

Wireless Specifications Mobile

Outdoor Modem Gateway Specification

WR-SP-OMG-I01-180823

ISSUED

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1 SCOPE

1.1 Introduction and Purpose

An Outdoor Modem Gateway (OMG) provides a physical interface between a Hybrid Fiber Coax (HFC) plant and an external small cell or similar radio-based device. Its purpose is to provide backhaul, power, Operational System Support (OSS), and network management needed to deliver and maintain service level agreement (SLA) metrics with an end customer. An end customer could be either internal (a cable operator) or external (a mobile operator, municipality, or other). This document addresses the specifications for an OMG to support the integration of small cells and remote radio devices into an existing HFC plant.

The purpose of an OMG is to provide HFC integration and service delivery (such as backhaul and power) to a single small cell, multiple small cells or other types of remote radio devices (RRDs) such as cameras, IoT, HaLow, or sensors.

1.2 Requirements

Throughout this document, the words that are used to define the significance of particular requirements are capitalized. These words are:

"MUST"	This word means that the item is an absolute requirement of this specification.
"MUST NOT"	This phrase means that the item is an absolute prohibition of this specification.
"SHOULD"	This word means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications SHOULD be understood and the case carefully weighed before choosing a different course.
"SHOULD NOT"	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications SHOULD be understood and the case carefully weighed before implementing any behavior described with this label.
"MAY"	This word means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.

2 REFERENCES

2.1 Normative References

In order to claim compliance with this specification, it is necessary to conform to the following standards and other works as indicated, in addition to the other requirements of this specification. Notwithstanding, intellectual property rights may be required to use or implement such normative references.

All references are subject to revision, and parties to agreement based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

- [CCAP-OSSlv3.1] CCAP Operations Support System Interface Specification, CM-SP-CCAP-OSSlv3.1-I12-180509, May 9, 2018, Cable Television Laboratories, Inc.
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- [ISO/IEC 8802-2] ISO/IEC 8802-2 (ANSI/IEEE Std. 802-2):1998, Information Technology-Telecommunications and information exchange between systems-Local and metropolitan area networks-Specific requirements-Part 2: Logical link control.
- [ISO/IEC 8802-3] ISO/IEC 8802-3 (ANSI/IEEE Std. 802.3): 2005, Information technology-Local and metropolitan area networks-Part 3: Carrier sense multiple access with collision detection (CSMA/CD) Access Method and Physical Layer Specifications.
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- [OSSI-TRv30] DOCSIS 3.0 OSSI Configuration Management Technical Report, CM-TR-OSSlv3.0-CM-V01-080926, September 26, 2008, Cable Television Laboratories, Inc.
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- [SCTE 81] Surge Withstand Test Procedure, ANSI/SCTE 81 2012, SCTE.
- [SCTE 91] Specification for 5/8-24 RF & AC Equipment Port, Female, ANSI/SCTE 91 2015, SCTE.

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[SCTE 158]	Recommended Environmental Condition Ranges for Broadband Communications Equipment, ANSI/SCTE 158 2016, SCTE.
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[TIA Standard 568-B.2-10]	TIA/EIA Standard, Commercial Building, Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components, May 2001. https://www.csd.uoc.gr/~hy435/material/TIA-EIA-568-B.2.pdf

2.2 Informative References

This specification uses the following informative references.

- QoS Requirements of Multimedia Applications: Brett Berliner, Brian Clark and Albert Hartono, Department of Computer Science and Engineering, The Ohio State University, Columbus, OH 43210

2.3 Reference Acquisition

- Cable Television Laboratories, Inc., 858 Coal Creek Circle, Louisville, CO 80027; Phone +1-303-661-9100; Fax +1-303-661-9199; <http://www.cablelabs.com>
- FCC: Federal Communications Commission, <http://www.fcc.gov/general/rules-regulations-title-47/>
- IEEE: Institute of Electrical and Electronics Engineers, +1 800 422 4633 (USA and Canada); <http://www.ieee.org>
- IETF: Internet Engineering Task Force () Secretariat, 48377 Fremont Blvd., Suite 117, Fremont, California 94538, USA, Phone: +1-510-492-4080, Fax: +1-510-492-4001, <http://www.ietf.org>
- IEC: International Electrotechnical Commission, <http://www.iec.ch>
- Innovation, Science and Economic Development Canada, Ottawa, Ontario, <http://www.ic.gc.ca/spectrum>
- MEF: Metro Ethernet Forum, 6033 W. Century Blvd, Suite 830, Los Angeles, CA 90045
Phone +1-310-642-2800; Fax +1-310-642-2808. Internet: <http://metroethernetforum.org>
- ITU: International Telecommunications Union , <http://www.itu.int/home/contact/index.html>
- International Organization for Standardization, ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, www.iso.org
- SCTE - Society of Cable Telecommunications Engineers Inc., 140 Philips Road, Exton, PA 19341; Phone: +1-610-363-6888 / 800-542-5040; Fax: +1-610-363-5898; <http://www.scte.org/>

3 TERMS AND DEFINITIONS

This specification uses the following terms and definitions:

HaLow IEEE 802.11ah, a wireless networking protocol

4 ABBREVIATIONS AND ACRONYMS

This specification uses the following abbreviations and acronyms:

3GPP	3 rd Generation Partnership Project
BSoD	Business Services over DOCSIS
CBRS	Citizens Broadband Radio Service
CCAP	Converged Cable Access Platform
CM	Cable Modem
CMCI	Cable Modem to Customer Premise Equipment Interface
CMTS	Cable Modem Termination System
DOCSIS	Data-Over-Cable System Interface Specification
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
HFC	Hybrid Fiber Coax
IoT	Internet of Things
IP	Internet Protocol
LAN	Local Area Network
LTE	Long Term Evolution
MAC	Media Access Control
MIB	Management Information Base
MSO	Multiple System Operators
OMG	Outdoor Modem Gateway
OSS	Operations Support System
OSSI	Operations Support System Interface
PoE	Power over Ethernet
QoS	Quality of Service
RoHS	Restriction of Hazardous Substances
RRD	Remote Radio Device
SLA	Service Level Agreement
SNMP	Simple Network Management Protocol defined in [ISO/IEC 8802-2].
VLAN	Virtual LAN

5 OVERVIEW

Mobile operators are deploying Long Term Evolution (LTE) small cells for network densification at an increasing rate to meet coverage and capacity demands and maintain quality user experience for their customers [FCC WT]. Multiple System Operators (MSOs) are well-positioned to host small cells in their cable plant and deliver high-speed backhaul due to inherent network qualities (i.e., DOCSIS network, existing infrastructure). Hosting small cells has an appealing value proposition and opportunity for MSOs to create an extra revenue stream that can also be applied to network infrastructure upgrades and earlier network expansion.

MSOs are also well-positioned to host their own small cells to meet internal business case needs. For example, some MSOs may possess a licensed mobile network and are seeking to densify small cells using their HFC plant. Other MSOs may be seeking to obtain licensed spectrum and build out a small cell network (i.e., 3.5 GHz CBRS band). As 5G continues to evolve, there may be further opportunity to host 5G small cells at proposed bands such as 38 GHz, 60 GHz, etc. MSOs are not limited to host small cells. There are various forms of similar remote radio devices (RRDs) that MSOs are well-suited to host such as cameras, sensors, IoT, and HaLow devices to support such use cases as smart cities, municipalities, and security systems.

An Outdoor Modem Gateway is needed to support such remote radio devices and act as an interface between the HFC plant and the RRD to deliver HFC services and power. An OMG device has several components as shown in Figure 1 and listed below.

- 1) Power from HFC or external
- 2) Cable Modem (with OSSI)
- 3) Ethernet interface to RRD (with optional fiber interface)
- 4) Power to RRD (via PoE or other)

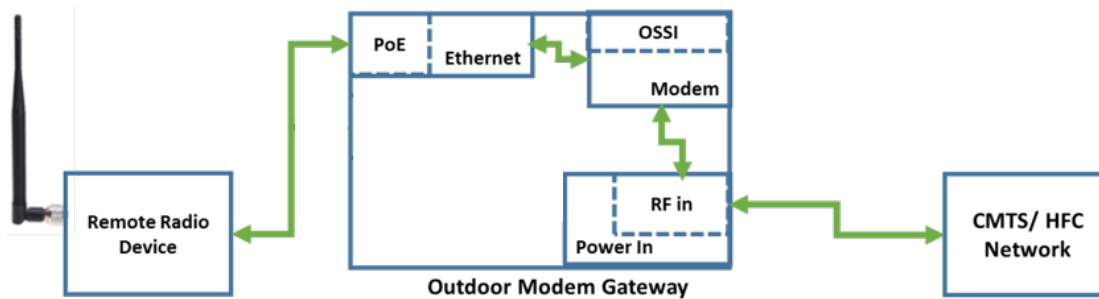


Figure 1 - OMG Block Diagram with HFC and Remote Radio Device interfaces

The OMG can be designed to support multiple configurations to deliver backhaul and power to an RRD, for example, serving a single or multiple set of RRDs as shown in Figure 2.

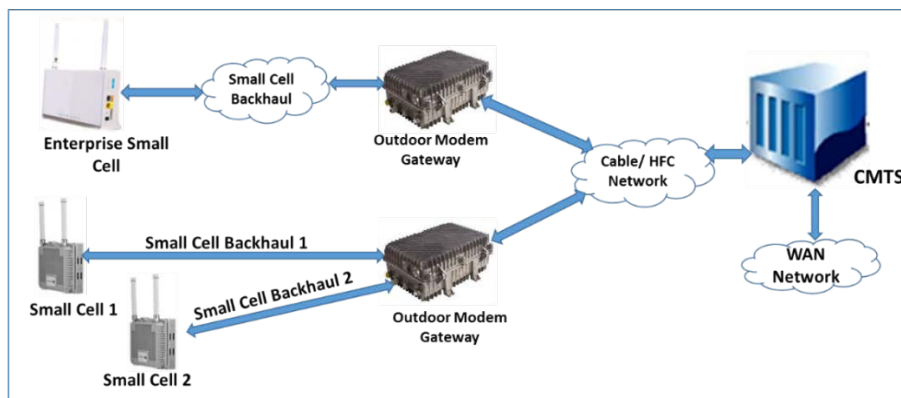


Figure 2 - OMG Delivering Backhaul and Power to Single and Multiple Remote Radio Devices

6 REQUIREMENTS

This section provides detailed requirements for Outdoor Modem Gateways. Requirements are divided into mounting options, power, backhaul, Operations Support System Interface (OSSI), and physical and environmental topics.

6.1 Mounting Options

Cable operators use various methods to mount external radio devices to the HFC plant contingent on several variables including, but not limited to, infrastructure, cable plant access, power availability, and placement opportunities at a given location. Commonly used mounting options are listed below and illustrated in Figure 3.

- Strand
- Pole
- Ground
- Pedestal
- Wall
- Vault

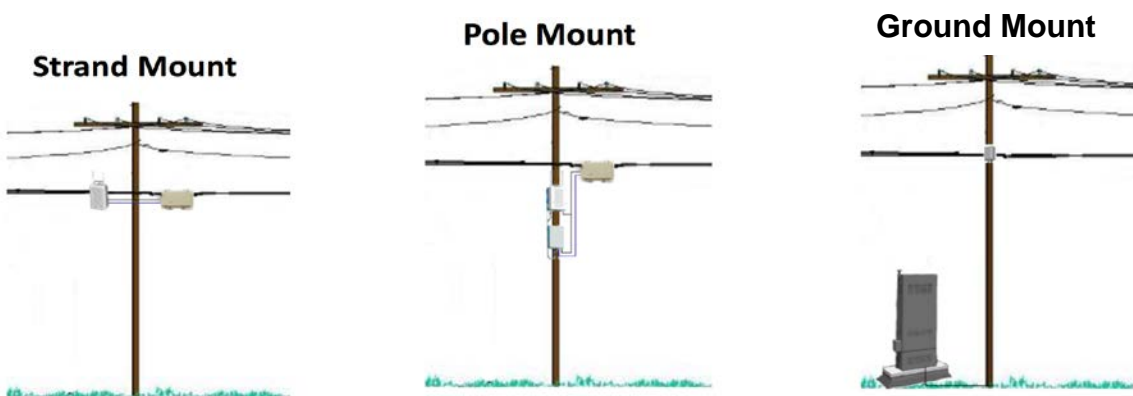


Figure 3 - Commonly used Mounting Options for Remote Devices into HFC Plant

The OMG MUST support one of the listed mounting options as determined by the cable operator to meet the specific needs of the HFC installation location.

6.2 Power

The Outdoor Modem Gateway MUST support electric power using one of the following sources:

1. HFC Plant power
2. External Power
 - Utility
 - Power Cabinet
 - Battery Backup

6.2.1 HFC Plant Power

When power is delivered from the HFC via coaxial cable to the OMG, the coaxial cable could be either RG-6/RG-59 (using a power-passing tap) or semi-rigid coaxial cable. Power-passing taps are suitable for low-amperage connections; semi-rigid can safely handle a great deal more power. This section does not differentiate between cable types or connections, as these are implementation-specific details.

When power is delivered from the HFC via coaxial cable to the OMG in a North American HFC plant, the voltage, current, and surge protection listed in Table 1 MUST be met.

Table 1 - North American HFC Plant Power Requirements for OMG

Voltage	60 to 90 AC @ 50/60 Hz; Sine or Quasi Square Wave
Current	15 Amps maximum
Surge Protection	>6000V

When power is delivered from the HFC via coaxial cable to the OMG in a South American HFC plant, the voltage, current, and surge protection listed in Table 2 MUST be met.

Table 2 - South American HFC Plant Power Requirements for OMG

Voltage	60 to 90 AC @ 50/60 Hz; Sine or Quasi Square Wave
Current	15 Amps maximum
Surge Protection	>6000V

When power is delivered from the HFC via coaxial cable to the OMG in a European HFC plant, the voltage, current, and surge protection listed in Table 3 MUST be met.

Table 3 - European HFC Plant Power Requirements for OMG

Voltage	48 to 90 AC @ 50/60 Hz; Sine or Quasi Square Wave
Current	15 Amps maximum
Surge Protection	>6000V

The coaxial cable MUST be shielded according to [IEEE 1143].

Power supply efficiency MUST be 90% or higher, as tested per [IEEE 1515], across the full operating temperature range.

6.2.2 External Power

When the Outdoor Modem Gateway is not powered by coax from the HFC network, various alternative power sources can be used such as local utility power, an outdoor power cabinet, battery backup, or solar power. Figure 2 illustrates possible scenarios.

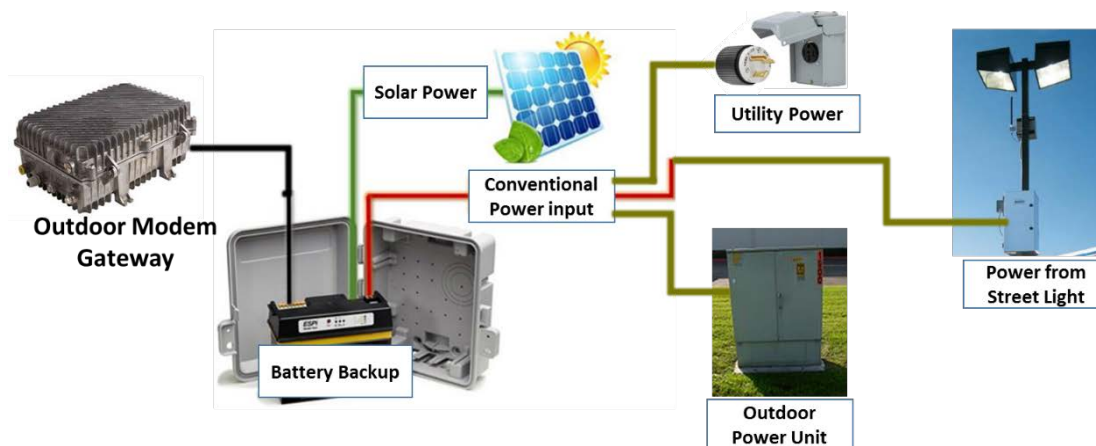


Figure 4 - External Power Sources to Outdoor Modem Gateway

When power is delivered from an external power source, the voltage, current, and surge protection listed in Table 4 **MUST** be met.

Table 4 - External Power Source Requirements for OMG

Voltage	90 to 240 AC @ 50/60 Hz; Sine or Quasi Square Wave
Current	120 VAC (nominal): 15 Amps max 240 VAC (nominal): 7.5 Amps max
Surge Protection	>6000V

The power cable **MUST** be shielded according to [IEEE 1143].

The power cables **MUST** be shielded with braid and foil to minimize ingress/egress effects as illustrated in Figure 5. The power plug **MUST** comply with NEMA 5-15 (for 120V) or NEMA 6-15 (for 240V) standards.

More information can be found in [IEEE 1143]. Similarly, the power connector to the OMG equipment **SHOULD** also follow best shielding practices.

Power supply efficiency **MUST** be 90% or higher, as tested per [IEEE 1515], across the full operating temperature range.

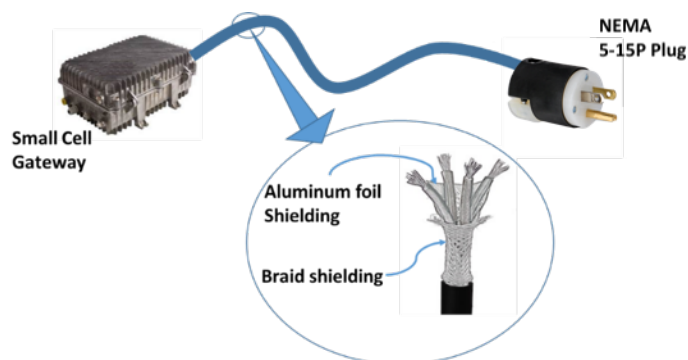


Figure 5 - Shielded Power Cable and Plug

Power failure alarms **MUST** be supported as part of the OSSI.

6.3 Cable Modem to HFC Plant Interface

A key component to the Outdoor Modem Gateway is the cable modem. It acts as the interface between the HFC and the Ethernet connection to the RRD. This section addresses cable modem requirements from the cable modem to the HFC plant interface as illustrated in Figure 6.

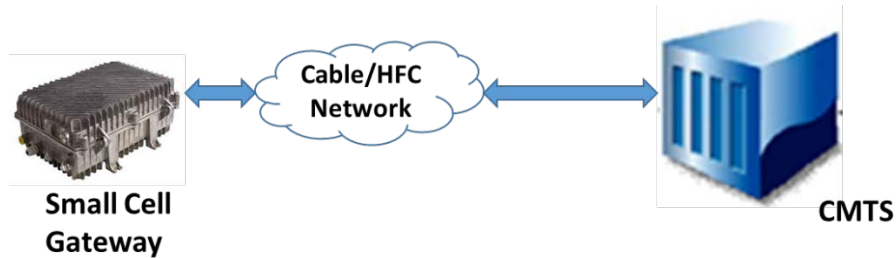


Figure 6 - OMG Interface to HFC and CMTS

There are three key cable modem features that are critical to the successful delivery of backhaul to RRDs that will enable SLAs to be met. These include: (1) DOCSIS requirements, (2) data rate delivery and (3) latency and are addressed in the following sections.

6.3.1 DOCSIS Requirements

All Outdoor Modem Gateway cable modems **MUST** comply with DOCSIS 3.1 specifications.

The list of specifications/technical reports that **MUST** be met to support Outdoor Modem Gateway to HFC plant interface and features is as follows:

- [OSSIV3.1]
- [OSSITRv30]
- [MULPIv3.1]
- [CCAP-OSSIV3.1]
- [PHYv3.1]
- [SECV3.1]

The cable modem **MUST** use one of the following to connect to the HFC network: an F-connector with 75-ohm impedance, minimum 16 dB return loss (with 75-ohm termination) and a minimum 10 dB return loss (with modem termination); or a 5/8"-24 port as specified by [SCTE 91].

6.3.2 Latency

The latency capabilities and performance of the OMG are defined by the integrated DOCSIS technology. Overall latency is defined by the HFC network architecture and configuration and deployed DOCSIS technologies. DOCSIS QoS requirements are defined in Section 6.10.

6.4 Remote Radio Device Interface

A key interface of the Outdoor Modem Gateway is the interface from the OMG to the RRD. This interface provides the data and power delivery to the RRD. This section addresses requirements from the OMG to the RRD as illustrated in Figure 7.

Small Cell Solution General Architecture

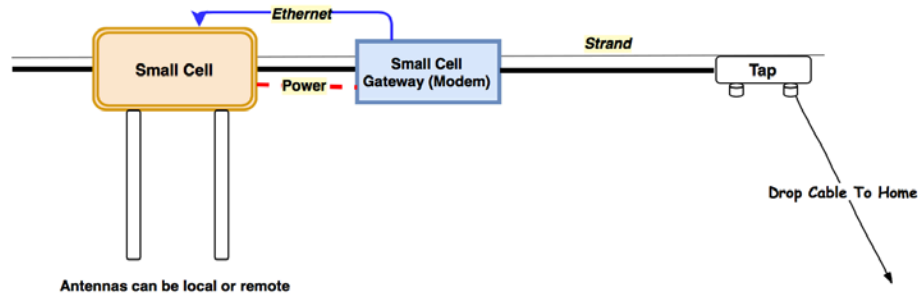


Figure 7 - OMG to RRD Interface

6.4.1 Data Delivery

The Outdoor Modem Gateway MUST employ Ethernet to deliver data to the remote radio device.

The Ethernet CMCI physical layer interface speed MUST conform to at least one of the following:

1. 100BASE-TX [ISO/IEC 8802-3] clause 25
2. 1000BASE-T [ISO/IEC 8802-3] clause 40
3. 2.5GBASE-T and 5GBASE-T [IEEE 802.3bz-2016]

The Ethernet cable MUST follow the shielding type as specified in [TIA Standard 568-B.2-10] and MUST use minimum of Category 6A (10 Gbps) shielded twisted pair. Proper grounding of the shielding MUST follow standard practices to prevent unwanted signal coupling into the Ethernet. The Ethernet connector MUST also have minimum shielding in support of the above standard.

If RJ-45 is used, it MUST be in accordance with [ISO/IEC 8802-3].

6.4.2 Power Delivery

The Outdoor Modem Gateway MUST deliver one of the following options to deliver power to the remote radio per the requirements below:

1. Power over Ethernet (PoE+), Type 2 or higher [IEEE 802.3]
2. Coaxial Cable

Power SHOULD be provided either via Ethernet connection from the OMG (PoE+) or externally. If providing external power, an AC/DC converter may be required. It is preferred that the power source be integrated into the OMG, but in the event that it cannot be integrated, a separate standalone device is acceptable. Alarms related to power failure MUST be supported.

If the OMG is powered via coax cable from the HFC plant, then the maximum input voltage is 90V. Depending on the power rating of the OMG, an appropriate number of PoE+ ports MUST be provided.

Table 5 - 802.3 PoE Specifications

PoE Type	Input Power (W)	Voltage range (V)	Max Current (mA)
802.3at Type 2 "PoE+"	30	50-57	600
802.3bt Type 3 "4PPoE"	60	50-57	1300
802.3bt Type 4	100	52-57	1731

The RRD power requirements will be defined by end customer input and be implemented by the cable operator. The input power per PoE type MUST be met as defined in Table 5 to meet the RRD power requirements.

Category 6A shielded PoE Ethernet cables MUST be used.

The power cables MUST be shielded with braid and foil to minimize ingress/egress effects, per [IEEE 1143]. Similarly, the power connector to the OMG equipment SHOULD also follow best shielding practices.

Power supply efficiency MUST be 90% or higher, as tested per [IEEE 1515], across the full operating temperature range.

6.5 Physical

6.5.1 Input Holes/Ports to OMG Casing

Input ports specification is typical, as coming from HFC:

- One for Coax/RF: Female F-type or 5/8"-24 with 75 Ohm impedance for connection to CMTS
- One for Coax/RF: Female F-type or 5/8"-24 with 75 Ohm impedance for loopback if required
- One for Power output connectors as described in Section 6.4.2.
- For PoE connector depending on number of Gigabit Ethernet interfaces provided by OMG, as described in Section 6.4.2 for power to remote radio device.

All holes for ports MUST be designed for the thickness of cables and weatherproof gaskets. Coax ports MUST conform to [SCTE 01] and [SCTE 91].

6.6 Environmental

The OMG MUST comply with the Class 1 requirements described in [SCTE 158] for temperature, humidity, and vibration conditions, and with the Class 2 requirements for altitude conditions.

The OMG MUST pass the salt-spray tests described in [SCTE 143].

6.7 Regulatory Compliance

All electrical and safety performance MUST comply with the following current Regulatory standards. Electrical surge testing MUST be performed in compliance with [SCTE 81].

- Environmental: UL50E/NEMA 6; [IEC 60529]: IP68
- Safety: [IEC 61000-4-2]: ED2
- Electrostatic Discharge: [IEC 61000-4-2]: level 3
- Electromagnetic Compatibility (EMC): [FCC Class B], [ICES-003]
- Restriction of Hazardous Substances (RoHS): Directive 2011/65/EU

6.8 Electromagnetic Interference (EMI) Isolation

There is a strong risk for egress and ingress interference between the cable network and wireless technologies. The strongest risk lies in wireless technologies transmitting below 1 GHz; however, with DOCSIS 3.1 deployed, additional risk might be experienced with technologies that transmit above 1 GHz.

The following EMI requirements MUST be met:

- Minimum EMI Rejection: >130 dB, given a -15 dBmV signal (worst case scenario) across all the RF spectrum.
- Chassis shielding and grounding
- Filtered connectors: Filter on Ethernet connector to filter ingress noise above 400 MHz (high pass filter), and filter on power connector.
- Weather sealed RJ-45
- Shielded internal cabling
- Properly grounded and non-projecting screws
- 10V EMF radiated emissions performance defined in [IEC 61000-4-6]
- 10V/m radiated immunity EMI performance defined in [IEC 61000-4-3]

6.9 Protection Circuitry

The OMG MUST have the following protection circuitry:

- Power surge protection from HFC to meet [IEEE C62.41], categories A3, B3, and C3
- Filtered power connectors (filter rejection of 20 dB)
- Filtered coaxial cable connectors (filter rejection of 20 dB)

6.10 Traffic Shaping and QoS

The following traffic shaping and Quality of Service (QoS) features defined in [SECv3.1] MUST be supported by the OMG:

- Flexible traffic filtering
- QoS Mapping
- Pre-Flow Bandwidth profiles
- Pre-Flow Statistics
- Zero-delay traffic shaping
- Wire-speed traffic filtering
- Plug & Go instant provisioning
- Business Services over DOCSIS (BSoD) with L2VPN support as specified in [L2VPN] [JB1]

Other traffic shaping and QoS features MAY also be supported.

The following 802.1Q Support (VLAN) features MUST be supported:

- EVC Creation
- VLAN tag add/removal/swap

6.11 Network Management

The following Network management protocols **MUST** be supported as defined in [OSSIV3.1]:

- SNMP v1
- SNMP v2C
- SNMP v3
- TFTP
- IPv4 Support
- IPv6 Support
- Management Information Bases (MIBS)
- IETF RFC support

The OMG **MAY** implement IPDR protocols as defined in Section 6 of [OSSIV3.1].

6.12 Operations Support System Interface (OSSI)

Operations Support System Interface (OSSI) is the logical interface connectivity between the end user (Outdoor Modem Gateway, in this case) and the packet processing function of Converged Cable Access Platform (CCAP). CableLabs specification [CCAP-OSSIV3.1] provides a detailed specification on OSSI for CMTS, CM, and CMCI. The OMG **SHOULD** meet or exceed the requirements outlined in [CCAP-OSSIV3.1]. Additional features **MAY** also be supported.

The following features defined in [OSSIV3.1] **MUST** be supported:

Fault Management: Section 8.1 Fault Management defines the OSSI MANAGEMENT OBJECTS for managing objects supporting CMTS and OMG fault management.

Configuration Management: Section 8.2 Configuration Management defines the CMTS and OMG configuration management.

Accounting Management: Section 8.3 Accounting Management defines the CMTS and OMG Accounting management.

Performance Management: Section 8.4 Performance Management defines the CMTS and OMG Performance management.

Security Management: Section 8.5 Security Management defines the CMTS and OMG Security management.

Power failure alarms **MUST** be supported as part of the OSSI.

6.12.1 Monitoring Features

The OMG **MUST** support the following monitoring features:

- Throughput SLA-Meter Performance Monitoring
- Pre-flow Statistics
- End-to-end OAM functionality
- Network level O&M platform for modem monitoring

6.12.2 Testing and Troubleshooting Features

The OMG MUST support the following testing and troubleshooting features:

- In-service throughput testing
- Layer 1, 2, 3, and 4 loopbacks
- Y.1564 service activation testing
- Smart loopbacks
- Test set interoperability

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