 Bridging Modes supported by the OmniBAS system and then provides the following typical scenarios:

- Mobile Backhaul (C-VLAN Mode)
- Mobile & Corporate Backhaul

Layer 2 Bridging Modes

Layer 2 bridging modes

OmniBAS supports the following L2 bridging modes:

- C-VLAN
- S-VLAN transparent
- S-VLAN provider
- S-VLAN transparent & provider

Layer 2 bridging modes features

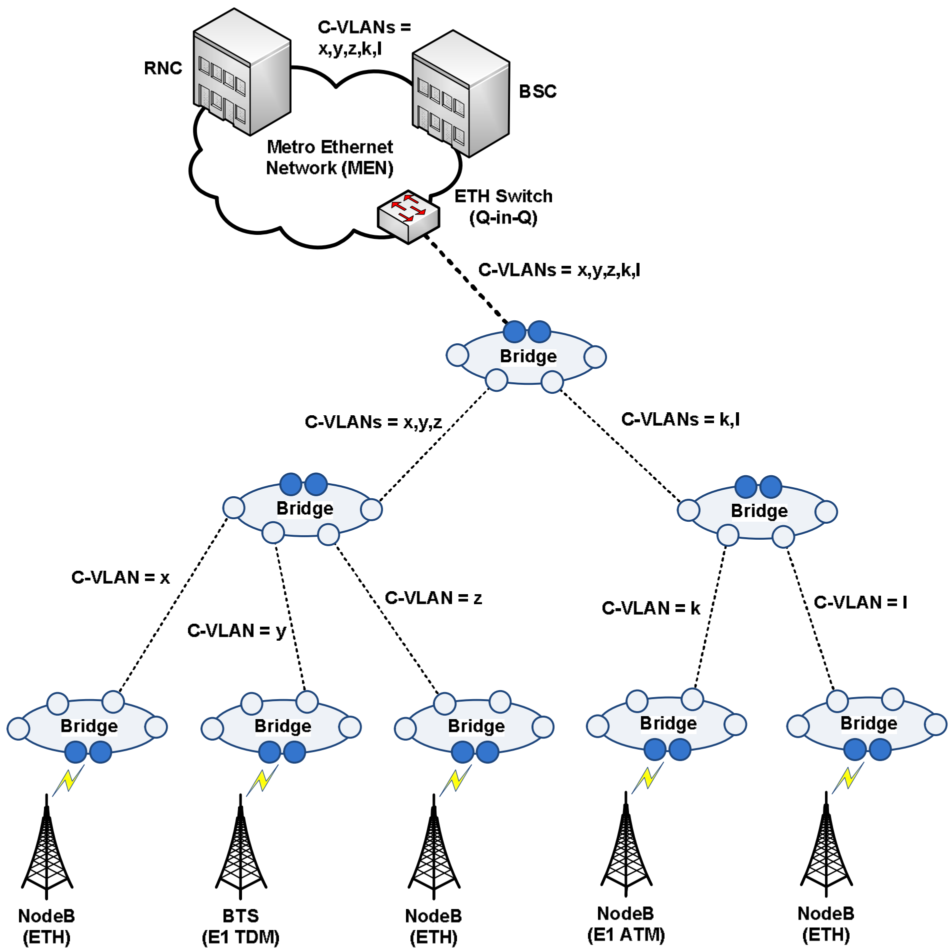
Bridging Modes	Features
C-VLAN	• Used solely for mobile backhaul applications • Normally, all L2 ports within wireless network are programmed for C-VLAN mode • L2 ports can accept untagged or single tagged Ethernet frames.
S-VLAN transparent S-VLAN provider S-VLAN transparent & provider	• Used for mobile and corporate concurrent backhaul applications • Normally, all L2 ports within wireless network are programmed for S-VLAN provider mode • L2 ports can accept the following Ethernet frames: – Untagged-only – Tagged-only – Untagged & tagged

Mobile Backhaul (C-VLAN Mode)

Introduction

The following network schematic depicts a typical wireless network where a mobile operator, with E1 and Ethernet interfaces, needs to backhaul traffic toward the RNC. The required interworking functionality is provided by the OmniBAS system.

Schematic



Description

Ethernet frames from all the BSs are forwarded to an Ethernet Switch, which adds/ strips an S-tag for each individual C-VLAN.

The Metro Ethernet Network (MEN) can be any of the following:

- IEEE 802.1ad (QinQ)
- PBB-TE
- MPLS – in this case an appropriate MPLS router is used for mapping C-VLANs to LSPs

A single VLAN id opens a tunnel through the MEN toward the RNC. Only C-VLAN tagged Ethernet frames are forwarded.

Continued on next page

Mobile Backhaul (C-VLAN Mode), Continued

Description (continued)

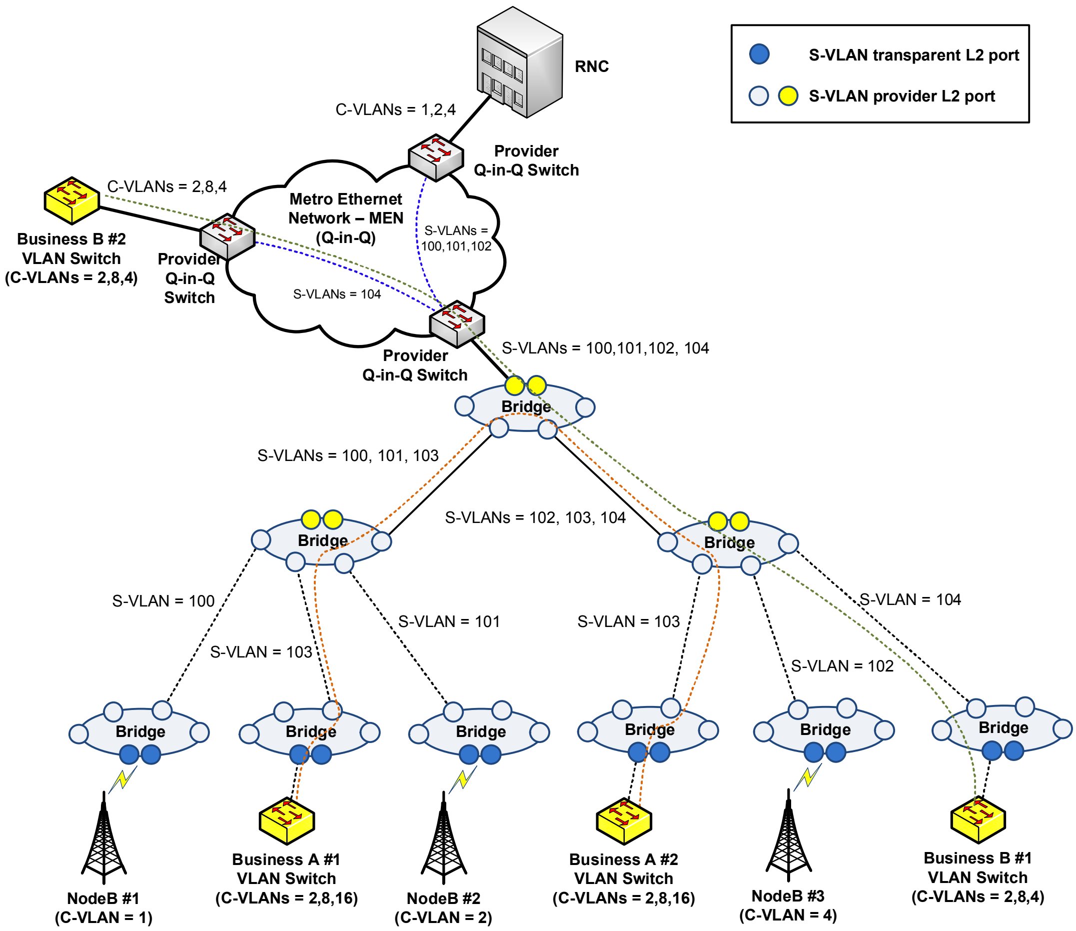
The OmniBAS's GbE ports (facing the access network) operate in C-VLAN mode and L2 ports are programmed to accept tagged-only Ethernet frames. Also, the OmniBAS's wireless ports operate in C-VLAN mode and L2 ports are programmed to accept tagged-only Ethernet frames for preventing undesired traffic from being forwarded.

Mobile & Corporate Backhaul

Introduction

The following network schematic depicts a typical wireless network where OmniBAS systems provide traffic backhaul services to mobile operators and to corporate customers simultaneously.

Schematic



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Mobile & Corporate Backhaul, Continued

Description

Ethernet traffic from NodeB sites is forwarded toward the RNC site, while corporate Ethernet traffic – from business A and business B sites – is forwarded toward the respective remote corporate premises.

OmniBAS nodes need to add the appropriate Service provider tags (S-tags). OmniBAS's functionality at the UNIs is as follows:

Site	Addition/ Stripping of S-tags
NodeB #1	OmniBAS at NodeB #1 site adds an S-tag=100 at ingress and strips the S-tag=100 at egress
NodeB #2	OmniBAS at NodeB #2 site adds an S-tag=101 at ingress and strips the S-tag=101 at egress
NodeB #3	OmniBAS at NodeB #3 site adds an S-tag=102 at ingress and strips the S-tag=102 at egress
Business A #1	OmniBAS at Business A #1 site adds an S-tag=103 for the whole user port (E-Line service) at ingress and strips the S-tag=103 at egress
Business A #2	OmniBAS at Business A #2 site adds an S-tag=103 for the whole user port (E-Line service) at ingress and strips the S-tag=103 at egress
Business B #1	OmniBAS at Business B #1 site adds an S-tag=104 for the whole user port (E-Line service) at ingress and strips the S-tag=104 at egress
Business B #2	The VLAN Switch at Business B #2 site adds an S-tag=104 for the whole user port (E-Line service) at ingress and strips the S-tag=104 at egress

The OmniBAS's GbE ports (facing the access network) operate in S-VLAN transparent mode. The ingress filter can be programmed to accept tagged-only Ethernet frames.

The Metro Ethernet Network (MEN) can be any of the following:

- IEEE 802.1ad (QinQ)
- PBB-TE
- MPLS – in this case an appropriate MPLS router is used for mapping C-VLANs to LSPs

The S-VLAN id is used for opening a tunnel toward the RNC and through the MEN. The OmniBAS's L2 ports, which are attached to the MEN, are configured in S-VLAN provider mode.

4.2 Adaptive Modulation & Coding

Introduction

In microwave PtP radio networks, the link performance as well as the service availability is highly affected by the weather conditions. OmniBAS incorporates a dynamic adaptive mechanism, which offers several significant benefits:

- Ensuring maximum bandwidth under all weather conditions – guaranteed critical services all the time
- Increasing capacity – excessive capacity can be exploited for value added packet-based services with high availability
- Increasing ARPU (in combination with the OmniBAS's statistical multiplexing capability)
- Extending reach with lower availability

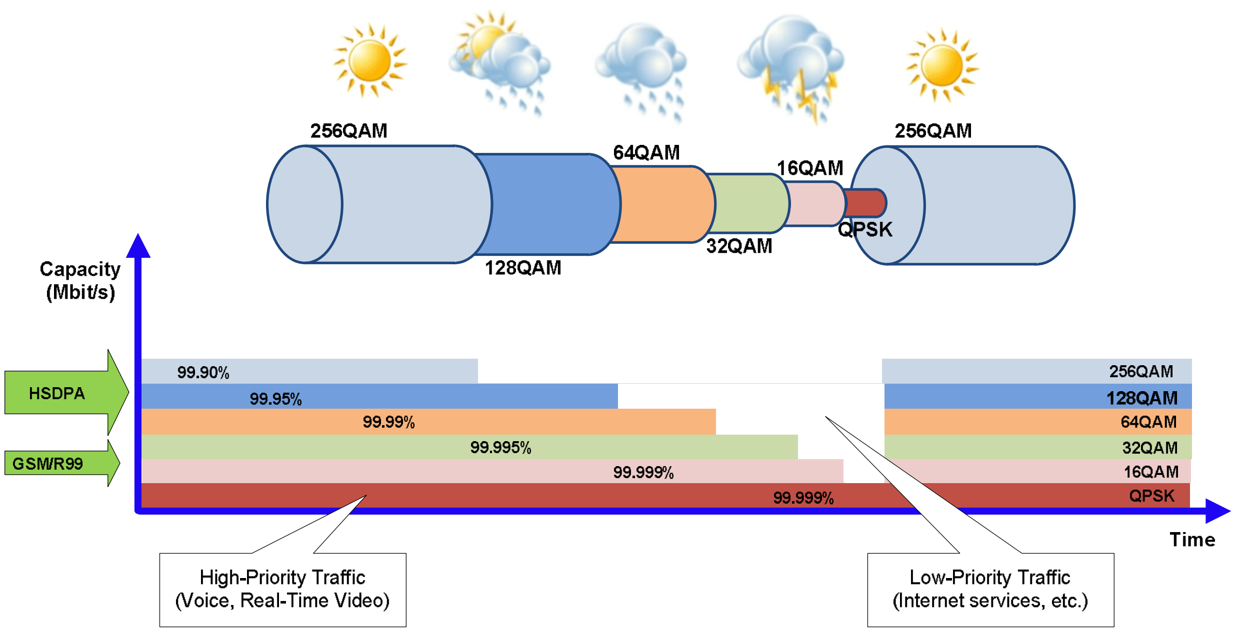
Description

OmniBAS automatically adjust modulation – from 256QAM to QPSK and vice versa – to enable higher throughputs and better spectral efficiencies. Switchover to another modulation is carried out seamlessly without affecting the link operation by any means.

OmniBAS is designed to always operate in the highest possible modulation, according to link quality metrics. This way, the critical, real-time applications run unaffected, independently of the weather conditions.

During stormy weather, for instance, OmniBAS automatically reduces the modulation so that non real-time, data-based applications may be affected by throughput degradation, but real-time, high-revenue applications (such as real-time video and voice) will continue to run uninterrupted.

Changing the modulation also varies the throughput proportionally. For example, 256QAM modulation can deliver four times the throughput of 4QAM (QPSK). The excessive bandwidth (other that that used for critical applications) can be allocated to non real-time applications, such as download services, which are less tolerant to system availability.



5 System Composition

This chapter describes the equipment of the OmniBAS system that includes:

- Main indoor equipment (OmniBAS-4W/ 2W)
- Traffic aggregation units (OmniWAY-12G/ 2G) that constitute optional indoor equipment
- Outdoor equipment (ODU-CF units and antennas)

OmniBAS Indoor Equipment (OmniBAS-4W/ 2W)

Description

OmniBAS-4W is an advanced Ethernet wireless device that constitutes the main Base Station indoor unit of the OmniBAS system.

OmniBAS-4W

OmniBAS-4W combines industry-leading modem density as it can be equipped with up to four modem/ IF modules only in an 1 RU unit providing flexible network deployments and configuration agility (1+0 /1+1 /2+0 /2+2 /3+0 /4+0, FD/ SD /HSB).

Alternatively, an economical variant constitutes the OmniBAS-2W that accommodates up to two modem/ IF modules providing flexible network deployments and the following configurations: 1+0 /1+1 /2+0, FD/ SD /HSB.

OmniBAS-2W

OmniBAS indoor equipment employs the latest microwave technologies to aggregate all legacy ATM/ TDM and Ethernet traffic and transport it toward the IP/ Ethernet core networks. Thanks to Pseudo Wire (PW) functionality the legacy ATM/ TDM traffic is converted to Ethernet packets for transporting toward the IP/ Ethernet backbone. Also, the Modem/ IF Module switches the Ethernet traffic towards Ethernet/ IP/ MPLS network.

OmniBAS-4W/ 2W is a 1 RU, 19“ device with fully modular architecture and all connection receptacles accessible from the front. Also, it features a high-bandwidth backplane with high aggregation capacity (4 Gbps) and advanced protection mechanisms (ODU, Modem/ IF module and GbE(1)).

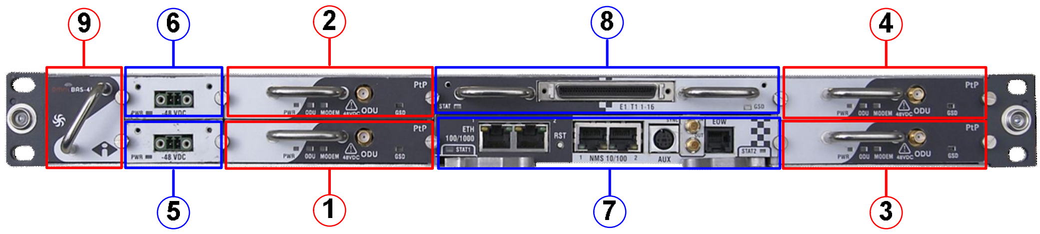
Continued on next page

(1) Only in OmniBAS-4W.

OmniBAS Indoor Equipment (OmniBAS-4W/ 2W), Continued

OmniBAS-4W modules

This paragraph represents the modules that constitute the OmniBAS-4W subrack. The following schematic helps identifying the slots numbering of the subrack.



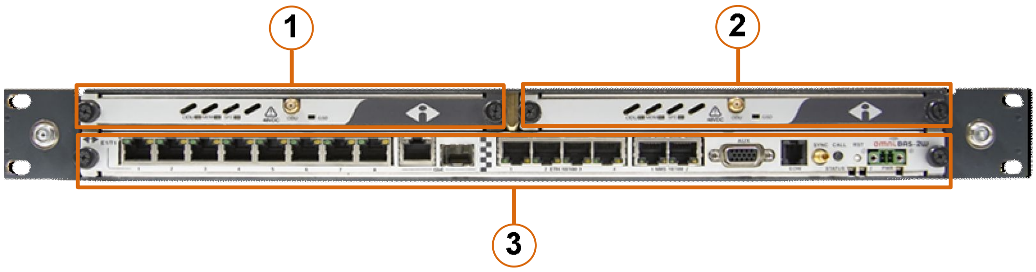
Module	Available Slots	Features
Modem/ IF Module	1, 2, 3, 4	• Native Ethernet unit • Throughput capability up to 400 Mbps • Fully adaptive modulation up to 256 QAM • TDM is carried in MEF8 PseudoWire • DAC, filtering, modulation and frequency up conversion in the transmit path / ADC, demodulation and frequency down conversion in the receive path • Multiplexing/ de-multiplexing between transmit and receive RF signals and service channel implementation between indoor-outdoor equipment
Power Module	5, 6	• Converts –48 V dc voltage to the dc voltage levels required by each component in the unit • Second power module can be added for providing power redundancy
Main Processor Module	7	• Ethernet switch capability • Aggregates all legacy TDM/ ATM and Ethernet traffic • Supports TDM over PseudoWire • Internally redundant for core interfaces
E1 Tributary Module	8	• Up to 16 E1 add drop
Fan Module	9	• Accommodates five fans to protect the housed electronics against overheating • Fully hot swappable

Continued on next page

OmniBAS Indoor Equipment (OmniBAS-4W/ 2W), Continued

OmniBAS-2W modules

OmniBAS-2W contains two slots for Modem/ IF modules and one slot for the Main Control Module. Below, the slots numbering and the modules description of the subrack are represented:



Module	Available Slots	Features
Modem/ IF Module	1, 2	• Native Ethernet unit • Throughput capability up to 400 Mbps • Fully adaptive modulation up to 256 QAM • TDM is carried in MEF8 PseudoWire • DAC, filtering, modulation and frequency up conversion in the transmit path / ADC, demodulation and frequency down conversion in the receive path • Multiplexing/ de-multiplexing between transmit and receive RF signals and service channel implementation between indoor-outdoor equipment • Accommodates one fan to protect the housed electronics against overheating
Main Control Module	3	• Ethernet switch capability • Aggregates all legacy TDM/ ATM and Ethernet traffic • Supports TDM over PseudoWire • Internally redundant for core interfaces • Up to 8 E1 add drop • Converts –48 V dc voltage to the dc voltage levels required by each component in the unit • Fully hot swappable

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OmniBAS Indoor Equipment (OmniBAS-4W/ 2W), Continued

Modules features/ interfaces per OmniBAS model

The following table provides the interfaces of each OmniBAS as well as the differences between them.

Module	Features/ Interfaces	OmniBAS-4W	OmniBAS-2W
Modem/ IF Module	Up to four radio modems (supporting 1+0 /1+1 /2+0 /2+2 /3+0 /4+0 configurations)	√	–
	Up to two radio modems (supporting 1+0 /1+1 /2+0 configurations)	–	√
	XPIC functionality [1]	√	–
Main Processor/ Control Module	GbE (add/ drop, electrical or optical) [2]	x2	x1
	Fast Ethernet	–	x4
	Fast Ethernet for Outband NMS/ Local Craft	x2	x2
	Serial/ Alarm	√	√
	External Sync (in/ out)	√	√
	64 kbit/s EOW	√	√
E1 Tributary Module	E1 add/ drop	x16	x8

(1) Future release

(2) The Main Processor Module of the OmniBAS-4W subrack is available in two versions, one equipped with two electrical GbE ports and one equipped with two optical GbE ports.
The Main Processor Module of the OmniBAS-2W subrack is equipped with one electrical port and one optical port, but only one (electrical or optical) is available at any time.

OmniBAS Outdoor Equipment

Introduction

The outdoor equipment of the OmniBAS system consists of outdoor radios (ODU-CF units) and integrated or standalone parabolic antennas.

The following photo shows an ODU-CF together with a standalone parabolic antenna:

About ODU-CF

OmniBAS system provides a complete family of ODU-CF units covering a wide range of operating frequencies: 6 / 7 / 8 / 11 / 13 / 15 / 18 / 23 / 38 GHz.

The ODU-CF incorporates the radio transceivers featuring capacity up to 400 Mbps. It supports adaptive modulation schemes from QPSK to 256 QAM and channel bandwidths from 7 MHz to 56 MHz. The capacity and modulation agility is achieved without the need of hardware change.

The manufacturer performs the setting of the two ODU-CF units per link according to the duplex spacing and the operation sub-band required by the customer

ODU-CF is environmentally hardened to guarantee quality operation under all conditions. The ODU-CF case meets IP55 requirements, is very rigid and is made of pressure die cast aluminum. It is suitable for mounting on a mast, through a mounting bracket included in the delivered package.

ODU-CF can be mounted directly on an integrated parabolic antenna or it can be connected with a standalone integrated antenna through a flexible, twistable waveguide.

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OmniBAS Outdoor Equipment, Continued

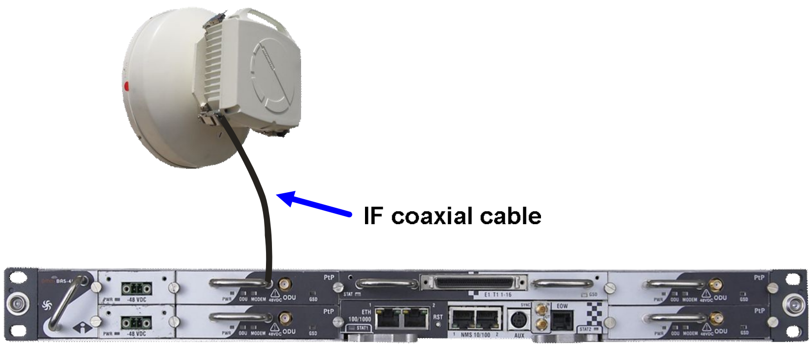
IF cabling

The interconnection between an ODU-CF with a Modem/ IF Module of the OmniBAS-4W/ 2W is performed through a 50 Ω coaxial IF cable.

The IF coaxial cable carries the following signals using frequency-division multiplexing:

- -48 V dc power to the ODU-CF
- Bidirectional Service Channel (S.C.) data, enabling communication between indoor and outdoor units
- 140 MHz Rx IF signal
- 350 MHz Tx IF signal

ODU-CF features female, N-Type receptacle to connect the IF coaxial cable.



Traffic Aggregation Units (OmniWAY-12G/ 2G)

Description

OmniWAY-12G (1) is a traffic aggregation unit used with the OmniBAS system to provide higher-order SDH interfaces (STM-1 VC-12 and VC-4) for network nodes requiring such connectivity.

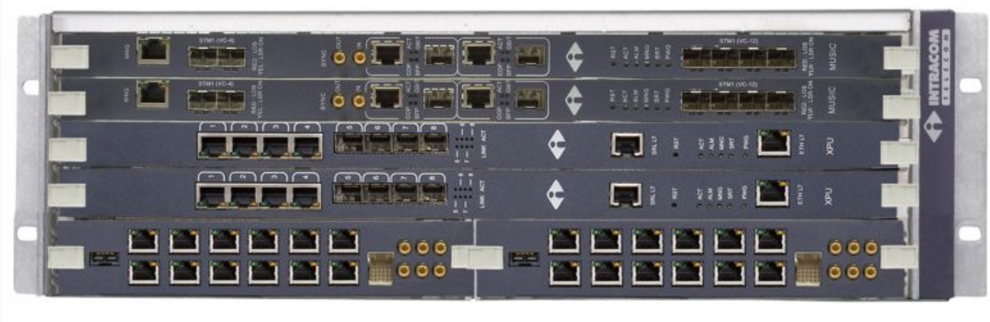
OmniWAY-12G is a 3 RU switch aggregation unit that best fits highly dense nodes requiring the highest level of protection.

Incorporating a powerful Ethernet switch, **OmniWAY-12G** aggregates packet-based traffic from multiple OmniBAS systems and forwards:

- TDM/ ATM traffic toward the SDH network
- Ethernet traffic toward the IP/MPLS network

The fully redundant design of the **OmniWAY-12G** provides complete line and module protection for uninterruptible service delivery.

The following photo shows the **OmniWAY-12G** subrack:



Alternatively, an economical variant constitutes the **OmniWAY-2G** that is a compact (1 RU, 19”) subrack used in case of low traffic aggregation requirements. The following photo shows the **OmniWAY-2G** subrack:

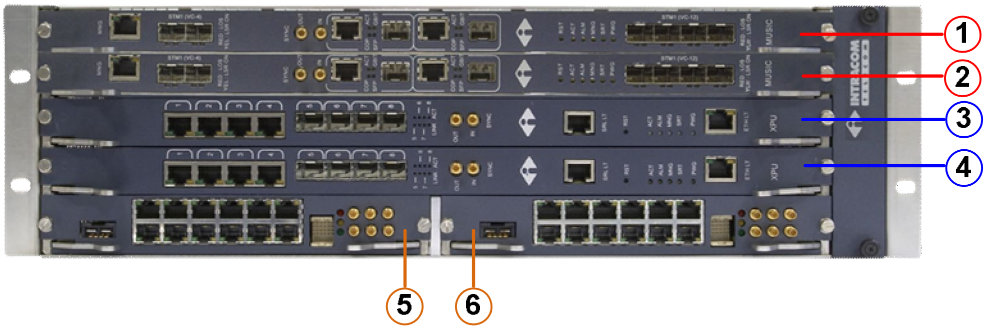
Continued on next page

(1) Future release

Traffic Aggregation Units (OmniWAY-12G/ 2G), Continued

OmniWAY-12G modules

This paragraph represents the modules that constitute the OmniWAY-12G subrack. The following schematic helps identifying the slots numbering of the subrack.



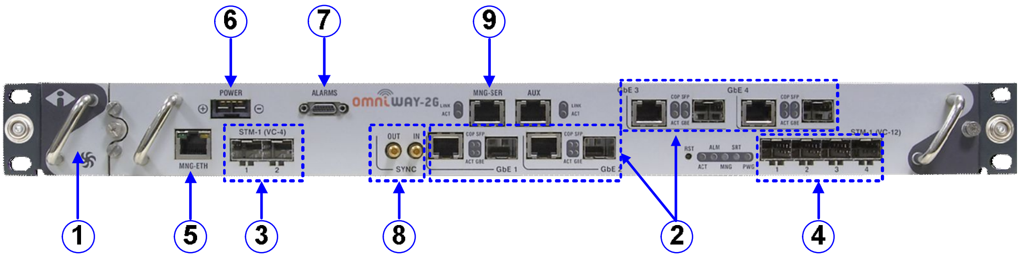
Module	Available Slots	Description
LU-12	1, 2	• Multiple Services Interface Card providing the following interfaces: – Optical SDH interfaces: 2 x STM-1 (VC-4) in 1+1 and 2+0 configurations and 4 x STM-1 (VC-12) in 2+2 configuration – Sync IN/ OUT reference timing ports • Up to two LU-12 cards can be used. The second one is added either to increase the STM-1 interfaces or to provide card protection.
PU-12	3, 4	• Broadband Processing Unit providing the following interfaces: – 4 x GbE electrical Ethernet interfaces – 4 x GbE optical Ethernet interfaces – RS-232 serial interface and Fast Ethernet interface for outband management • Up to two PU-12 cards can be used. The second one is added for providing card protection.
Interface unit	5, 6	• Interface unit providing: – 12 x GbE traffic aggregation interfaces (optical or electrical) – I/O port, for external alarms – 6 x Sync OUT reference timing ports – DC power input • Up to two Interface units can be used. The second one is added for providing protection.

Continued on next page

Traffic Aggregation Units (OmniWAY-12G/ 2G), Continued

OmniWAY-2G front view description

Below, the description of the OmniWAY-2G front view is provided. All connection receptacles of OmniWAY-2G are accessible from the front panel.



Item	Interface
1	Fan module accommodating fans for protecting the housed electronics against overheating during operation.
2	4 x GbE traffic aggregation interfaces (optical or electrical)
3	2 x STM-1 / VC-4 (optical, 2+0 / 1+1)
4	4 x STM-1 / VC-12 (optical, 2+0 / 2+2)
5	Fast Ethernet, for outband management
6	DC power input
7	I/O port, for external alarms
8	Sync IN/ OUT reference timing ports
9	Serial RS-232, for local management

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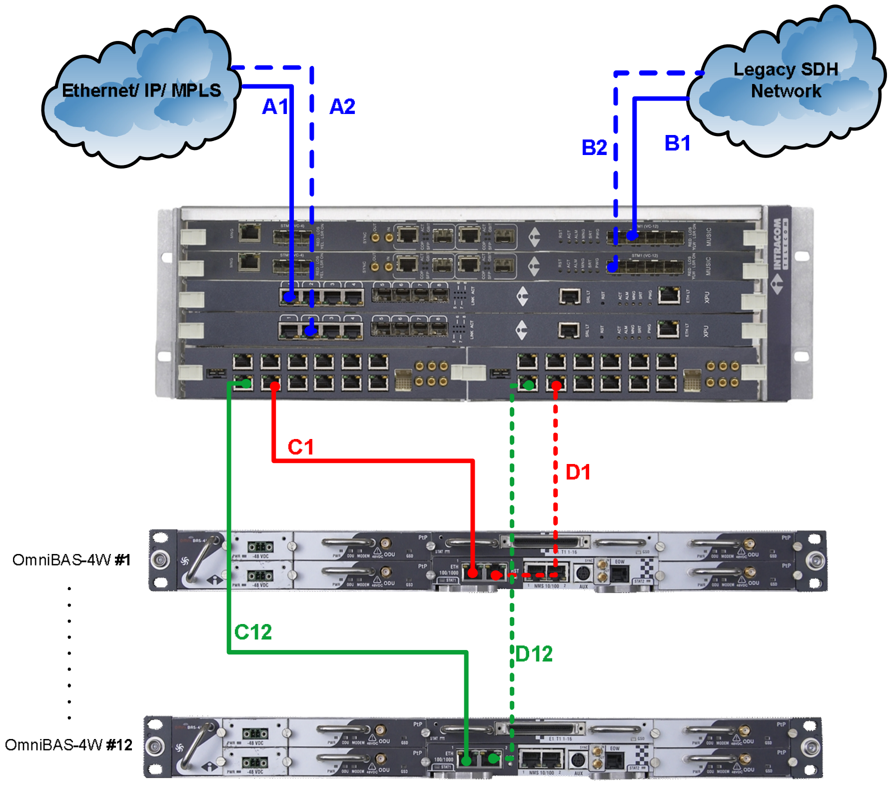
Traffic Aggregation Units (OmniWAY-12G/ 2G), Continued

OmniBAS/ OmniWAY-12G interconnection

As the following schematic shows, the OmniWAY-12G subrack:

- Aggregates packet traffic from multiple OmniBAS systems (up to twelve) through the GbE interfaces of the E1 Tributary Module
- Regarding Ethernet traffic, this is processed by the internal switch of the PU-12 card and forwarded toward the Ethernet/ IP/MPLS network through the GbE interfaces provided by the PU-12 card.
- Regarding legacy traffic, this is first converted internally to packets and then forwarded toward the legacy SDH network through the STM-1/ VC-12 interfaces provided by the LU-12 card.

For protection purposes all OmniWAY cabling with the distribution networks and OmniBAS-4W subracks is duplicated.



Cabling	Description
A1	Uplink working path towards IP/ MPLS network (through GbE interface)
A2	Uplink protected path towards IP/ MPLS network (through GbE interface)
B1	Uplink working path towards legacy SDH network (through STM-1/ VC-12 interface)
B2	Uplink protected path towards legacy SDH network (through STM-1/ VC-12 interface)
C1…C12	Traffic aggregation working path (through GbE interface)
D1…D12	Traffic aggregation protected path (through GbE interface)

Continued on next page

Traffic Aggregation Units (OmniWAY-12G/ 2G), Continued

OmniBAS/ OmniWAY-2G interconnection

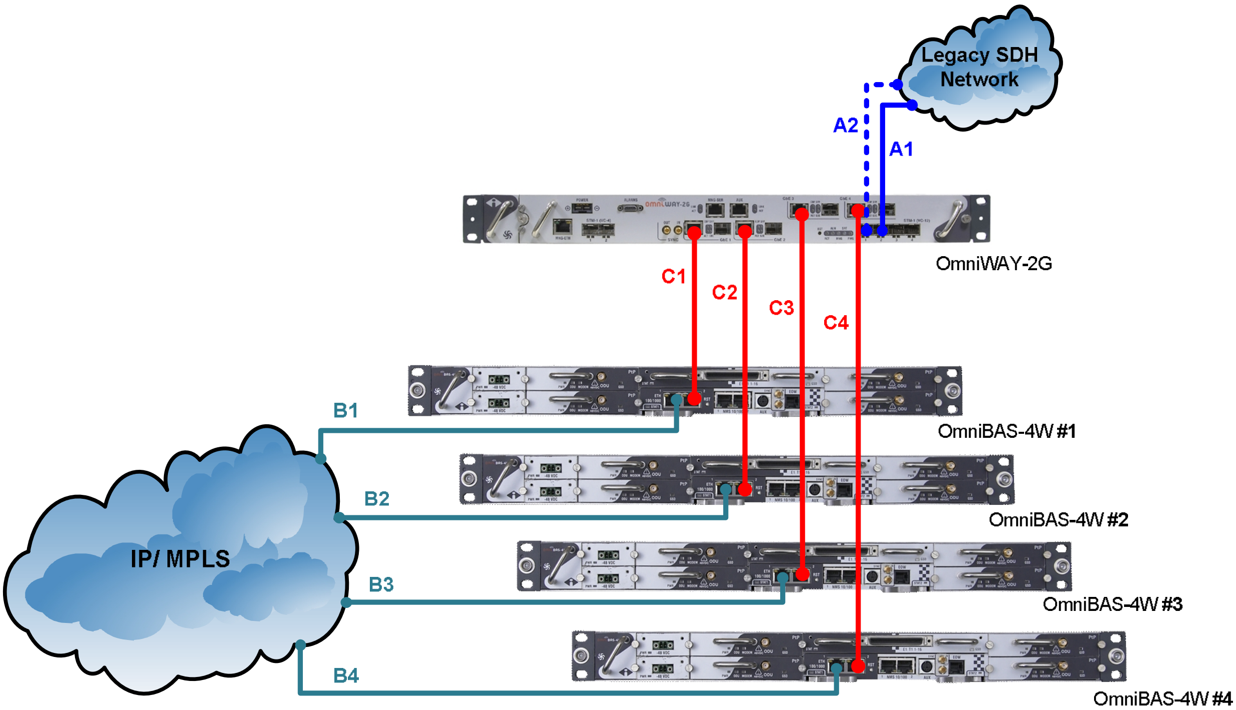
The cabling example depicted in the following schematic shows an OmniWAY-2G subrack that is used for aggregating legacy traffic from four OmniBAS-4W systems.

The interconnection with the OmniWAY-2G is realized through the one available GbE interface of each OmniBAS-4W system.

The OmniWAY-2G subrack:

- Aggregates packet traffic (from the OmniBAS-4W systems) through its GbE interfaces.
- Internally converts packets (associated with legacy traffic) to stream, which is forwarded toward the SDH network through the STM-1 interfaces.

The OmniBAS-4W systems switch and forward packets (associated with Ethernet traffic) toward the IP/MPLS network through the second GbE interface.



Cabling	Description
A1	Uplink working path towards legacy SDH network (through STM-1/ VC-12 interface of the OmniWAY-2G)
A2	Uplink protected path towards legacy SDH network (through STM-1/ VC-12 interface of the OmniWAY-2G)
B1 … B4	Uplink GbE connections toward the IP/MPLS network for Ethernet traffic
C1 … C4	GbE interconnections for carrying packets (associated with legacy-only traffic) toward the OmniWAY-2G

6 Managing OmniBAS Networks

The management of the OmniBAS system can be performed:

- Locally, through the **Local Craft Terminal** application
- Remotely, through the INTRACOM TELECOM's Unified Management Suite (**uni│MS**).

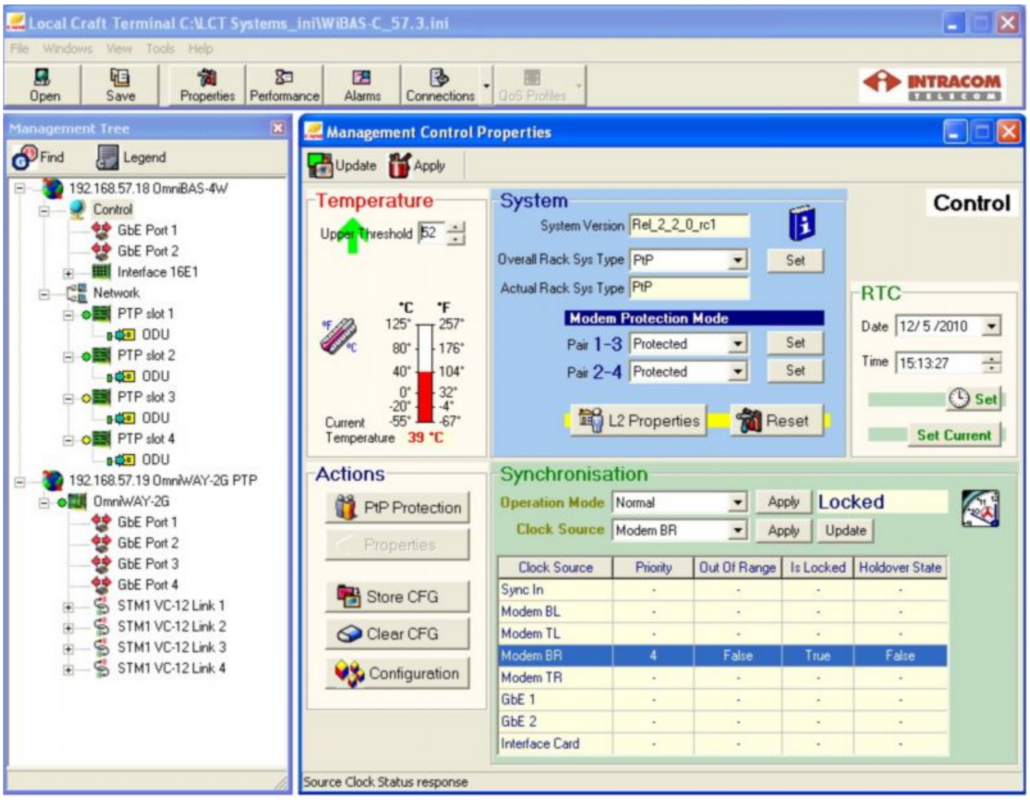
Both management applications provide easy and efficient configuration and monitoring of the OmniBAS system.

6.1 Local Craft Terminal

About LCT GUI

The OmniBAS / OmniWAY Local Craft Terminal is a robust SNMP based application designed to locally manage the OmniBAS and OmniWAY-2G systems.

The Local Craft Terminal application features a user-friendly GUI (see below) displaying the OmniBAS / OmniWAY system elements in a tree structure (left side pane). The parameters of each managed element are also displayed (right side pane) providing efficient monitoring and configuration of the OmniBAS and OmniWAY systems.



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Local Craft Terminal, Continued

Management functions

The following main functions are provided through Local Craft Terminal for the management of the OmniBAS and OmniWAY systems:

- Configuration Management:
  - Monitoring and configuration of OmniBAS elements (processor module, modems, tributary module, fan trays, power supplies, interfaces, ODU-CF units, etc.)
  - Configuration and Monitoring of PtP links
  - Monitoring and configuration of OmniWAY elements (fan trays, power supplies, interfaces, etc.)
  - Setting of the L2 bridging mode
  - Configuration and Monitoring of Ethernet and PW TDM traffic
  - Setting of Ethernet QoS (IEEE 802.1 P/Q priority in a VLAN packet (Layer 2) and DSCP in an IP packet (Layer 3))
  - Setting of static MAC addresses
  - Configuration of systems synchronization
  - Re-configuration of systems in case of interruptions
  - Backup and restore of systems configuration
- Fault Management:
  - Monitoring of system active alarms and events
  - Active alarms and events storage (in log files)
- Test Management:
  - Loopback tests on the E1 lines of the tributary module
  - Loopback tests on the STM-1 / VC-12 ports
- Performance Management:
  - Monitoring of GbE performance
  - Monitoring of Ethernet traffic performance
  - Monitoring of PW TDM traffic performance
  - Monitoring of PW statistics
  - Monitoring of L2 ports performance

6.2 Unified Management Suite (uni|MS)

Overview

Introduction

uni|MS Unified Management Suite constitutes INTRACOM TELECOM's solution for the rapid deployment, efficient supervision and consistent management of telecommunications networks from a centralized location.

uni|MS is a unified, high-scale and carrier-class Element, Network and Service Management suite for all INTRACOM TELECOM products, wireless and wireline, as well as for third party products through add-on drivers.

Highlights

- Platform and vendor independent for low CapEx and OpEx – full Java implementation, not requiring third party operating system or data storage software
- Multi-tier architecture for fitting small and large-scale networks – uni|MS is composed of multiple software server processes that are running into a single hardware server, or distributed to multiple hardware servers for scalability and redundancy; one or more clients provide user interaction
- Open and expandable system for managing new network elements through drivers – new features can be added through add-on application modules
- Flexible and user configurable Graphical User Interface (GUI) with advanced drag-n-drop capabilities
- Advanced security features – hardened operating system ensures compliance to strict NOC security guidelines with fine-grained users, roles & privileges
- Northbound interfaces – various OSS/BSS integration protocols are supported including Web services, SNMP, JAVA and JDBC
- Data-centric design for assured high system performance

Key characteristics

- 24x7 operation – no downtime during backup times
- Real-time status presentation of the managed network
- Collection of inventory-relevant metadata (serial numbers, firmware releases, etc.) from the managed elements
- Remote firmware upgrades (bulk or individual) and configuration backup
- Advanced reporting capabilities; users can define their own reports with SQL and add them in menus – the reports are interactive, i.e. users can perform actions from within the reports
- Detailed event logging regarding user / system / element actions
- Service agnostic workflow engine (standard BPEL 2.0) supporting convergent business logic for service provisioning and activation

Continued on next page

Overview, Continued

Key characteristics (continued)

- Web services / SOAP implementation of SOA allowing the rapid integration with legacy systems
- Incorporated Enterprise Service Bus supporting unlimited number of incoming service provisioning requests and thousands of simultaneous outgoing connections

Layered Architecture

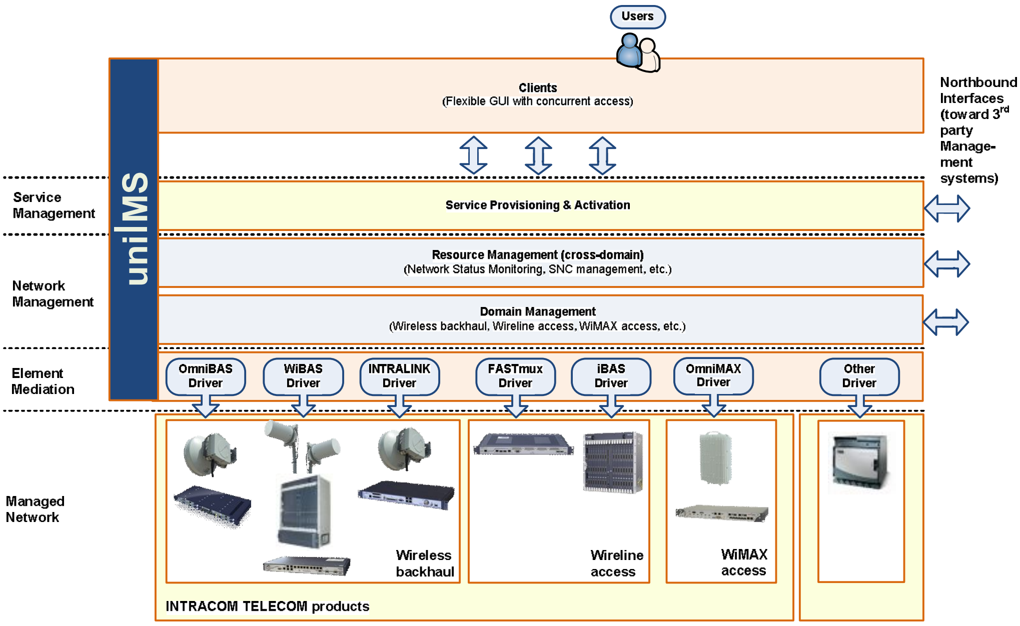
Introduction

uniIMS is a client – server system built on a completely element-independent Java/ J2EE modern framework. uniIMS employs a truly modular software structure design, which allows server processes to be distributed or duplicated, for practically supporting an unlimited number of managed network elements and system users.

Layered architecture

uniIMS's layered architecture is described below:

- **Element Mediation layer,** which provides the communication with the managed elements for applying management functions. Each element type has its own driver; multiple drivers may run concurrently in the same uniIMS server
- **Domain Management layer,** which implements FCPS (Fault - Configuration - Performance - Security) management functions on multiple element types belonging to a technology domain (wireless backhaul domain, WiMAX domain, wireline access domain, etc.)
- **Resource Management layer,** which provides cross-domain management capabilities such as status management, report management, sub-network connection (SNC) management, etc.
- **Service Management layer,** which implements service provisioning and activation functions, via a service agnostic workflow (BPEL) and a design environment, for realizing rapid service provisioning of GSM, CDMA, VoIP, xDSL, IPTV, IMS services
- **Client layer,** which consists of multiple clients running the Graphical User Interface (GUI) concurrently; the clients enable authorized users to interact with uniIMS



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Layered Architecture, Continued

Element Mediation layer

uniIMS's Element Mediation layer consists of drivers, each corresponding to a managed element type.

The drivers implement the communication with the managed elements for applying management functions such as configuration changes, performance counters collection, alarms (traps) collection, service provisioning, inventory collection and others.

Communication with the managed elements is based on various protocols, such as SNMP, HTTP, FTP, CLI, etc.

The management connectivity between uniIMS and the managed elements can be realized in two ways:

- **Outband:** there exists a separate network for management communication completely separate from the network that uniIMS is managing. This external management communication network must provide IP connectivity between the uniIMS server(s) and all managed network elements. The advantage of using an outband connection is that the management communication is not dependent on the state of the managed network
- **Inband:** communication between uniIMS servers and managed network elements is implemented through the managed network itself. Using inband, maintenance of a separate management communication network is not needed. The disadvantage is that management communication is dependent on the state of the managed network

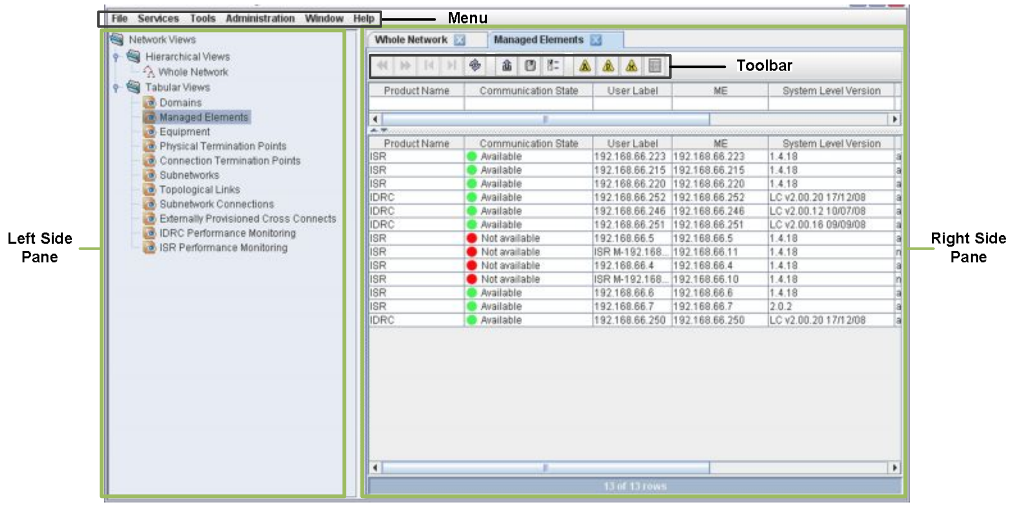
About Graphical User Interface

Introduction

uni|MS features a highly customizable, user-friendly and drag-n-drop-enabled GUI that suites specific user preferences. Users are able to customize the viewing space in their monitors and also apply filtering to the displayed data.

uni|MS GUI representation

The main environment of the uni|MS is shown below:



At the left side pane, uni|MS GUI presents the network in a hierarchical structure displaying all the elements within the managed network in a tree-like manner.

At the right side pane, uni|MS GUI incorporates flexible tabs for helping users manage the way they browse their system reports (e.g. Domains, Managed Elements, Physical Terminations, etc.)

Using uni|MS GUI

The user can create geographical and administration Domains to group elements that are also included in the network hierarchy. Users can add managed elements, as well as sub-networks to Domains with simple drag-n-drop actions. Domains can be hierarchical (Domains into a Domain). Users can easily change the network hierarchy through drag-n-drop. Actions can be performed to both individual elements and to Domains.

Multiple GUI instances can view the same piece of information, which is automatically updated in case of changes in the network. uni|MS ensures that all the GUI clients' views are consistent at all times.

The GUI also incorporates flexible tabs (right side pane) for helping users manage the way they browse their system reports (e.g. Domains, Managed Elements, Physical Terminations, etc.).

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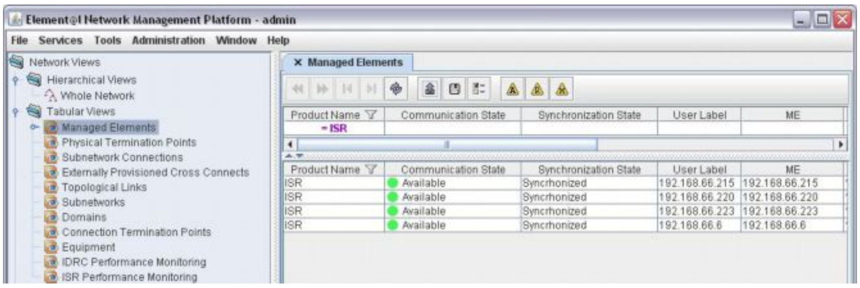
About Graphical User Interface, Continued

Using uni(MS GUI (continued)

The tabs at right side pane also allow quick access to multiple reports concurrently, while the advanced report formatting and filtering capabilities increase convenience during use.



Management Functions

Introduction

This paragraph represents the management functions that the uniIMS provides.

Fault management

uniIMS's Fault Management (FM) is responsible for the detection, isolation and resolution of problems in order to keep the supervised network running at an optimum level, provide a measure of fault tolerance and minimize downtime.

The main functions of uniIMS's fault management include:

- Problem correlation
- Problem visualization
- Problem management

Users can monitor alarms in real-time, while active and historical alarms are stored in the relational database, and are presented with additional views that provide extensive filtering and exporting capabilities.

Configuration management

The main tasks of uniIMS's Configuration Management (CM) include the following:

- Automatic discovery and initial configuration of the network elements and of their components
- Monitoring of network configuration parameters
- Network re-configuration (in case of interruptions)
- Adaptation to planned operational modifications or user requirements
- Configuration backup and restore

Performance management

uniIMS's Performance Management (PM) constitutes a means of measuring the quality of several operating parameters. It ensures that the supervised network is operating as expected and that the available network resources are efficiently allocated.

Performance is determined by a specific period where appropriate measurements are taken on specific network elements (such as ports, traffic connections, etc.).

Within this period, measurement data is collected and stored in the database for later view or further analysis. When necessary, measurement data can be exported to files and presented in a list or graphical form.

Continued on next page

Management Functions, Continued

Security management

uniIMS's Security Management (SM) is responsible to protect both the entire network and the managed elements against intentional or accidental abuse, unauthorized access and communication loss.

Security management is also responsible to set constraints per managed element according to the TMF MTNM specifications.

uniIMS incorporates enhanced security features:

- Security customizable per user (username / password – role – assigned domains – allowed actions), according to predefined templates
- Configurable security event logging, regarding user activities, based on several logging criteria

Test management

uniIMS's Test Management (TEM) is responsible for localizing faults, dispatching corrective actions and preventively detecting possible trouble spots within the managed network.

The uniIMS's testing capabilities, which include BER tests, setting of loopbacks, etc., are provided by the add-on drivers of the managed elements.

uniIMS manages test execution and progress, while test results are presented in real-time.

Inventory management

uniIMS's Inventory Management (IVM) provides to users an overview of the installed equipment together with its location.

uniIMS's IM facilitates this task by automatically collecting hardware and software information from the managed elements and storing them in a database for later view or export to other systems.

Software management

The uniIMS's software management capabilities enable the remote and centralized software update of the managed elements for keeping network's operational status up-to-date, or for adding new management features.

Add-on Applications

Network status management

uniIMS's Status Management (SM) allows users monitor the operational status of the network in real-time through an integrated graphical map-view. This map-view provides a view of the managed elements in their geographical location together with visual information of the elements' operational and fault status.

uniIMS's network status management also provides a graphical representation of the elements' physical layout (including subracks, cards, etc.), which is interactive to enable fault and configuration management capabilities.

The uniIMS's network status management features include:

- Vector background maps with representation of domains
- Displaying real-time operational and alarm status information
- Realistic representation of equipment with real-time alarm status
- Zoom-in / zoom-out capabilities (resizing)
- Drill-in / drill-out capabilities to display underneath entities (e.g. elements of a domain, cards of an element, etc.)
- Hide / show capabilities for nodes, cards, shelves, etc.
- Showing links between the displayed elements

SNC management

uniIMS's Sub-Network Connection (SNC) Management allows users to create and manage sub-networks and their connections.

Combined with uniIMS's Status Management (SM), users can add sub-networks, topological links and create ATM, TDM and Ethernet connections that can be monitored in a graphical circuit layout with real-time alarm indications and drill-in and drill-out capabilities.

Sub-networks, topological links and sub-network connections are created through intuitive wizards and can then be validated, activated / deactivated and deleted.

Report management

uniIMS's Report Management (REM) is an add-on application that allows users to create ad-hoc reports. These reports are listed in the left-side pane for quick navigation and are organized in folders to suit specific user preferences. Reports are presented in tabular form showing element-relevant data retrieved from the uniIMS database.

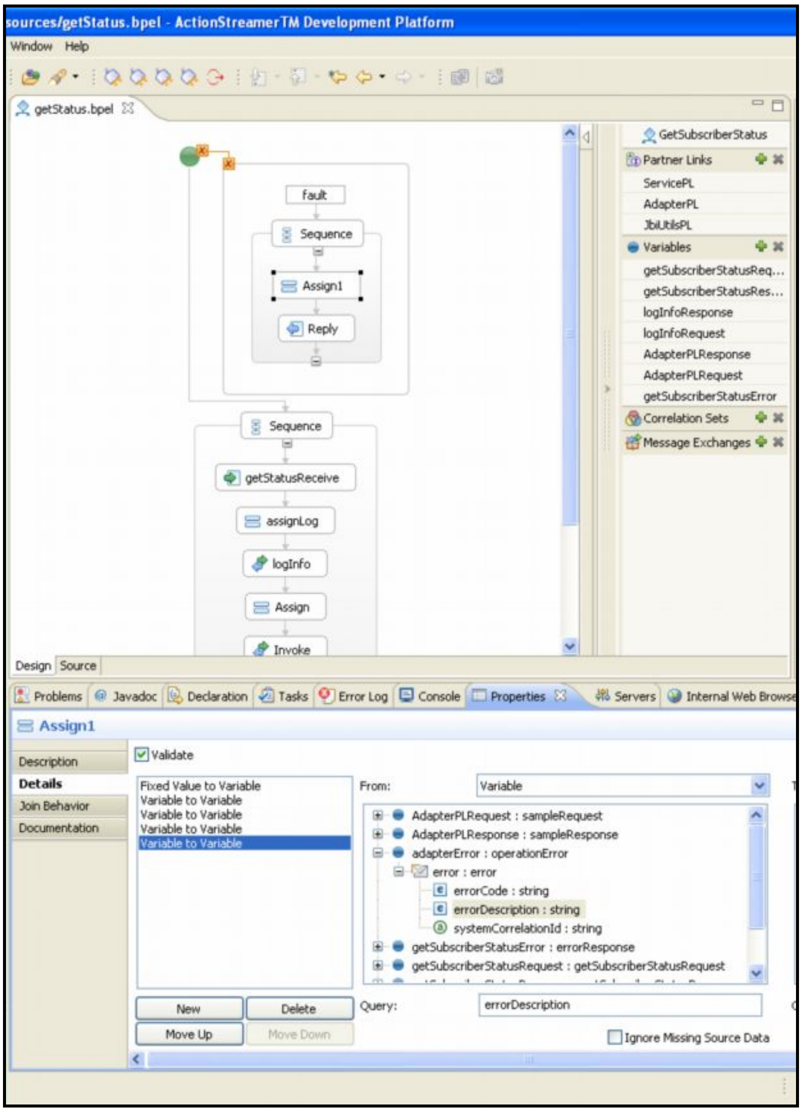
Users are provided with a graphical presentation of the relational database that makes report design much more convenient. This way, users can view the database structure, run SQL queries and finally view the results.

Service Provisioning

uniIMS provides convergent service provisioning capabilities addressing the need for automated service provisioning across multi-vendor networks and diverse IT environments.

uniIMS's ActionStreamer™ is an integrated service provisioning toolkit for the mobile or fixed operator needing to rapidly introduce new services across their existing OSS / BSS and network infrastructure.

ActionStreamer™ makes service provisioning an easy and intuitive task through a graphical, BPEL standard (BPEL 2.0) workflow environment (see screenshot below) that allows users to fully design, create, build, package, test and deploy new business processes, or modify existing ones.



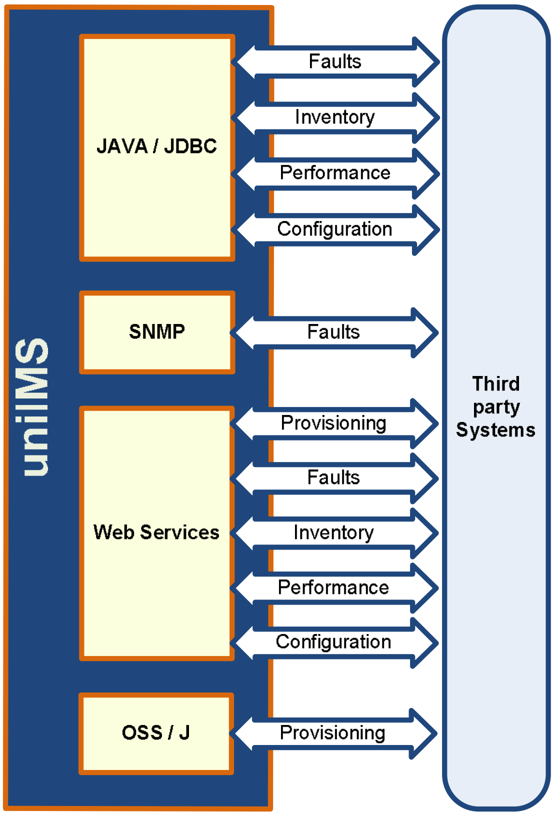
Integration with 3rd Party Systems

uniIMS ensures rapid plug-and-play integration with external OSS or third party management systems through its open architecture, which supports scalability, extendibility and smooth integration with external systems.

Off-the-self integration is provided through standardized northbound interfaces, including Web Services, JAVA, JDBC and SNMP. These interfaces fully cover the management functions (configuration, fault, performance, inventory and service provisioning), as required for integrated management.

uniIMS provides EMS to NMS integration (through Web Services), according to the Tele-management Forum's MTNM standard.

uniIMS is easily integrated with Order management systems to realize service provisioning via the open SOA architecture and Web Services interface. Order activation is realized through integration with other third party Element Management Systems (EMS), or directly with Network Elements.



7 Technical Specifications

This chapter provides the technical specifications of the OmniBAS system.
The chapter includes the following sections:

7.1 OmniBAS System Specifications

General

Specification	Description
Operating Frequency Bands	6 / 7 / 8 / 11 / 13 / 15 / 18 / 23 / 38 GHz
Modulation (adaptive) Schemes	4 / 8 / 16 / 32 / 64 / 128 / 256 QAM
Channel Size	7 / 14 / 28 / 56 MHz
Link Modes	• 1+0 / 2+0 • 1+1 (HSB/ SD/ FD) • 3+0 / 4+0 (OmniBAS-4W only) • 2+2 (HSB/ SD/ FD) (OmniBAS-4W only)
Operating DC Voltage	-40 V to -60 V (-48 V typ.)
Operating Temperature	-5 °C to 45 °C
Relative Humidity	10% to 95%, non-condensing

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OmniBAS System Specifications, Continued

Networking

Specification	Description
TDM	• ITU-T G.703 / G.736 / G.775 / G.823 • ITU-T G.783
Ethernet	• IEEE 802.3u (100 Mbit/s electrical) • IEEE 802.3z (1000 Mbit/s optical) • IEEE 802.3ab (1000 Mbit/s electrical) • IEEE 802.1q (Virtual LAN) • IEEE 802.1p (QoS) • IEEE 802.1ad (Provider bridging)
Ethernet Synchronization	• Synchronous ETH • IEEE 1588v2 (1)
Ethernet Ring Protection	ITU-T G.8032
STM-1 (VC-12 / VC-4)	ITU-T G.707 / G.781 / G.783
L2 Bridging Modes	• C VLAN • S-VLAN transparent • S-VLAN provider
QoS	• per ETH port • per VLAN • per p-bit • DSCP

Standards

Specification	Description
EMC	• ETSI EN 301 489–1 v1.6.1 (2002-09) • ETSI EN 301 489–4 v1.3.1 (2002-08)
Electrical Safety	EN 60950-1:2001
Resistibility	ITU K.20
Environmental	• Operation: ETSI EN 300 019-2-3 v2.1.2:2003, Class 3.2 • Transportation: ETSI EN 300 019-2-2 v2.1.2:1999, Class 2.3 • Storage: ETSI EN 300 019-2-1 v2.1.2:2000, Class 1.1
Radio	ETSI EN 302 217-2-2

(1) Future release

7.2 Indoor Equipment Specifications

This paragraph provides the technical specifications of the following units:

- OmniBAS-4W/ 2W
- OmniWAY-12G
- OmniWAY-2G

OmniBAS-4W/ 2W

Technical specifications

Specification	OmniBAS-4W	OmniBAS-2W
Max. Bitrate (gross) (Mbit/s)	1600	800
Operating DC Voltage (V)	-40 to -60 (-48 typ.)	
Max. Power Consumption (W) (*)	87 (for 4+0 configuration without XPIC)	46 (for 2+0 configuration)
Dimensions (mm)	45 (1U) x 437 x 284.7	45 (1U) x 407 x 240
Weight (kg)	8.4	8
Operating Temperature	-5 ºC to 45 ºC	
Humidity (at 30 ºC)	10% to 95%, non-condensing	

Interfaces

Interface	OmniBAS-4W	OmniBAS-2W
GbE (optical or electrical)	2	1
E1	16	8
Fast Ethernet	–	4
Fast Ethernet for Outband NMS/ Local Craft	2	2
Sync IN / OUT	1	1
Serial RS-232 (I/O port for alarms)	1	1
EOW (Engineering Order Wire)	1	1

(*) Plus the power consumption of the interconnected ODU-CF

OmniWAY-12G

Technical specifications

Specification	Description
Operating DC Voltage (V)	-40 to -60 (-48 typ.)
Maximum Power Consumption (W)	300
Dimensions (mm)	133.5 (3U) x 437 x 265
Weight (kg)	13.5
Operating Temperature	-5 ºC to 45 ºC
Humidity (at 30 ºC)	10% to 95%, non-condensing

Interfaces

- 12 x GbE, electrical (traffic aggregation)
- 8 x GbE (four electrical & four optical)
- 4 x STM-1 / VC-12 (optical, 2+0 / 2+2)(*)
- 2 x STM-1 / VC-4 (optical, 2+0 / 1+1) (*)
- Fast Ethernet (outband management)
- External I/O
- 12 x Sync OUT & 1 Sync IN

OmniWAY-2G

Technical specifications

Specification	Description
Operating DC Voltage (V)	-40 to -60 (-48 typ.)
Maximum Power Consumption (W)	80
Dimensions (mm)	45 (1U) x 437 x 245
Weight (kg)	6.5
Operating Temperature	-5 ºC to 45 ºC
Humidity (at 30 ºC)	10% to 95%, non-condensing

Interfaces

- 4 x GbE, optical or electrical (traffic aggregation)
- 4 x STM-1 / VC-12 (optical, 2+0 / 2+2)
- 2 x STM-1 / VC-4 (optical, 2+0 / 1+1)
- Fast Ethernet (outband management)
- Serial RS-232
- External I/O
- Sync IN / OUT

(*) Interfaces are also protected at card-level.

7.3 ODU-CF Specifications

This section provides the technical specifications of the ODU-CF units (General Specifications and Specifications per ODU-CF Model).

General Specifications

Electrical

Specification	Description
Output Power Accuracy (max.)	• ± 1.5 dB (+25 °C) • ± 2 dB (-33 °C to +55 °C)
RSSI (RSL) Accuracy (typ.)	• ± 2 dB (+25 °C) • ± 3 dB (-33 °C to +55 °C)
Max. Rx Level (No Damage)	10 dBm
Frequency Stability (max.)	± 7 ppm
Frequency Resolution	250 kHz
Input Voltage (*)	-48 V (-40 V to –60 V)
Safety	EN 60950
EMC	ETSI EN 301489-1, ETSI EN 301489-4
RoHS	2002/ 95/ EC

Environmental

Specification	Description
Operating Temperature	-33 °C to +55 °C (ETSI EN 300 019-2-4 V2.1.2, Class 4.1) / Operational at -50 °C
Transportation & Storage Temperature	-40 °C to +70 °C (ETSI EN 300 019-2-2 V2.1.2, Class 2.3)
Relative Humidity (at 30 ºC)	90% to 100% (condensation), 93% (steady state) (ETSI EN 300 019-2-4 V2.1.2, Class 4.1)

Mechanical

Specification	ODU-CF					
	6 GHz	7/ 8 GHz	11/ 13 GHz	15 GHz	18/ 23 GHz	38 GHz
Dimensions (H x W x D) (mm)	250 x 247 x 106		237 x 247 x 89			
Weight (kg)	< 6		< 4			
Input Flange	UBR70	UBR84	UBR120	UBR140	UBR220	UBR320

(*) The ODU-CF is power supplied from the OmniBAS-4W/ 2W through the IF coaxial cable.

Specifications per ODU-CF Model

6 GHz Band

Specification	Description						
	256 QAM	**128 QAM**	**64 QAM**	**32 QAM**	**16 QAM**	**8 PSK**	**4 QAM**
Frequency Band	5.9 GHz to 7.1 GHz						
RF Channel Arrangement	ITU-R F.383/ 384						
Tx/ Rx Spacing (Duplex Spacing)	252 / 240 / 340 MHz						
Power Consumption	34 W (Typ.)						
Radio Perform. ETSI standard	ETSI EN 302 217-2-2						
Tx Output Power (upper) (dBm)	21	23	24	26	27	28	29
Tx Output Power (lower) (dBm)	9						
ATPC Range (dB)	12	14	15	17	18	19	20
Rx Overload at BER 10^{-6} (dBm, typ.)	-18	-17	-17	-15	-14	-13	-11

7 GHz Band

Specification	Description						
	256 QAM	**128 QAM**	**64 QAM**	**32 QAM**	**16 QAM**	**8 PSK**	**4 QAM**
Frequency Band	7.1 GHz to 7.9 GHz						
RF Channel Arrangement	ITU-R F.385-8						
Tx/ Rx Spacing (Duplex Spacing)	154 / 161 / 168 / 245 MHz						
Power Consumption	34 W (Typ.)						
Radio Perform. ETSI standard	ETSI EN 302 217-2-2						
Tx Output Power (upper) (dBm)	20	22	23	25	26	27	28
Tx Output Power (lower) (dBm)	9						
ATPC Range (dB)	11	13	14	16	17	18	19
Rx Overload at BER 10^{-6} (dBm, typ.)	-18	-17	-17	-15	-14	-13	-11

Continued on next page

Specifications per ODU-CF Model, Continued

8 GHz Band

Specification	Description						
	256 QAM	128 QAM	64 QAM	32 QAM	16 QAM	8 PSK	4 QAM
Frequency Band	7.7 GHz to 8.5 GHz						
RF Channel Arrangement	ITU-R F.386-6						
Tx/ Rx Spacing (Duplex Spacing)	119 / 126 / 266 MHz						
Power Consumption	34 W (Typ.)						
Radio Perform. ETSI standard	ETSI EN 302 217-2-2						
Tx Output Power (upper) (dBm)	19	21	22	24	25	26	27
Tx Output Power (lower) (dBm)	9						
ATPC Range (dB)	10	12	13	15	16	17	18
Rx Overload at BER 10^{-6} (dBm, typ.)	-18	-17	-17	-15	-14	-13	-11

11 GHz Band

Specification	Description						
	256 QAM	128 QAM	64 QAM	32 QAM	16 QAM	8 PSK	4 QAM
Frequency Band	10.7 GHz to 11.7 GHz						
RF Channel Arrangement	ITU-R F.387-7						
Tx/ Rx Spacing (Duplex Spacing)	490 / 530 MHz						
Power Consumption	26 W (Typ.)						
Radio Perform. ETSI standard	ETSI EN 302 217-2-2						
Tx Output Power (upper) (dBm)	19	21	22	24	25	26	27
Tx Output Power (lower) (dBm)	7						
ATPC Range (dB)	12	14	15	17	18	19	20
Rx Overload at BER 10^{-6} (dBm, typ.)	-18	-17	-17	-15	-14	-13	-11

Continued on next page

Specifications per ODU-CF Model, Continued

13 GHz Band

Specification	Description						
	256 QAM	128 QAM	64 QAM	32 QAM	16 QAM	8 PSK	4 QAM
Frequency Band	12.75 GHz to 13.25 GHz						
RF Channel Arrangement	ITU-R F.497-6						
Tx/ Rx Spacing (Duplex Spacing)	266 MHz						
Power Consumption	26 W (Typ.)						
Radio Perform. ETSI standard	ETSI EN 302 217-2-2						
Tx Output Power (upper) (dBm)	16	18	19	21	22	23	24
Tx Output Power (lower) (dBm)	7						
ATPC Range (dB)	9	11	12	14	15	16	17
Rx Overload at BER 10^{-6} (dBm, typ.)	-18	-17	-17	-15	-14	-13	-11

15 GHz Band

Specification	Description						
	256 QAM	128 QAM	64 QAM	32 QAM	16 QAM	8 PSK	4 QAM
Frequency Band	14.5 GHz to 15.35 GHz						
RF Channel Arrangement	ITU-R F.636-3						
Tx/ Rx Spacing (Duplex Spacing)	420 / 490 / 728 MHz						
Power Consumption	23 W (Typ.)						
Radio Perform. ETSI standard	ETSI EN 302 217-2-2						
Tx Output Power (upper) (dBm)	16	18	19	21	22	23	24
Tx Output Power (lower) (dBm)	7						
ATPC Range (dB)	9	11	12	14	15	16	17
Rx Overload at BER 10^{-6} (dBm, typ.)	-18	-17	-17	-15	-14	-13	-11

Continued on next page

Specifications per ODU-CF Model, Continued

18 GHz Band

Specification	Description						
	256 QAM	128 QAM	64 QAM	32 QAM	16 QAM	8 PSK	4 QAM
Frequency Band	17.7 GHz to 19.7 GHz						
RF Channel Arrangement	ITU-R F.595-8						
Tx/ Rx Spacing (Duplex Spacing)	1008 / 1010 MHz						
Power Consumption	23 W (Typ.)						
Radio Perform. ETSI standard	ETSI EN 302 217-2-2						
Tx Output Power (upper) (dBm)	16	18	19	21	22	23	24
Tx Output Power (lower) (dBm)	7						
ATPC Range (dB)	9	11	12	14	15	16	17
Rx Overload at BER 10^{-6} (dBm, typ.)	-18	-17	-17	-15	-14	-13	-11

23 GHz Band

Specification	Description						
	256 QAM	128 QAM	64 QAM	32 QAM	16 QAM	8 PSK	4 QAM
Frequency Band	21.2 GHz to 23.6 GHz						
RF Channel Arrangement	ITU-R F.637-3						
Tx/ Rx Spacing (Duplex Spacing)	1008 / 1232 MHz						
Power Consumption	23 W (Typ.)						
Radio Perform. ETSI standard	ETSI EN 302 217-2-2						
Tx Output Power (upper) (dBm)	15	17	18	20	21	22	23
Tx Output Power (lower) (dBm)	6						
ATPC Range (dB)	9	11	12	14	15	16	17
Rx Overload at BER 10^{-6} (dBm, typ.)	-18	-17	-17	-15	-14	-13	-11

Continued on next page

Specifications per ODU-CF Model, Continued

38 GHz Band

Specification	Description						
	256 QAM	**128 QAM**	**64 QAM**	**32 QAM**	**16 QAM**	**8 PSK**	**4 QAM**
Frequency Band	37.0 GHz to 39.5 GHz						
RF Channel Arrangement	ITU-R F.749-2						
Tx/ Rx Spacing (Duplex Spacing)	1260 MHz						
Power Consumption	23 W (Typ.)						
Radio Perform. ETSI standard	ETSI EN 302 217-2-2						
Tx Output Power (upper) (dBm)	13	15	16	18	19	20	21
Tx Output Power (lower) (dBm)	6						
ATPC Range (dB)	7	9	10	12	13	14	15
Rx Overload at BER 10^{-6} (dBm, typ.)	-19	-18	-18	-16	-15	-14	-12

7.4 Radio & Modem Performance

Introduction

This section provides the radio and modem performance of the OmniBAS system, inclusive of:

- Rx Thresholds
- System Gain
- Net Throughput
- Link Ranges

Configuration scenarios for OmniBAS performance

The radio and modem performance provided in this section concerns the following configuration scenarios of the OmniBAS system:

- Max. Robustness Configuration
- Optimized Robustness/ Capacity Configuration
- Max. Capacity Configuration

Next table describes the three different configuration scenarios of the OmniBAS system:

Continued on next page

Radio & Modem Performance, Continued

Configuration scenarios for OmniBAS performance (continued)

		OmniBAS System Configuration Scenarios		
		Max. Robustness	**Optimized Robustness / Capacity**	**Max. Capacity**
Characteristics	Symbol Rate	Min.	Intermediate	Max.
	FEC overhead	Max.	Intermediate	Min.
	Adaptive modulation switching margins	Max.	Intermediate	Min.
Effects	Radio	Conformance with the steepest spectral mask using 0.25 rolloff factor. 1 dB higher transmit power than Optimized Robustness/ Capacity configuration.	Conformance with spectral masks using 0.15 rolloff factor. 1 dB lower transmit power than Max. Robustness configuration	Same transmit power as Optimized Robustness/ Capacity configuration.
	Sensitivity	Max., due to the highest FEC overhead). *0.5 dB higher sensitivity than Optimized Robustness/ Capacity configuration.*	Normal, due to the intermediate FEC overhead.	Min., due to the lowest FEC overhead. *0.5 dB lower sensitivity than Optimized Robustness/ Capacity configuration.*
	Immunity in variable channel conditions	Increased	Normal	Smaller
Typical Applications		Maximum transmit power applications (long haul, over-sea paths). Best for frequency congested applications.	Normal capacity applications. Suitable for frequency congested applications.	Maximum capacity applications. Not suitable for frequency congested applications.
		Maximum system gain applications (long-haul, over-sea paths).	Normal system gain applications (sort, medium-haul paths).	Normal system gain applications (sort, medium -haul paths).
		Maximum link reliability applications. Best for fast and deep fading paths	Normal link reliability applications. Suitable for fast and deep fading paths.	Less demanding link reliability applications. Not suitable for fast and deep fading paths.

Rx Thresholds

Introduction

This paragraph provides the OmniBAS Rx Thresholds (at BER = 10^{-6}) for the following cases:

Case	Modulation Type	OmniBAS Configuration Scenarios	Frequency Bands
Case #1	Fixed	Max. Robustness Configuration	All available frequency bands (6 / 7 / 8 /11 / 13 /15 / 18 / 23 / 38 GHz)
Case #2	Adaptive		
Case #3	Fixed	Optimized Robustness/ Capacity Configuration	
Case #4	Adaptive		
Case #5	Fixed	Max. Capacity Configuration	
Case #6	Adaptive		

For the description of the OmniBAS configuration scenarios, see par. Configuration scenarios for OmniBAS performance, on page 56.

Continued on next page

Rx Thresholds, Continued

Case #1

The following table provides the Rx Threshold values of an OmniBAS system in case of Max. Robustness Configuration and Fixed Modulation:

Rx Threshold (dBm) at BER=10^{-6} for Max. Robustness Configuration & Fixed Modulation				
Modulation	**Ch. Size**	**ODU-CF**		
		6 /7 /8 /11 /13 /15 GHz	**18 / 23 GHz**	**38 GHz**
256 QAM	56 MHz	-68.8	-67.8	-66.3
	28 MHz	-71.8	-70.8	-69.3
	14 MHz	-74.8	-73.8	-72.3
	7 MHz	-77.8	-76.8	-75.3
128 QAM	56 MHz	-71.1	-70.1	-68.6
	28 MHz	-74.1	-73.1	-71.6
	14 MHz	-77.1	-76.1	-74.6
	7 MHz	-80.1	-79.1	-77.6
64 QAM	56 MHz	-73.8	-72.8	-71.3
	28 MHz	-76.8	-75.8	-74.3
	14 MHz	-79.8	-78.8	-77.3
	7 MHz	-82.8	-81.8	-80.3
32 QAM	56 MHz	-76.2	-75.2	-73.7
	28 MHz	-79.2	-78.2	-76.7
	14 MHz	-82.2	-81.2	-79.7
	7 MHz	-85.2	-84.2	-82.7
16 QAM	56 MHz	-79.7	-78.7	-77.2
	28 MHz	-82.7	-81.7	-80.2
	14 MHz	-85.7	-84.7	-83.2
	7 MHz	-88.7	-87.7	-86.2
8 PSK	56 MHz	N/A	N/A	N/A
	28 MHz	N/A	N/A	N/A
	14 MHz	N/A	N/A	N/A
	7 MHz	N/A	N/A	N/A
4 QAM Low FEC	56 MHz	-85.3	-84.3	-82.8
	28 MHz	-88.3	-87.3	-85.8
	14 MHz	-91.3	-90.3	-88.8
	7 MHz	-94.3	-93.3	-91.8
4 QAM High FEC	56 MHz	-87.6	-86.6	-85.1
	28 MHz	-90.6	-89.6	-88.1
	14 MHz	-93.6	-92.6	-91.1
	7 MHz	-96.6	-95.6	-94.1

Continued on next page

Rx Thresholds, Continued

Case #2

The following table provides the Rx Threshold values of an OmniBAS system for Max. Robustness Configuration and Adaptive Modulation:

Rx Threshold (dBm) at BER=10^{-6} for Max. Robustness Configuration & Adaptive Modulation				
Modulation	**Ch. Size**	**ODU-CF**		
		6 /7 /8 /11 /13 /15 GHz	**18 / 23 GHz**	**38 GHz**
256 QAM	56 MHz	-60.6	-59.6	-58.1
	28 MHz	-63.6	-62.6	-61.1
	14 MHz	-66.6	-65.6	-64.1
	7 MHz	-69.6	-68.6	-67.1
128 QAM	56 MHz	-62.9	-61.9	-60.4
	28 MHz	-65.9	-64.9	-63.4
	14 MHz	-68.9	-67.9	-66.4
	7 MHz	-71.9	-70.9	-69.4
64 QAM	56 MHz	-65.6	-64.6	-63.1
	28 MHz	-68.6	-67.6	-66.1
	14 MHz	-71.6	-70.6	-69.1
	7 MHz	-74.6	-73.6	-72.1
32 QAM	56 MHz	-68.0	-67.0	-65.5
	28 MHz	-71.0	-70.0	-68.5
	14 MHz	-74.0	-73.0	-71.5
	7 MHz	-77.0	-76.0	-74.5
16 QAM	56 MHz	-71.5	-70.5	-69.0
	28 MHz	-74.5	-73.5	-72.0
	14 MHz	-77.5	-76.5	-75.0
	7 MHz	-80.5	-79.5	-78.0
8 PSK	56 MHz	N/A	N/A	N/A
	28 MHz	N/A	N/A	N/A
	14 MHz	N/A	N/A	N/A
	7 MHz	N/A	N/A	N/A
4 QAM Low FEC	56 MHz	-77.1	-76.1	-74.6
	28 MHz	-80.1	-79.1	-77.6
	14 MHz	-83.1	-82.1	-80.6
	7 MHz	-86.1	-85.1	-83.6
4 QAM High FEC	56 MHz	-87.6	-86.6	-85.1
	28 MHz	-90.6	-89.6	-88.1
	14 MHz	-93.6	-92.6	-91.1
	7 MHz	-96.6	-95.6	-94.1

Continued on next page

Rx Thresholds, Continued

Case #3

The following table provides the Rx Threshold values of an OmniBAS system for Optimized Robustness/ Capacity Configuration and Fixed Modulation:

Rx Threshold (dBm) at BER=10^{-6} for Optimized Robustness/ Capacity Configuration & Fixed Modulation				
Modulation	**Ch. Size**	**ODU-CF**		
		6 /7 /8 /11 /13 /15 GHz	**18 / 23 GHz**	**38 GHz**
256 QAM	56 MHz	-67.4	-66.4	-64.9
	28 MHz	-70.2	-69.2	-67.7
	14 MHz	-73.3	-72.3	-70.8
	7 MHz	-76.3	-75.3	-73.8
128 QAM	56 MHz	-69.9	-68.9	-67.4
	28 MHz	-72.7	-71.7	-70.2
	14 MHz	-75.8	-74.8	-73.3
	7 MHz	-78.8	-77.8	-76.3
64 QAM	56 MHz	-72.5	-71.5	-70.0
	28 MHz	-75.3	-74.3	-72.8
	14 MHz	-78.4	-77.4	-75.9
	7 MHz	-81.4	-80.4	-78.9
32 QAM	56 MHz	-75.0	-74.0	-72.5
	28 MHz	-77.8	-76.8	-75.3
	14 MHz	-80.9	-79.9	-78.4
	7 MHz	-83.9	-82.9	-81.4
16 QAM	56 MHz	-78.4	-77.4	-75.9
	28 MHz	-81.2	-80.2	-78.7
	14 MHz	-84.3	-83.3	-81.8
	7 MHz	-87.3	-86.3	-84.8
8 PSK	56 MHz	-81.3	-80.3	-78.8
	28 MHz	-84.1	-83.1	-81.6
	14 MHz	-87.2	-86.2	-84.7
	7 MHz	-90.2	-89.2	-87.7
4 QAM Low FEC	56 MHz	-84.9	-83.9	-82.4
	28 MHz	-87.7	-86.7	-85.2
	14 MHz	-90.8	-89.8	-88.3
	7 MHz	-93.8	-92.8	-91.3
4 QAM High FEC	56 MHz	-87.3	-86.3	-84.8
	28 MHz	-90.1	-89.1	-87.6
	14 MHz	-93.2	-92.2	-90.7
	7 MHz	-96.2	-95.2	-93.7

Continued on next page

Rx Thresholds, Continued

Case #4

The following table provides the Rx Threshold values of an OmniBAS system for Optimized Robustness/ Capacity Configuration and Adaptive Modulation:

Rx Threshold (dBm) at BER=10^{-6} for Optimized Robustness/ Capacity Configuration & Adaptive Modulation				
Modulation	**Ch. Size**	**ODU-CF**		
		6 /7 /8 /11 /13 /15 GHz	**18 / 23 GHz**	**38 GHz**
256 QAM	56 MHz	-62.4	-61.4	-59.9
	28 MHz	-65.2	-64.2	-62.7
	14 MHz	-68.3	-67.3	-65.8
	7 MHz	-71.3	-70.3	-68.8
128 QAM	56 MHz	-64.9	-63.9	-62.4
	28 MHz	-67.7	-66.7	-65.2
	14 MHz	-70.8	-69.8	-68.3
	7 MHz	-73.8	-72.8	-71.3
64 QAM	56 MHz	-67.5	-66.5	-65.0
	28 MHz	-70.3	-69.3	-67.8
	14 MHz	-73.4	-72.4	-70.9
	7 MHz	-76.4	-75.4	-73.9
32 QAM	56 MHz	-70.0	-69.0	-67.5
	28 MHz	-72.8	-71.8	-70.3
	14 MHz	-75.9	-74.9	-73.4
	7 MHz	-78.9	-77.9	-76.4
16 QAM	56 MHz	-73.4	-72.4	-70.9
	28 MHz	-76.2	-75.2	-73.7
	14 MHz	-79.3	-78.3	-76.8
	7 MHz	-82.3	-81.3	-79.8
8 PSK	56 MHz	-75.3	-74.3	-72.8
	28 MHz	-78.1	-77.1	-75.6
	14 MHz	-81.2	-80.2	-78.7
	7 MHz	-84.2	-83.2	-81.7
4 QAM Low FEC	56 MHz	-79.9	-78.9	-77.4
	28 MHz	-82.7	-81.7	-80.2
	14 MHz	-85.8	-84.8	-83.3
	7 MHz	-88.8	-87.8	-86.3
4 QAM High FEC	56 MHz	-87.3	-86.3	-84.8
	28 MHz	-90.1	-89.1	-87.6
	14 MHz	-93.2	-92.2	-90.7
	7 MHz	-96.2	-95.2	-93.7

Continued on next page

Rx Thresholds, Continued

Case #5

The following table provides the Rx Threshold values of an OmniBAS system for Max. Capacity Configuration and Fixed Modulation:

Rx Threshold (dBm) at BER=10^{-6} for Max. Capacity Configuration & Fixed Modulation				
Modulation	**Ch. Size**	**ODU-CF**		
		6 /7 /8 /11 /13 /15 GHz	**18 / 23 GHz**	**38 GHz**
256 QAM	56 MHz	-65.2	-64.2	-62.7
	28 MHz	-67.8	-66.8	-65.3
	14 MHz	-70.8	-69.8	-68.3
	7 MHz	-73.9	-72.9	-71.4
128 QAM	56 MHz	-67.2	-66.2	-64.7
	28 MHz	-69.8	-68.8	-67.3
	14 MHz	-72.8	-71.8	-70.3
	7 MHz	-75.9	-74.9	-73.4
64 QAM	56 MHz	-70.1	-69.1	-67.6
	28 MHz	-72.7	-71.7	-70.2
	14 MHz	-75.7	-74.7	-73.2
	7 MHz	-78.8	-77.8	-76.3
32 QAM	56 MHz	-73.2	-72.2	-70.7
	28 MHz	-75.8	-74.8	-73.3
	14 MHz	-78.8	-77.8	-76.3
	7 MHz	-81.9	-80.9	-79.4
16 QAM	56 MHz	-76.0	-75.0	-73.5
	28 MHz	-78.6	-77.6	-76.1
	14 MHz	-81.6	-80.6	-79.1
	7 MHz	-84.7	-83.7	-82.2
8 PSK	56 MHz	-80.7	-79.7	-78.2
	28 MHz	-83.3	-82.3	-80.8
	14 MHz	-86.3	-85.3	-83.8
	7 MHz	-89.4	-88.4	-86.9
4 QAM Low FEC	56 MHz	-83.8	-82.8	-81.3
	28 MHz	-86.4	-85.4	-83.9
	14 MHz	-89.4	-88.4	-86.9
	7 MHz	-92.5	-91.5	-90.0
4 QAM High FEC	56 MHz	-87.1	-86.1	-84.6
	28 MHz	-89.7	-88.7	-87.2
	14 MHz	-92.7	-91.7	-90.2
	7 MHz	-95.8	-94.8	-93.3

Continued on next page

Rx Thresholds, Continued

Case #6

The following table provides the Rx Threshold values of an OmniBAS system for Max. Capacity Configuration and Adaptive Modulation:

Rx Threshold (dBm) at BER=10^{-6} for Max. Capacity Configuration & Adaptive Modulation				
Modulation	**Ch. Size**	**ODU-CF**		
		6 /7 /8 /11 /13 /15 GHz	**18 / 23 GHz**	**38 GHz**
256 QAM	56 MHz	-62.0	-61.0	-59.5
	28 MHz	-64.6	-63.6	-62.1
	14 MHz	-67.6	-66.6	-65.1
	7 MHz	-70.6	-69.6	-68.1
128 QAM	56 MHz	-64.0	-63.0	-61.5
	28 MHz	-66.6	-65.6	-64.1
	14 MHz	-69.6	-68.6	-67.1
	7 MHz	-72.6	-71.6	-70.1
64 QAM	56 MHz	-66.9	-65.9	-64.4
	28 MHz	-69.5	-68.5	-67.0
	14 MHz	-72.5	-71.5	-70.0
	7 MHz	-75.5	-74.5	-73.0
32 QAM	56 MHz	-70.0	-69.0	-67.5
	28 MHz	-72.6	-71.6	-70.1
	14 MHz	-75.6	-74.6	-73.1
	7 MHz	-78.6	-77.6	-76.1
16 QAM	56 MHz	-72.8	-71.8	-70.3
	28 MHz	-75.4	-74.4	-72.9
	14 MHz	-78.4	-77.4	-75.9
	7 MHz	-81.4	-80.4	-78.9
8 PSK	56 MHz	-76.5	-75.5	-74.0
	28 MHz	-79.1	-78.1	-76.6
	14 MHz	-82.1	-81.1	-79.6
	7 MHz	-85.1	-84.1	-82.6
4 QAM Low FEC	56 MHz	-80.6	-79.6	-78.1
	28 MHz	-83.2	-82.2	-80.7
	14 MHz	-86.2	-85.2	-83.7
	7 MHz	-89.2	-88.2	-86.7
4 QAM High FEC	56 MHz	-87.1	-86.1	-84.6
	28 MHz	-89.7	-88.7	-87.2
	14 MHz	-92.7	-91.7	-90.2
	7 MHz	-95.8	-94.8	-93.3

System Gain

Introduction

This paragraph provides the OmniBAS system gains (at BER = 10^{-6}) for the following cases:

Case	Modulation Type	OmniBAS Configuration Scenarios	Frequency Bands
Case #1	Fixed	Max. Robustness Configuration	All available frequency bands (6 / 7 / 8 /11 / 13 /15 / 18 / 23 / 38 GHz)
Case #2	Adaptive		
Case #3	Fixed	Optimized Robustness/ Capacity Configuration	
Case #4	Adaptive		
Case #5	Fixed	Max. Capacity Configuration	
Case #6	Adaptive		

For the description of the OmniBAS configuration scenarios, see par. Configuration scenarios for OmniBAS performance, on page 56.

Continued on next page

System Gain, Continued

Case #1

The following table provides the OmniBAS system gains in case of Max. Robustness configuration and Fixed Modulation:

System Gain (dB) at BER=10^{-6} for Max. Robustness Configuration & Fixed Modulation								
Modulation	**Ch.Size**	**ODU-CF**						
		6 GHz	**7 GHz**	**8/ 11 GHz**	**13/ 15 GHz**	**18 GHz**	**23 GHz**	**38 GHz**
256 QAM	56 MHz	89.8	88.8	87.8	84.8	83.8	82.8	79.3
	28 MHz	92.8	91.8	90.8	87.8	86.8	85.8	82.3
	14 MHz	95.8	94.8	93.8	90.8	89.8	88.8	85.3
	7 MHz	98.8	97.8	96.8	93.8	92.8	91.8	88.3
128 QAM	56 MHz	94.1	93.1	92.1	89.1	88.1	87.1	83.6
	28 MHz	97.1	96.1	95.1	92.1	91.1	90.1	86.6
	14 MHz	100.1	99.1	98.1	95.1	94.1	93.1	89.6
	7 MHz	103.1	102.1	101.1	98.1	97.1	96.1	92.6
64 QAM	56 MHz	97.8	96.8	95.8	92.8	91.8	90.8	87.3
	28 MHz	100.8	99.8	98.8	95.8	94.8	93.8	90.3
	14 MHz	103.8	102.8	101.8	98.8	97.8	96.8	93.3
	7 MHz	106.8	105.8	104.8	101.8	100.8	99.8	96.3
32 QAM	56 MHz	102.2	101.2	100.2	97.2	96.2	95.2	91.7
	28 MHz	105.2	104.2	103.2	100.2	99.2	98.2	94.7
	14 MHz	108.2	107.2	106.2	103.2	102.2	101.2	97.7
	7 MHz	111.2	110.2	109.2	106.2	105.2	104.2	100.7
16 QAM	56 MHz	106.7	105.7	104.7	101.7	100.7	99.7	96.2
	28 MHz	109.7	108.7	107.7	104.7	103.7	102.7	99.2
	14 MHz	112.7	111.7	110.7	107.7	106.7	105.7	102.2
	7 MHz	115.7	114.7	113.7	110.7	109.7	108.7	105.2
8 PSK	56 MHz	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	28 MHz	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	14 MHz	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	7 MHz	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4 QAM Low FEC	56 MHz	114.3	113.3	112.3	109.3	108.3	107.3	103.8
	28 MHz	117.3	116.3	115.3	112.3	111.3	110.3	106.8
	14 MHz	120.3	119.3	118.3	115.3	114.3	113.3	109.8
	7 MHz	123.3	122.3	121.3	118.3	117.3	116.3	112.8
4 QAM High FEC	56 MHz	116.6	115.6	114.6	111.6	110.6	109.6	106.1
	28 MHz	119.6	118.6	117.6	114.6	113.6	112.6	109.1
	14 MHz	122.6	121.6	120.6	117.6	116.6	115.6	112.1
	7 MHz	125.6	124.6	123.6	120.6	119.6	118.6	115.1

Continued on next page

System Gain, Continued

Case #2

The following table provides the OmniBAS system gains in case of Max. Robustness configuration and Adaptive Modulation:

System Gain (dB) at BER=10^{-6} for Max. Robustness Configuration & Adaptive Modulation								
Modulation	**Ch.Size**	**ODU-CF**						
		6 GHz	**7 GHz**	**8/ 11 GHz**	**13/ 15 GHz**	**18 GHz**	**23 GHz**	**38 GHz**
256 QAM	56 MHz	81.6	80.6	79.6	76.6	75.6	74.6	71.1
	28 MHz	84.6	83.6	82.6	79.6	78.6	77.6	74.1
	14 MHz	87.6	86.6	85.6	82.6	81.6	80.6	77.1
	7 MHz	90.6	89.6	88.6	85.6	84.6	83.6	80.1
128 QAM	56 MHz	85.9	84.9	83.9	80.9	79.9	78.9	75.4
	28 MHz	88.9	87.9	86.9	83.9	82.9	81.9	78.4
	14 MHz	91.9	90.9	89.9	86.9	85.9	84.9	81.4
	7 MHz	94.9	93.9	92.9	89.9	88.9	87.9	84.4
64 QAM	56 MHz	89.6	88.6	87.6	84.6	83.6	82.6	79.1
	28 MHz	92.6	91.6	90.6	87.6	86.6	85.6	82.1
	14 MHz	95.6	94.6	93.6	90.6	89.6	88.6	85.1
	7 MHz	98.6	97.6	96.6	93.6	92.6	91.6	88.1
32 QAM	56 MHz	94.0	93.0	92.0	89.0	88.0	87.0	83.5
	28 MHz	97.0	96.0	95.0	92.0	91.0	90.0	86.5
	14 MHz	100.0	99.0	98.0	95.0	94.0	93.0	89.5
	7 MHz	103.0	102.0	101.0	98.0	97.0	96.0	92.5
16 QAM	56 MHz	98.5	97.5	96.5	93.5	92.5	91.5	88.0
	28 MHz	101.5	100.5	99.5	96.5	95.5	94.5	91.0
	14 MHz	104.5	103.5	102.5	99.5	98.5	97.5	94.0
	7 MHz	107.5	106.5	105.5	102.5	101.5	100.5	97.0
8 PSK	56 MHz	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	28 MHz	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	14 MHz	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	7 MHz	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4 QAM Low FEC	56 MHz	106.1	105.1	104.1	101.1	100.1	99.1	95.6
	28 MHz	109.1	108.1	107.1	104.1	103.1	102.1	98.6
	14 MHz	112.1	111.1	110.1	107.1	106.1	105.1	101.6
	7 MHz	115.1	114.1	113.1	110.1	109.1	108.1	104.6
4 QAM High FEC	56 MHz	116.6	115.6	114.6	111.6	110.6	109.6	106.1
	28 MHz	119.6	118.6	117.6	114.6	113.6	112.6	109.1
	14 MHz	122.6	121.6	120.6	117.6	116.6	115.6	112.1
	7 MHz	125.6	124.6	123.6	120.6	119.6	118.6	115.1

Continued on next page

System Gain, Continued

Case #3

The following table provides the OmniBAS system gains in case of Optimized Robustness/ Capacity configuration and Fixed Modulation:

System Gain (dB) at BER=10^{-6} for Optimized Robustness/ Capacity Configuration & Fixed Modulation								
Modulation	**Ch.Size**	**ODU-CF**						
		6 GHz	**7 GHz**	**8/ 11 GHz**	**13/ 15 GHz**	**18 GHz**	**23 GHz**	**38 GHz**
256 QAM	56 MHz	88.4	87.4	86.4	83.4	82.4	81.4	77.9
	28 MHz	91.2	90.2	89.2	86.2	85.2	84.2	80.7
	14 MHz	94.3	93.3	92.3	89.3	88.3	87.3	83.8
	7 MHz	97.3	96.3	95.3	92.3	91.3	90.3	86.8
128 QAM	56 MHz	92.9	91.9	90.9	87.9	86.9	85.9	82.4
	28 MHz	95.7	94.7	93.7	90.7	89.7	88.7	85.2
	14 MHz	98.8	97.8	96.8	93.8	92.8	91.8	88.3
	7 MHz	101.8	100.8	99.8	96.8	95.8	94.8	91.3
64 QAM	56 MHz	96.5	95.5	94.5	91.5	90.5	89.5	86.0
	28 MHz	99.3	98.3	97.3	94.3	93.3	92.3	88.8
	14 MHz	102.4	101.4	100.4	97.4	96.4	95.4	91.9
	7 MHz	105.4	104.4	103.4	100.4	99.4	98.4	94.9
32 QAM	56 MHz	101.0	100.0	99.0	96.0	95.0	94.0	90.5
	28 MHz	103.8	102.8	101.8	98.8	97.8	96.8	93.3
	14 MHz	106.9	105.9	104.9	101.9	100.9	99.9	96.4
	7 MHz	109.9	108.9	107.9	104.9	103.9	102.9	99.4
16 QAM	56 MHz	105.4	104.4	103.4	100.4	99.4	98.4	94.9
	28 MHz	108.2	107.2	106.2	103.2	102.2	101.2	97.7
	14 MHz	111.3	110.3	109.3	106.3	105.3	104.3	100.8
	7 MHz	114.3	113.3	112.3	109.3	108.3	107.3	103.8
8 PSK	56 MHz	109.3	108.3	107.3	104.3	103.3	102.3	98.8
	28 MHz	112.1	111.1	110.1	107.1	106.1	105.1	101.6
	14 MHz	115.2	114.2	113.2	110.2	109.2	108.2	104.7
	7 MHz	118.2	117.2	116.2	113.2	112.2	111.2	107.7
4 QAM Low FEC	56 MHz	113.9	112.9	111.9	108.9	107.9	106.9	103.4
	28 MHz	116.7	115.7	114.7	111.7	110.7	109.7	106.2
	14 MHz	119.8	118.8	117.8	114.8	113.8	112.8	109.3
	7 MHz	122.8	121.8	120.8	117.8	116.8	115.8	112.3
4 QAM High FEC	56 MHz	116.3	115.3	114.3	111.3	110.3	109.3	105.8
	28 MHz	119.1	118.1	117.1	114.1	113.1	112.1	108.6
	14 MHz	122.2	121.2	120.2	117.2	116.2	115.2	111.7
	7 MHz	125.2	124.2	123.2	120.2	119.2	118.2	114.7

Continued on next page

System Gain, Continued

Case #4

The following table provides the OmniBAS system gains in case of Optimized Robustness/ Capacity configuration and Adaptive Modulation:

System Gain (dB) at BER=10^{-6} for Optimized Robustness/ Capacity Configuration & Adaptive Modulation								
Modulation	**Ch.Size**	**ODU-CF**						
		6 GHz	**7 GHz**	**8/ 11 GHz**	**13/ 15 GHz**	**18 GHz**	**23 GHz**	**38 GHz**
256 QAM	56 MHz	83.4	82.4	81.4	78.4	77.4	76.4	72.9
	28 MHz	86.2	85.2	84.2	81.2	80.2	79.2	75.7
	14 MHz	89.3	88.3	87.3	84.3	83.3	82.3	78.8
	7 MHz	92.3	91.3	90.3	87.3	86.3	85.3	81.8
128 QAM	56 MHz	87.9	86.9	85.9	82.9	81.9	80.9	77.4
	28 MHz	90.7	89.7	88.7	85.7	84.7	83.7	80.2
	14 MHz	93.8	92.8	91.8	88.8	87.8	86.8	83.3
	7 MHz	96.8	95.8	94.8	91.8	90.8	89.8	86.3
64 QAM	56 MHz	91.5	90.5	89.5	86.5	85.5	84.5	81.0
	28 MHz	94.3	93.3	92.3	89.3	88.3	87.3	83.8
	14 MHz	97.4	96.4	95.4	92.4	91.4	90.4	86.9
	7 MHz	100.4	99.4	98.4	95.4	94.4	93.4	89.9
32 QAM	56 MHz	96.0	95.0	94.0	91.0	90.0	89.0	85.5
	28 MHz	98.8	97.8	96.8	93.8	92.8	91.8	88.3
	14 MHz	101.9	100.9	99.9	96.9	95.9	94.9	91.4
	7 MHz	104.9	103.9	102.9	99.9	98.9	97.9	94.4
16 QAM	56 MHz	100.4	99.4	98.4	95.4	94.4	93.4	89.9
	28 MHz	103.2	102.2	101.2	98.2	97.2	96.2	92.7
	14 MHz	106.3	105.3	104.3	101.3	100.3	99.3	95.8
	7 MHz	109.3	108.3	107.3	104.3	103.3	102.3	98.8
8 PSK	56 MHz	103.3	102.3	101.3	98.3	97.3	96.3	92.8
	28 MHz	106.1	105.1	104.1	101.1	100.1	99.1	95.6
	14 MHz	109.2	108.2	107.2	104.2	103.2	102.2	98.7
	7 MHz	112.2	111.2	110.2	107.2	106.2	105.2	101.7
4 QAM Low FEC	56 MHz	108.9	107.9	106.9	103.9	102.9	101.9	98.4
	28 MHz	111.7	110.7	109.7	106.7	105.7	104.7	101.2
	14 MHz	114.8	113.8	112.8	109.8	108.8	107.8	104.3
	7 MHz	117.8	116.8	115.8	112.8	111.8	110.8	107.3
4 QAM High FEC	56 MHz	116.3	115.3	114.3	111.3	110.3	109.3	105.8
	28 MHz	119.1	118.1	117.1	114.1	113.1	112.1	108.6
	14 MHz	122.2	121.2	120.2	117.2	116.2	115.2	111.7
	7 MHz	125.2	124.2	123.2	120.2	119.2	118.2	114.7

Continued on next page

System Gain, Continued

Case #5

The following table provides the OmniBAS system gains in case of Max. Capacity configuration and Fixed Modulation:

System Gain (dB) at BER=10^{-6} for Max. Capacity Configuration & Fixed Modulation								
Modulation	**Ch.Size**	**ODU-CF**						
		6 GHz	**7 GHz**	**8/ 11 GHz**	**13/ 15 GHz**	**18 GHz**	**23 GHz**	**38 GHz**
256 QAM	56 MHz	86.2	85.2	84.2	81.2	80.2	79.2	75.7
	28 MHz	88.8	87.8	86.8	83.8	82.8	81.8	78.3
	14 MHz	91.8	90.8	89.8	86.8	85.8	84.8	81.3
	7 MHz	94.9	93.9	92.9	89.9	88.9	87.9	84.4
128 QAM	56 MHz	90.2	89.2	88.2	85.2	84.2	83.2	79.7
	28 MHz	92.8	91.8	90.8	87.8	86.8	85.8	82.3
	14 MHz	95.8	94.8	93.8	90.8	89.8	88.8	85.3
	7 MHz	98.9	97.9	96.9	93.9	92.9	91.9	88.4
64 QAM	56 MHz	94.1	93.1	92.1	89.1	88.1	87.1	83.6
	28 MHz	96.7	95.7	94.7	91.7	90.7	89.7	86.2
	14 MHz	99.7	98.7	97.7	94.7	93.7	92.7	89.2
	7 MHz	102.8	101.8	100.8	97.8	96.8	95.8	92.3
32 QAM	56 MHz	99.2	98.2	97.2	94.2	93.2	92.2	88.7
	28 MHz	101.8	100.8	99.8	96.8	95.8	94.8	91.3
	14 MHz	104.8	103.8	102.8	99.8	98.8	97.8	94.3
	7 MHz	107.9	106.9	105.9	102.9	101.9	100.9	97.4
16 QAM	56 MHz	103.0	102.0	101.0	98.0	97.0	96.0	92.5
	28 MHz	105.6	104.6	103.6	100.6	99.6	98.6	95.1
	14 MHz	108.6	107.6	106.6	103.6	102.6	101.6	98.1
	7 MHz	111.7	110.7	109.7	106.7	105.7	104.7	101.2
8 PSK	56 MHz	108.7	107.7	106.7	103.7	102.7	101.7	98.2
	28 MHz	111.3	110.3	109.3	106.3	105.3	104.3	100.8
	14 MHz	114.3	113.3	112.3	109.3	108.3	107.3	103.8
	7 MHz	117.4	116.4	115.4	112.4	111.4	110.4	106.9
4 QAM Low FEC	56 MHz	112.8	111.8	110.8	107.8	106.8	105.8	102.3
	28 MHz	115.4	114.4	113.4	110.4	109.4	108.4	104.9
	14 MHz	118.4	117.4	116.4	113.4	112.4	111.4	107.9
	7 MHz	121.5	120.5	119.5	116.5	115.5	114.5	111.0
4 QAM High FEC	56 MHz	116.1	115.1	114.1	111.1	110.1	109.1	105.6
	28 MHz	118.7	117.7	116.7	113.7	112.7	111.7	108.2
	14 MHz	121.7	120.7	119.7	116.7	115.7	114.7	111.2
	7 MHz	124.8	123.8	122.8	119.8	118.8	117.8	114.3

Continued on next page

System Gain, Continued

Case #6

The following table provides the OmniBAS system gains in case of Max. Capacity configuration and Adaptive Modulation:

System Gain (dB) at BER=10^{-6} for Max. Capacity Configuration & Adaptive Modulation								
Modulation	**Ch.Size**	**ODU-CF**						
		6 GHz	**7 GHz**	**8/ 11 GHz**	**13/ 15 GHz**	**18 GHz**	**23 GHz**	**38 GHz**
256 QAM	56 MHz	83.0	82.0	81.0	78.0	77.0	76.0	72.5
	28 MHz	85.6	84.6	83.6	80.6	79.6	78.6	75.1
	14 MHz	88.6	87.6	86.6	83.6	82.6	81.6	78.1
	7 MHz	91.6	90.6	89.6	86.6	85.6	84.6	81.1
128 QAM	56 MHz	87.0	86.0	85.0	82.0	81.0	80.0	76.5
	28 MHz	89.6	88.6	87.6	84.6	83.6	82.6	79.1
	14 MHz	92.6	91.6	90.6	87.6	86.6	85.6	82.1
	7 MHz	95.6	94.6	93.6	90.6	89.6	88.6	85.1
64 QAM	56 MHz	90.9	89.9	88.9	85.9	84.9	83.9	80.4
	28 MHz	93.5	92.5	91.5	88.5	87.5	86.5	83.0
	14 MHz	96.5	95.5	94.5	91.5	90.5	89.5	86.0
	7 MHz	99.5	98.5	97.5	94.5	93.5	92.5	89.0
32 QAM	56 MHz	96.0	95.0	94.0	91.0	90.0	89.0	85.5
	28 MHz	98.6	97.6	96.6	93.6	92.6	91.6	88.1
	14 MHz	101.6	100.6	99.6	96.6	95.6	94.6	91.1
	7 MHz	104.6	103.6	102.6	99.6	98.6	97.6	94.1
16 QAM	56 MHz	99.8	98.8	97.8	94.8	93.8	92.8	89.3
	28 MHz	102.4	101.4	100.4	97.4	96.4	95.4	91.9
	14 MHz	105.4	104.4	103.4	100.4	99.4	98.4	94.9
	7 MHz	108.4	107.4	106.4	103.4	102.4	101.4	97.9
8 PSK	56 MHz	104.5	103.5	102.5	99.5	98.5	97.5	94.0
	28 MHz	107.1	106.1	105.1	102.1	101.1	100.1	96.6
	14 MHz	110.1	109.1	108.1	105.1	104.1	103.1	99.6
	7 MHz	113.1	112.1	111.1	108.1	107.1	106.1	102.6
4 QAM Low FEC	56 MHz	109.6	108.6	107.6	104.6	103.6	102.6	99.1
	28 MHz	112.2	111.2	110.2	107.2	106.2	105.2	101.7
	14 MHz	115.2	114.2	113.2	110.2	109.2	108.2	104.7
	7 MHz	118.2	117.2	116.2	113.2	112.2	111.2	107.7
4 QAM High FEC	56 MHz	116.1	115.1	114.1	111.1	110.1	109.1	105.6
	28 MHz	118.7	117.7	116.7	113.7	112.7	111.7	108.2
	14 MHz	121.7	120.7	119.7	116.7	115.7	114.7	111.2
	7 MHz	124.8	123.8	122.8	119.8	118.8	117.8	114.3

Net Throughput

Introduction

This paragraph provides the maximum throughput values of an OmniBAS link for the following configuration scenarios:

- Max. Robustness Configuration
- Optimized Robustness / Capacity Configuration
- Max. Capacity Configuration

For the description of the OmniBAS configuration scenarios, see par. Configuration scenarios for OmniBAS performance, on page 56.

Max. throughput values for Max. Robustness configuration

The following table provides the maximum throughput values for an OmniBAS link in case of Max. Robustness configuration:

Modulation	Value per Channel Size (Mbit/s)			
	56 MHz	28 MHz	14 MHz	7 MHz
256 QAM	293.57	146.28	72.23	35.21
128 QAM	258.78	128.89	63.59	30.90
64 QAM	221.19	110.10	54.22	26.26
32 QAM	179.81	89.40	43.84	21.26
16 QAM	143.90	71.45	34.99	16.74
8 PSK	N/A	N/A	N/A	N/A
4 QAM (Low FEC)	71.68	35.34	17.11	7.98
4 QAM (High FEC)	62.30	30.65	14.78	6.85

Max. throughput values for Optimized Robustness / Capacity configuration

The following table provides the maximum throughput values for an OmniBAS link in case of Optimized Robustness/ Capacity configuration:

Modulation	Value per Channel Size (Mbit/s)			
	56 MHz	28 MHz	14 MHz	7 MHz
256 QAM	333.04	172.15	84.64	41.28
128 QAM	293.80	151.81	74.59	36.32
64 QAM	251.51	129.89	63.71	30.94
32 QAM	204.51	105.53	51.61	24.94
16 QAM	163.54	84.29	41.16	19.83
8 PSK	105.94	54.43	26.44	12.61
4 QAM (Low FEC)	81.41	41.72	20.16	9.48
4 QAM (High FEC)	67.70	34.61	16.64	7.75

Continued on next page

Net Throughput, Continued

Max. throughput values for Max. Capacity configuration

The following table provides the maximum throughput values for an OmniBAS link in case of Max. Capacity configuration:

Modulation	Value per Channel Size (Mbit/s)			
	56 MHz	28 MHz	14 MHz	7 MHz
256 QAM	357.88	195.01	96.81	47.70
128 QAM	315.61	171.93	85.28	42.05
64 QAM	270.49	147.29	73.01	35.87
32 QAM	219.85	119.62	59.46	28.81
16 QAM	175.75	95.54	47.23	22.98
8 PSK	115.12	62.42	30.67	14.80
4 QAM (Low FEC)	87.46	47.31	23.16	11.03
4 QAM (High FEC)	69.76	37.65	18.31	8.64

Link Ranges

Introduction

This paragraph provides link ranges values for the Athens, Moscow and New Delhi in 7 / 18 / 38 GHz frequency bands.

Assumptions

For the calculation of the provided link ranges, the following assumptions are taken into account:

Parameters	Regions		
	Athens	Moscow	New Delhi
Rain Intensity (R0.01) (*)	47.11 mm/hr	31.72 mm/hr	57.01 mm/hr
Geo-climatic Factor (**)	1.41E-03	1.97E-04	5.23E-04
Average Site Height (ASL)	250 m	200 m	225 m
Site Antenna Height Difference	50 m		
Frequency bands	7 / 18 / 38 GHz		
Channel Sizes	28 / 56 MHz		
Modulation schemes	256 QAM to 4 QAM		
Annual Availability (due to propagation)	99.995%		
Modulation selection	Adaptive		
Link Mode	1+0		
Antenna Used	High Performance Parabolic Antenna (1.8 m diameter for 7 GHz band and 0.6 m diameter for 18 / 38 GHz band) (***)		
Antenna Polarization	Vertical		

Prerequisites

The ranges values mentioned hereinafter are indicative and cannot be used for dimensioning and design (special analysis per region and network is necessary).
The provided link ranges values are valid with the following prerequisites:

- No intra-system or inter-system interference effects
- No antenna off-axis loss effects
- Clear LoS
- No adverse propagation conditions (ducting, etc)
- Professional installation

Continued on next page

(*) According to ITU-R Rec. P.837-5
(**) According to ITU-R Rec. P.530-12
(***) See also Appendix - Antenna Characteristics (page 77) for the technical specifications of the antennas.

Link Ranges, Continued

Ranges at 7 GHz

Modulation	Link Ranges (km) at 7 GHz					
	Athens		Moscow		New Delhi	
	56 MHz	28 MHz	56 MHz	28 MHz	56 MHz	28 MHz
4 QAM 3/4	55.9	61.6	80.7	88.9	65.0	71.5
4 QAM 9/10	46.5	51.2	67.0	73.8	54.1	59.5
8 PSK	37.5	41.2	53.9	59.3	43.6	47.9
16 QAM	34.4	37.8	49.5	54.4	40.0	44.0
32 QAM	29.7	32.6	42.6	46.9	34.5	37.9
64 QAM	25.9	28.5	37.1	40.8	30.1	33.1
128 QAM	22.5	24.7	32.1	35.3	26.1	28.6
256 QAM	18.6	20.5	26.8	29.2	21.6	23.8

Ranges at 18 GHz

Modulation	Link Ranges (km) at 18 GHz					
	Athens		Moscow		New Delhi	
	56 MHz	28 MHz	56 MHz	28 MHz	56 MHz	28 MHz
4 QAM 3/4	15.4	16.7	22.1	24.2	14.4	15.7
4 QAM 9/10	13.1	14.2	18.6	20.4	12.3	13.4
8 PSK	10.8	11.8	15.1	16.6	10.1	11.0
16 QAM	10.0	10.9	13.9	15.3	9.4	10.2
32 QAM	8.7	9.5	12.0	13.2	8.1	8.9
64 QAM	7.6	8.4	10.4	11.5	7.1	7.8
128 QAM	6.6	7.3	8.9	9.9	6.2	6.8
256 QAM	5.4	6.0	7.2	8.0	5.1	5.6

Ranges at 38 GHz

Modulation	Link Ranges (km) at 38 GHz					
	Athens		Moscow		New Delhi	
	56 MHz	28 MHz	56 MHz	28 MHz	56 MHz	28 MHz
4 QAM 3/4	5.0	5.3	6.8	7.2	4.7	4.9
4 QAM 9/10	4.5	4.8	6.1	6.4	4.2	4.5
8 PSK	4.0	4.2	5.3	5.7	3.7	3.9
16 QAM	3.8	4.0	5.0	5.4	3.5	3.8
32 QAM	3.4	3.7	4.6	4.9	3.2	3.4
64 QAM	3.1	3.3	4.1	4.4	2.9	3.1
128 QAM	2.8	3.0	3.7	4.0	2.6	2.8
256 QAM	2.4	2.6	3.2	3.4	2.3	2.5

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Appendix - Antenna Characteristics

Introduction

This appendix provides the characteristics of the following parabolic antennas that can be used for the OmniBAS system:

- Antennas at 6 GHz Band
- Antennas at 7 GHz & 8 GHz Bands
- Antennas at 11 GHz Band
- Antennas at 13 GHz Band
- Antennas at 15 GHz Band
- Antennas at 18 GHz Band
- Antennas at 23 GHz Band
- Antennas at 38 GHz Band

NOTE Other antennas, with different characteristics, are available upon customer request.

Antenna selection criteria

The antenna selection criteria mentioned in the tables of this Appendix are the following:

- **Frequency** - Frequencies over 10 GHz are subject to greater attenuation, particularly in bad weather conditions and rain, since water and water vapors absorb the microwave radiation. Consequently, as the operation frequency increases, the maximum distance between the transmitter and the receiver decreases.
- **Diameter** -The greater the diameter of the antenna is, the greater the gain and the number of dBi. The higher the operating frequency is, the smaller the diameter of the antenna can be to achieve the same gain. In other words, the microwave systems that operate at high frequencies have much smaller and consequently cheaper antennas.
- **Mid Gain** as the average value is the most representative.
- **F/B Ratio** to control interferences at the rear side of the antenna.
- **Polarization** (single or dual). The DP (Dual Polarization) antennas offer the possibility of two signals with different polarization transmission from the same antenna.
- **XPD** (Cross Polar Discrimination) to ensure low levels of disturbing cross-polarized signals and thus a safer reception. Typical XPD values range from 30 dB for standard antennas to 40 dB for Ultra High Performance antennas.
- **Weight** for the arrangement of the antenna mounting onto the pole/tower.
- If the antenna is **integrated** (i.e. customized for direct ODU-CF attachment) or not
- **Antenna vendor code** number to be used as reference for the antenna specifications. Do not use this code to place an order.

Antennas at 6 GHz Band

Introduction

The following tables provide the antennas characteristics used at the following frequency bands:

- 5.925 GHz to 6.425 GHz (6 GHz (Lo))
- 6.425 GHz to 7.125 GHz (6 GHz (Hi))

NOTE Other antennas, with different characteristics, are available upon customer request.

High Performance

Freq. Band (6GHz)	Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polari-zation	XPD (dB)	Weight (kg)	Inte-grated	Antenna Vendor Code
Lo	4 (1.2)	34.5	56	DP	30	45	–	RFS: DAX 4-59
Lo	6 (1.8)	38.7	64	DP	30	95	–	RFS: DAX 6-59
Lo	8 (2.4)	41.3	67	DP	30	180	–	RFS: DAX 8-59
Lo	10 (3.0)	43.2	69	DP	30	290	–	RFS: DAX 10-59
Hi	4 (1.2)	35.3	58	DP	30	45	–	RFS: DAX 4-65
Hi	6 (1.8)	39.7	64	DP	30	95	–	RFS: DAX 6-65
Hi	8 (2.4)	42.2	68	DP	30	180	–	RFS: DAX 8-65
Hi	10 (3.0)	43.9	70	DP	30	290	–	RFS: DAX 10-65
Lo / Hi	4 (1.2)	35.7	62	SP	30	80	√	KATHREIN: HP 12-059 S WB
Lo / Hi	6 (1.8)	39.3	68	SP	30	150	√	KATHREIN: HP 18-059 S WB

Continued on next page

Antennas at 6 GHz Band, Continued

Ultra High Performance & High XPD

Freq. Band (6GHz)	Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polari-zation	XPD (dB)	Weight (kg)	Inte-grated	Antenna Vendor Code
Lo	6 (1.8)	38.7	69	DP	40	95	–	RFS: UXA 6-59
Lo	8 (2.4)	41.3	71	DP	40	180	–	RFS: UXA 8-59
Lo	10 (3.0)	43.2	74	DP	40	290	–	RFS: UXA 10-59
Lo	12 (3.7)	44.8	76	DP	40	420	–	RFS: UXA 12-59
Hi	6 (1.8)	39.7	69	DP	40	95	–	RFS: UXA 6-65
Hi	8 (2.4)	42.2	71	DP	40	180	–	RFS: UXA 8-65
Hi	10 (3.0)	43.9	74	DP	40	290	–	RFS: UXA 10-65
Hi	12 (3.7)	45.6	76	DP	40	420	–	RFS: UXA 12-65

Antennas at 7 GHz & 8 GHz Bands

Introduction

The following tables provide the antennas characteristics used at 7.125 GHz to 8.500 GHz frequency band.

NOTE Other antennas, with different characteristics, are available upon customer request.

High Performance

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polari-zation	XPD (dB)	Weight (kg)	Inte-grated	Antenna Vendor Code
2 (0.6)	31.3	52	SP	30	15	–	RFS: DA2-W71 or equivalent
4 (1.2)	37.3	62	SP	30	45	–	RFS: DA4-W71 or equivalent
6 (1.8)	40.8	66	SP	30	120	–	RFS: DA6-W71 or equivalent
8 (2.4)	43.3	68	SP	30	180	–	RFS: DA8-W71 or equivalent
10 (3.0)	45.3	70	SP	30	290	–	RFS: DA10-W71 or equivalent

Ultra High Performance

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polari-zation	XPD (dB)	Weight (kg)	Inte-grated	Antenna Vendor Code
4 (1.2)	36.9	63	SP	30	39	✓	RFS: SB4-W71 or equivalent
4 (1.2)	37.0	63	SP	30	51	✓	KATHREIN: THP12-071SWB
6 (1.8)	40.8	67	SP	30	95	✓	RFS: SU6-W71 or equivalent
6 (1.8)	40.6	67	DP	30	95	–	RFS: SUX6-W71 or equivalent
8 (2.4)	43.1	71	DP	30	180	–	RFS: UDA8-W71 or equivalent
10 (3.0)	45.1	73	DP	30	290	–	RFS: UDA10-W71 or equivalent

Antennas at 11 GHz Band

Introduction

The following tables provide the antennas characteristics used at 10.7 GHz to 11.7 GHz frequency band.

NOTE Other antennas, with different characteristics, are available upon customer request.

High Performance

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polari-zation	XPD (dB)	Weight (kg)	Integrated	Antenna Vendor Code
2 (0.6)	35.1	60	SP	30	12	√	RFS: SB2-107
4 (1.2)	40.4	66	DP	32	35	–	RFS: SUX 4-107
4 (1.2)	40.4	67	SP	30	35	√	RFS: SB4-107
6 (1.8)	43.9	70	DP	32	95	–	RFS: SUX 6-107
6 (1.8)	44.0	70	SP	32	95	√	RFS: SU6-107
8 (2.4)	46.2	69	DP	30	180	–	RFS: DAX 8-107
10 (3.0)	48.2	70	DP	30	290	–	RFS: DAX 10-107
12 (3.7)	49.6	72	DP	30	420	–	RFS: DAX 12-107

Ultra High Performance – High XPD

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polari-zation	XPD (dB)	Weight (kg)	Integrated	Antenna Vendor Code
4 (1.2)	40.4	70	DP	40	40	–	RFS: UXA 4-107
6 (1.8)	43.8	73	DP	40	95	–	RFS: UXA 6-107
8 (2.4)	46.2	75	DP	40	180	–	RFS: UXA 8-107
10 (3.0)	48.2	77	DP	40	290	–	RFS: UXA 10-107
12 (3.7)	49.6	78	DP	40	420	–	RFS: UXA 12-107

Antennas at 13 GHz Band

Introduction

The following tables provide the antennas characteristics used at 12.70 GHz to 13.25 GHz frequency band.

NOTE Other antennas, with different characteristics, are available upon customer request.

High Performance

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polarization	XPD (dB)	Weight (kg)	Integrated	Antenna Vendor Code
1 (0.3)	29.8	56	SP	30	4	✓	RFS: SB1-127
2 (0.6)	35.2	61	SP	30	12	✓	RFS: SB2-127
4 (1.2)	41.5	67	SP	30	35	✓	RFS: SB4-127
6 (1.8)	45.3	66	SP	30	110	–	RFS: SD6-127 or equivalent
8 (2.4)	47.7	71	SP	30	180	–	RFS: DA8-127 or equivalent
10 (3.0)	49.5	71	SP	30	290	–	RFS: DA10-127 or equivalent

Ultra High Performance

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polarization	XPD (dB)	Weight (kg)	Integrated	Antenna Vendor Code
2 (0.6)	35.3	65	DP	32	15	–	RFS: SUX2-127 or equivalent
3 (0.9)	38.8	64	DP	32	23	–	RFS: SUX3-127 or equivalent
4 (1.2)	41.5	67	DP	32	35	–	RFS: SUX4-127 or equivalent
6 (1.8)	45.1	72	SP	32	110	✓	RFS: SU6-127

High XPD

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polarization	XPD (dB)	Weight (kg)	Integrated	Antenna Vendor Code
4 (1.2)	41.4	67	DP	40	40	–	RFS: UXA4-127 or equivalent
6 (1.8)	45.1	73	DP	40	110	–	RFS: UXA6-127 or equivalent
8 (2.4)	47.5	75	DP	40	180	–	RFS: UXA8-127 or equivalent

Antennas at 15 GHz Band

Introduction

The following tables provide the antennas characteristics used at 14.20 GHz to 15.35 GHz frequency band.

NOTE Other antennas, with different characteristics, are available upon customer request.

High Performance

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polari-zation	XPD (dB)	Weight (kg)	Inte-grated	Antenna Vendor Code
1 (0.3)	31.1	53	SP	30	4	✓	RFS: SB1-142
2 (0.6)	36.3	58	SP	30	12	✓	RFS: SB2-142
2 (0.6)	36.4	65	DP	32	15	–	RFS: SUX2-142B or equivalent
2 (0.6)	36.8 (2)	65	SP	30	11	✓	KATHREIN: THP06-144S
3 (0.9)	39.9	64	DP	32	23	–	RFS: SUX3-142 or equivalent
4 (1.2)	42.4	70	DP	32	35	–	RFS: SUX4-142 or equivalent
4 (1.2)	42.5	70	SP	30	35	✓	RFS: SB4-142
4 (1.2)	42.7 (2)	70	SP	30	51	✓	KATHREIN: THP12-144S
8 (2.4)	48.5 (2)	70	SP	30	180	–	RFS: DA8-142 or equivalent
10 (3.0)	50.5 (2)	72	SP	30	360	–	RFS: DA10-142 or equivalent

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(2) *This antenna is used at 14.40 GHz to 15.35 GHz frequency band.*

Antennas at 15 GHz Band, Continued

Ultra High Performance

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polari-zation	XPD (dB)	Weight (kg)	Integrated	Antenna Vendor Code
2 (0.6)	36.4	62	DP	32	15	–	RFS: SUX2-142 or equivalent
3 (0.9)	39.9	64	DP	32	23	–	RFS: SUX3-142 or equivalent
4 (1.2)	42.4	70	DP	32	35	–	RFS: SUX4-142 or equivalent
4 (1.2)	42.5	70	SP	32	35	–	RFS: SU4-142 or equivalent
6 (1.8)	46.0	72	SP	32	110	✓	RFS: SU6-142
6 (1.8)	46.0(3)	72	SP	32	110	–	RFS: SU6-142 or equivalent

High XPD

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polari-zation	XPD (dB)	Weight (kg)	Integrated	Antenna Vendor Code
2 (0.6)	36.5	64	DP	36	15	–	RFS: UXA2-142 or equivalent
4 (1.2)	42.5	70	DP	36	40	–	RFS: UXA4-142 or equivalent
6 (1.8)	46.0	75	DP	38	110	–	RFS: UXA6-142 or equivalent

(3) *This antenna is used at 14.25 GHz to 15.35 GHz frequency band.*

Antennas at 18 GHz Band

Introduction

The following tables provide the antennas characteristics used at 17.7 GHz to 19.7 GHz frequency band.

NOTE Other antennas, with different characteristics, are available upon customer request.

High Performance

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polarization	XPD (dB)	Weight (kg)	Integrated	Antenna Vendor Code
1 (0.3)	33.3	55	SP	30	4	✓	RFS: SB1-190
1 (0.3)	33.8	58	SP	30	7	✓	KATHREIN: THP03-177S
2 (0.6)	39.0	67	SP	30	11	✓	KATHREIN: THP06-177S
2 (0.6)	39.0	70	SP	30	12	✓	RFS: SB2-190
4 (1.2)	44.5	72	SP	30	35	✓	RFS: SB4-190
4 (1.2)	44.7	73	SP	30	51	✓	KATHREIN: THP12-177S

Ultra High Performance

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polarization	XPD (dB)	Weight (kg)	Integrated	Antenna Vendor Code
4 (1.2)	44.6	67	SP	32	35	–	RFS: SU4-190 or equivalent
6 (1.8)	48.0	75	SP	32	110	✓	RFS: SU6-190
6 (1.8)	48.0	75	SP	32	110	✓	RFS: SU6-190 or equivalent

High XPD

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polarization	XPD (dB)	Weight (kg)	Integrated	Antenna Vendor Code
1 (0.3)	33.0	58	DP	30	5	–	RFS: SUX1-190 or equivalent
2 (0.6)	38.3	66	DP	36	15	–	RFS: UXA2-190 or equivalent
4 (1.2)	44.5	72	DP	36	40	–	RFS: UXA4-190 or equivalent
6 (1.8)	47.9	71	DP	32	110	–	RFS: SUX6-190 or equivalent

Antennas at 23 GHz Band

Introduction

The following tables provide the antennas characteristics used at 21.2 GHz to 23.6 GHz frequency band.

NOTE Other antennas, with different characteristics, are available upon customer request.

High Performance

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polari-zation	XPD (dB)	Weight (kg)	Integrated	Antenna Vendor Code
1 (0.3)	34.9	61	SP	30	4	✓	RFS: SB1-220
1 (0.3)	35.1	62	SP	30	7	✓	KATHREIN: THP03-212S
2 (0.6)	40.1	66	SP	30	12	✓	RFS: SB2-220
4 (1.2)	46.1	72	SP	30	33	✓	RFS: SB4-220
4 (1.2)	46.3	72	SP	30	51	✓	KATHREIN: THP12-212S

Ultra High Performance

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polari-zation	XPD (dB)	Weight (kg)	Integrated	Antenna Vendor Code)
3 (0.9)	43.5	68	DP	32	23	–	RFS: SUX3-220 or equivalent
4 (1.2)	46.0	72	DP	32	35	–	RFS: SUX4-220 or equivalent

High XPD

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polari-zation	XPD (dB)	Weight (kg)	Integrated	Antenna Vendor Code
2 (0.6)	40.0	66	DP	36	15	–	RFS: UXA2-220 or equivalent

Antennas at 38 GHz Band

Introduction

The following table provides the antennas characteristics used at 37.0 GHz to 40.0 GHz frequency band.

NOTE Other antennas, with different characteristics, are available upon customer request.

High Performance

Diameter ft (m)	Mid Gain (dBi)	F/B Ratio (dB)	Polari-zation	XPD (dB)	Weight (kg)	Integrated	Antenna Vendor Code
1 (0.3)	39.6	60	SP	30	4	✓	RFS: SB1-380
2 (0.6)	44.5	63	SP	30	12	✓	RFS: SB2-380

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Glossary

ADC	Analog - to - Digital Conversion
ARPU	Average Revenue Per User
ATM	Asynchronous Transfer Mode
ATPC	Adaptive Transmission Power Control
BER	Bit Error Ratio
BPEL	Business Process Execution Language
BS	Base Station
BSC	Base Station Controller
BSS	Business Support Systems
BTS	Base Transceiver Station
CapEx	Capital Expenditure
CDMA	Code Division Multiple Access
CLEC	Competitive Local Exchange Carrier
CLI	Command Line Interface
C-VLAN	Customer VLAN
DAC	Digital - to - Analog Conversion
DSCP	Differentiated Services Code Point
DP	Dual Polarization
DSL(1)	Digital Subscriber Line
EMC	Electromagnetic Compatibility
EOW	Engineering Order Wire
EMS	Element Management System
ETH	Ethernet
ETSI	European Telecommunications Standards Institute
EV-DO	Evolution-Data Optimized
F/B Ratio	Front-to-Back Ratio
FCPS	Fault - Configuration - Performance - Security
FD	Frequency Diversity
FEC	Forward Error Correction
FTP	File Transfer Protocol
GbE	Gigabit Ethernet

Continued on next page

(1) or xDSL

Glossary, Continued

GSM	Global System for Mobile Communications
GUI	Graphical User Interface
HSB	Hot Stand By
HSDPA	High-Speed Downlink Packet Access
HSPA	High Speed Packet Access
HTTP	Hyper Text Transfer Protocol
IEEE	Institute of Electrical & Electronics Engineers
IF	Intermediate Frequency
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IPTV	Internet Protocol Television
ISP	Internet Service Provider
ITU	International Telecommunication Union
JDBC	Java Database Connectivity
LAN	Local Area Network
LCT	Local Craft Terminal
LTE	Long Term Evolution
LSP	Label Switched Path
MEN	Metro Ethernet Network
MNGT	Management
MPLS	Multi-Protocol Label Switching
MTNM	Multi-Technology Network Management
NOC	Network Operations Center
ODU	Outdoor Unit
OpEX	Operational Expenditure
OSS	Operations Support Systems
PBB-TE	Provider Backbone Transport Traffic Engineering
PBX	Private Branch eXchange
PDH	Plesiochronous Digital Hierarchy
PSU	Power Supply Unit
PtP	Point-to-Point
PtMP	Point-to-Multipoint

Continued on next page

Glossary, Continued

PW	Pseudo-Wire
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
QPSK	Quadrature Phase-Shift Keying
RF	Radio Frequency
RNC	Remote Node Controller
RoHS	Restriction of Hazardous Substances
RSL	Received Signal Level
RSSI	Receiver Signal Strength Indicator
RU	Rack Unit
SOA	Service-Oriented Architecture
SOAP	Simple Object Access Protocol
SD	Space Diversity
SDH	Synchronous Digital Hierarchy
SNC	Sub-Network Connection
SNMP	Signaling Network Management Protocol
STM-1	Synchronous Transport Module
SP	Single Polarization
SQL	Simple Query Language
S-VLAN	Service VLAN
TDM	Time Division Multiplexing
TMF	Tele-Management Forum
UNI	User Network Interface
uni│MS	Unified Management Suite
VLAN	Virtual Local Area Network
VoIP	Voice over IP
WiMAX	Worldwide Interoperability for Microwave Access
xDSL	Digital Subscriber Line
XPD	Cross Polar Discrimination
XPIC	Cross Polarization Interference Canceller

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