**Facebook Voyager Program**

**Transponder Technical Requirements**

**Document Number: TBD**

# Document Revision History

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# Document Approval History

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# Executive Summary

This requirements document captures the hardware and preliminary application software requirements for the Facebook Voyager DWDM transponder. This transponder is a component of the Facebook Voyager metro optical DWDM transport system, which is a point-to-point Layer 1 optical transport system to be used within the Facebook metro network over distances of roughly 10 km to 100 km. In future expansions Facebook is considering to use the same transponder for long haul applications.

## Requirements Overview

The Voyager requirements hierarchy consists of layered requirements as follows:

1. **Level 1 Requirements:** These requirements consist of network use cases within the FB network are business goals and the overall business strategy for developing this technology within FB, including the cost targets, ODM costs, personnel requirements, and integrated investment required for this effort. Level 1 Requirements are not captured in this document.
2. **Level 2 Requirements:** Level 2 requirements are system requirements including network applications, client and line interface requirements, and management requirements for controlling this system and performance requirements. Also included at Level 2 are environmental and compliance requirements for deploying this equipment. Implementation decisions cannot change Level 2 requirements. Many Level 2 requirements are omitted in this document and the ones that are described are only discussed for reference purposes*.*
3. **Level 3 Requirements:** Level 3 requirements are network element requirements associated with the individual modules associated with this system. There will be 2 main opto-electronic modules associated with this system termed a Transponder Module and a Optical Line Interface Module (OLIM). This document describes the Transponder Level 3 requirements.
4. **Level 4 Requirements**: Level 4 requirements consist of requirements on the major components that comprise the modules. This includes major chips, major optoelectronic modules, the controller, and embedded software. Many Level 4 requirements pass up to Level 3 with margin. This document does not specify Level 4 component requirements. The detailed requirements of the components such as the Broadcom Tomahawk ASIC and the Acacia AC400 are included in this document by reference.

Figure 1 below shows the requirements hierarchy.



Figure . Requirements hierarchy for the Voyager system. The requirements for the transponder module contained in this document are shown in red.

Requirements must be verified, and must be verified by design, inspection, analysis, or test. In this document the requirement verification process is specified.

## Development and Implementation Requirements

This document is not a development or project plan and does not address and programmatic or development issues. This document describes the requirements for the transponder. However, there are certain implementation requirements that are addressed in this section

It is expected that all key components of the transponder will be based on Facebook Wedge100 Open Compute Project (OCP) switch or will be commercially available components. The transponder will use two Acacia AC400 coherent optical subsystems, and hence the use of two AC400 subsystems per transponder module is considered as a requirement. The specification of the AC400 are incorporated into this requirements document by reference, and specifications of the AC400, including performance, management, and configuration, are implicitly included in this requirements document. There is currently no requirement for a second optical module vendor with form-factor/management interchangeability, but that option will be explored in a future implementation phase.

In the case of the aggregation subsystem, the Broadcom Tomahawk chip shall be used in a manner as similar as possible to Wedge100.

The transponder will strongly leverage the Open Compute Project (OCP) Wedge100 switch platform. That means that the mechanical form factor, the power supplies, thermal management, COME-E micro-server, and Board Management Controller (BMC) should replicate the Wedge100. Wedge100 utilizes FBOSS as FW-SW platform. Clearly changes will be required to use this overall platform, but leveraging the platform should be considered a design implementation goal.

The following table describes the characteristics of the different potential development phases of modules described in this requirements document

|  |  |
| --- | --- |
| Prototype Module | First prototypes   1. Component and board qualification not required 2. Board may have known defects or white wires 3. Requirements non-compliance acceptable but shall be documented |
| Engineering Module | Final version of design and module   1. Component qualification required 2. Requirements compliance complete except as agreed upon by vendor and Facebook |
| GA Module | Qualified Module   1. Module meets all requirements 2. Module fully qualified to agreed upon standards 3. Any requirements noncompliance formally waived by Facebook |

The transponder shall be designed to meet the requirements and certification standards described in this document. However, actual formal certification activity is not a part of Phase 1.0 of this program. However, that does not mean that the design should not be targeted for full compliance. It is expected that transponders delivered under Voyager 1.0 will be Engineering Models as per the above definition.

# Level 2 Requirements

## Summary

Many Level 2 requirements are omitted in this document and the ones that are described are only discussed for reference purposes*.* For reference purposes, a typical metro optical DWDM system is illustrated in Figure 2. The dashed lines demarcate the major system interfaces. The numbers in the picture identify the system elements and the major system interfaces.

1. The entire node is identified by (1). This consists of multiple modules, mechanical hardware, embedded software, and other system components
2. The client data interfaces are identified by (2). These are pluggable optical interfaces compliant with various standards
3. The primary fiber link and primary line side interface is identified by (3).
4. The optional redundant fiber link and line side interface is identified by (4)
5. The local management interfaces are identified by (5)
6. The management interfaces are identified by (6)

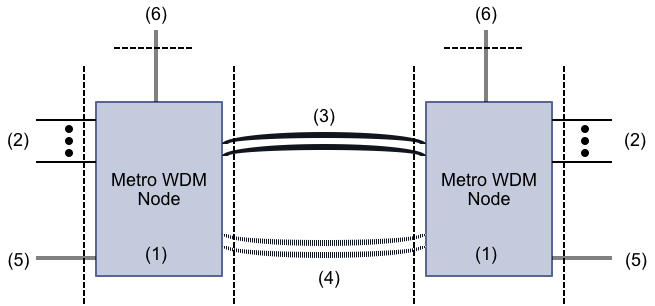


Figure . Overall system diagram of the metro DWDM system

## System Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| L2-1. System Requirements | | | |
| ID | L2 Requirement | Rational/Comment | Verification |
| L2-1-1 | The system and all system components shall be compliant with requirements for use in Facebook facilities and 3rd party facilities such as Equinix or other POP’s and data centers, in all geographical locations worldwide | FB to provide detailed compliance requirements when compliance testing is necessary | Test |
| L2-1-2 | The system shall support all fiber types | Detailed system specifications depend on fiber type | Design |
| L2-1-3 | The system shall support fiber spans of up to 120 km and up to 30 dB of span loss with accompanying channel impairments |  | Test |
| L2-1-4 | The system shall support either a single fiber path or a primary and redundant fiber path |  | Test |
| L2-1-5 | The system shall support up to 96 wavelengths at a 50GHz spacing in C-band, each coherently modulated with 100G QPSK or 200G 16-QAM format. |  | Design |
| L2-1-6 | The system shall be designed with beginning of life excess optical EOL OSNR margin of at least 1 dB |  | Analysis |
| L2-1-7 | The system shall support the following subsystem functionalities   1. Automatic protection switching 2. Optical Channel Monitoring 3. Optical Service Channel 4. Optical Time domain Reflectometry | Initial releases may omit some of this functionality | Design |
| L2-1-8 | The system shall have a nominal minimum lifetime of 3 years | 3-5 years is the expected lifetime in the FB network | Analysis |
| L2-1-9 | The performance of the system (fiber reach 120km, 96channels, 1dB OSNR margin) is expected to be better than BER 10E-15 over life-time. | Acacia Line side performance, excludes client interfaces | Analysis/Test |

## System Management Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| L2-2. System Management Requirements | | | |
| ID | L2 Requirement | Rational/Comment | Verification |
| L2-2-1 | There shall be local system management capabilities that can control and monitor all system parameters including   1. Configuration management 2. Provisioning management 3. Fault management 4. Performance management 5. Maintenance management 6. Security management |  | Design |
| L2-2-2 | There shall be remote system management capabilities access through the DCN that can control and monitor all system parameters including   1. Configuration management 2. Provisioning management 3. Fault management 4. Performance management 5. Maintenance management 6. Security management |  | Design |
| L2-2-3 | Local management access shall not be required for performing any system function. |  | Design |
| L2-2-4 | There shall be a one-for-one correspondence between the local and remote management capabilities |  | Test |
| L2-2-5 | The system shall conform to NETCONF-YANG models for all management capabilities | Additional details contained in the SW requirements section | Design/Test |
| L2-2-6 | All software-firmware upgrades shall be non-service affecting |  | Test |

## Environmental and Compliance Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| L2-4. Environmental Requirements | | | |
| ID | L2 Requirement | Rational/Comment | Verification |
| L2-4-1 | A system node shall satisfy the following sections of GR-63-CORE   1. Section 2.0: Spatial Requirements 2. Section 4.2.2: Self-Extinguish and Fire Spread and Smoke measurements 3. Section 4.2.3: Fire Resistance 4. Section 4.4: Earthquake 5. Section 4.6: Acoustic Noise | TBC | Test |
| L2-4-2 | A system node shall satisfy the following sections of GR-1089-CORE   1. Section 3.2: EMI Emission (10KHz through 10 GHz, Open door) 2. Section 4.0: Lightning and AC power fault (2nd level) 3. Section 7.0: Electrical Safety 4. Section 9.0: Bonding and Grounding | TBC | Test |
| L2-4-3 | The system node shall meet all requirements over the following operating conditions   1. Air inlet temperature: +5C to +40C 2. Relative Humidity: 0% to 85% 3. Altitude: 0-3,000 m | QSFP28 client optics must be at < 55C case temperature | Test |
| L2-4-4 | The system node shall operate short term (<96 consecutive hours) over the following conditions   1. Temperature up to +45C, no fan failure 2. Temperature 40C, up to 1 fan failure in any transponder module | QSFP28 client optics must be at < **60C** case temperature | Test |
| L2-4-5 | All individual modules associated with this system shall comply with the following storage environments   1. Temperature: -40C to +85C 2. Relative Humidity: 0% to 85% 3. Storage time: up to 2 years |  | Design/Analysis |
| L2-4-6 | Laser Safety: the overall system shall be classified as Class 1M and compliant with the following laser safety regulations   1. IEC/EN 60825-1: 2007 2. IEC/EN 60825-2: 2004 + A1 + A2 3. ANSI Z136.2 4. FDA 21 CFR 1040: Performance Standard for Light Emitting Products   Individual module laser safety and laser shutoff requirements shall be described in the module requirements sections |  | Design/Test |

# Level 3 Transponder Requirements

Level 3 requirements are high-level requirements associated with each module and the module level subsystems (or components). This document contains the Level 3 requirements for the transponder module.

Shown below in Figure 3 is a block diagram of the transponder module. The dashed rectangle denotes the selected implementation option consisting of an Acacia AC400 module; each AC400 supports 400G of capacity and two AC400 subsystems will be used in the transponder module (only one AC400 is shown). The aggregation subsystem is a Broadcom Tomahawk with a full complement of 32 Falcon cores.

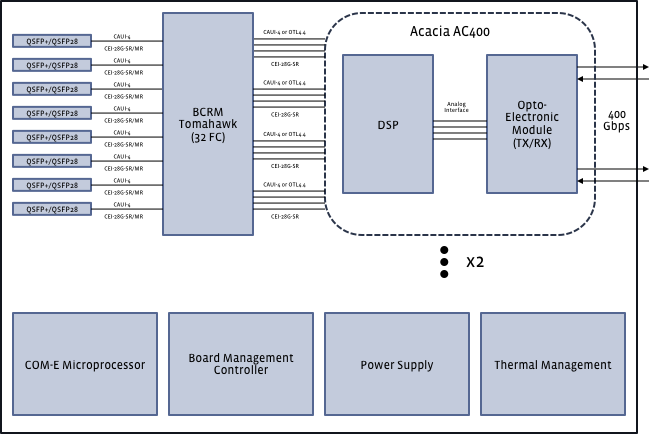


Figure . System block diagram of the transponder module

## Environmental Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| 1. Environmental Requirements | | | |
| ID | L3 Requirement | Rational/Comment | Verification |
| 1-1: Operating Conditions | The transponder meet all requirements over the following operating conditions   1. Air inlet temperature: +5C to +40C 2. Relative Humidity: 0% to 85% 3. Altitude: 0-3,000 m | QSFP28 Client optics must be at < **55C** case temperature | Test |
| 1-2: Short-Term Operating Conditions | The transponder shall operate short term (<96 consecutive hours) over the following conditions   1. Temperature: +5 to +45C, no fan failure 2. Temperature: +5C to 40C, up to 1 fan failure | QSFP28 Client optics must be at < **60C** case temperature | Test |
| 1-2: Extended Operating Conditions | The transponder shall operate without permanent damage over the following extended operating conditions   1. Temperature: 0C to +55C | Other requirements do not need to be met | Test |
| 1-3: Storage Conditions | The transponder shall comply with the following storage environments   1. Temperature: -40C to +85C 2. Relative Humidity: 0% to 85% 3. Storage time: up to 2 years |  | Test/Analysis |
| 1-4: Air Flow | The maximum allowable air flow through the transponder is 250 CFM |  | Analysis |

## Hardware Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| 2.Hardware Requirements | | | |
| ID | L3 Requirement | Rational/Comment | Verification |
| 2-1: Mechanical Requirements | | | |
| 2-1-1: Chassis | The transponder chassis shall be based on a 1RU “pizza box” with maximum dimensions of   1. Chassis Width: 440 mm (17.32”) 2. Chassis Depth 507 mm (19.97”) 3. Chassis Height: 44 mm (1.74”) |  | Design |
| 2-1-2: Rack Types | The transponder shall be able to be mounted in standard equipment racks   1. Either 19” or 23” wide racks 2. Either 2-post or 4-post racks 3. Racks are either ANSI or ETSI compliant. |  | Design/Test |
| 2-1-3: Rack Mounting | The transponder shall be supported with rails or other hardware that   1. Supports the module weight and doesn’t require manually supporting the entire weight of the module 2. Holds the module level to within +/- 2 mm over the entire area of the module | +/- 2 mm TBC | Design/Test |
| 2-2: Power Requirements | | | |
| 2-2-1: Power Supply Types | The transponder shall be powered by redundant, 1+1 power supplies that are field replaceable and hot swappable |  | Design |
| 2-2-2: Voltage ranges | The transponder shall permit either AC or DC power supplies to be used   |  |  |  |  | | --- | --- | --- | --- | | Input | Voltage | Current | Power (W) | | 54VDC typical  40V - 72V | 12 | 62 | 750 | | 54VDC typical  40V - 72V | 12 | 33 | 400 | | 120/240VAC | 12 | 62 | 750 | | Power supply requirements TBC | Design |
| 2-3: Thermal Requirements | | | |
| 2-3-1: Fans | The transponder shall be cooled with independently field replaceable fans | Number of fans is an implementation option | Design |
| 2-3-3: Thermal conditions met during fan failure | The short term operating requirements must be met with 1 for N fan failure | Any one fan may fail | Design |
| 2-3-4: Air flow and Acoustic limitations | The maximum allowable air flow through the transponder is 250 CFM at a acoustic noise level of 75 db measured 0.5 meters from the transponder | Acoustic noise levels TBD. GR 63, Issue 2, R4-74 | Design |
| 2-4: Electrical Interfaces | | | |
| 2-4-1: Front Panel Electrical connectors | The transponder shall have the following front panel local management interfaces   1. RJ-45 1000Base-T connector 2. RJ45 and RS232 Serial Console port with pin-out to be compliant with existing FB infrastructure 3. At least one (1) USB-A Connectors 4. Facebook 14 –pin debug connector | TBC | Design |
| 2-4-2: Rear Panel Electrical Connector | The transponder shall have the following rear panel rack monitor management interfaces   1. One (1) or more RJ45 port used for OOB or debug console 2. GPIO Interface | TBC | Design |
| 2-5: Visual LED indicators | | | |
| 2-5-1: LED | There will be an LED array on the front panel to denote operational state of the transponder | LED logic TBD, should replicate WEDGE 100. | Design/Test |

## Client Interface Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| 3. Client Side Optical Interface Requirements | | | |
| ID | L3 Requirement | Rational/Comment | Verification |
| 3-1: Client interface types | Client ports shall accept the following client interfaces with no restrictions   1. QSFP28-CWDM4 2. QSFP28-LR4 3. Electrical DAC cables | QSFP28-LR4 client optics compliant to 70C  Electrical DAC cable TBD | Test |
| 3-2: Client Interface Power-Thermal characteristics | QSFP28-CWDM4 client optics shall have the following specifications   1. Complaint with QSFP28 CWDM4 MSA 2. 3.5 W max power consumption 3. 55C max case temperature |  | Design |
| 3-2: Number of Client interfaces | The transponder module shall have a minimum of 12 QSFP28 ports. The transponder module shall have up to a maximum of 24 QSFP28 ports. 12 or 16 client ports are acceptable.  Given engineering constraints a reasonable upper limit appears to be 16 client ports | It is possible that thermal design constraints may limit the population of client ports to 8 QSFp28 pluggable units for certain deployment scenarios | Design |
| 3-3: Client optics specifications and management | Each client optic shall demonstrate compliance as follows:   1. Mechanical compliance to SFF-8661, 2. Management compliance to SFF-8636, “SM-R” (Separable Module Required) requirements only 3. Power and low speed electrical compliance to SFF-8679 |  | Test/ Analysis |
| 3-4: Client interface 10GE support | Each QSFP28 client interface shall be able to be operated in a 4x10GE mode | Applies to both CWDM and LR4 | Test/ Analysis |

## Network Interface Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| 4. Network Side Optical Interface Requirements | | | |
| ID | L3 Requirement | Rational/Comment | Verification |
| 4-1: AC 400 | The transponder module shall contain two (2) Acacia AC400 coherent optical subsystems | Each AC400 is a 400Gbps capacity optical subsystem | Design |
| 4-2: Number of fibers | The transponder module shall have 4 fiber pairs terminated on the front panel with LC connectors. Each fiber pair shall carry 1 wavelength. |  | Design |
| 4-3: Optical Signal Format | Each line side optical signal shall consist of a selectable 100G QPSK or 200G 16-QAM optical signal at a selectable ITU grid wavelength between 1530nm-1565nm on a 50GHz grid as per ITU-T G.694.1. | See Appendix A for wavelength grid. | Design |
| 4-4: Optical Powers | Each line side optical signal shall be transmitted with an adjustable power determined by the AC400. Each line side optical signal shall be received in the range determined by the AC400. | See AC400 specifications | Test |
| 4-5: PRBS Generation | Any wavelength shall be able to be tested using internal PRBS generation, detection, and loopback capabilities |  | Design |
| 4-6: Optical Bandwidth | The maximum optical bandwidth of any signal shall be < 45GHz (-20 dB). The encapsulation format may be proprietary | TBC: The optical signal bandwidth and spectrum shall be adjustable in the AC400 DSP by setting the type of filtering (raised cosine or root-raised cosine) and roll-off factor; for example, for raised cosine spectrum, Bopt = Rs\*(1+), where Rs is the symbol rate | Test |

## Ethernet Switch Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| 5. Ethernet Switch Requirements | | | |
| ID | L3 Requirement | Rational/Comment | Verification |
| 5-1: Ethernet switch size | The transponder module shall contain a layer two switch that has up to 2400G of I/O host capacity and 800G of I/O network capacity. | Host I/O capacity TBD based on layout considerations | Design |
| 5-2: Ethernet Switch Chipset Type | The Ethernet switch shall be Broadcom Tomahawk 56960 with 2400G or more of I/O capacity and 32 Falcon cores   * P/N: BCM56962B1KFSBG * 2400G IO Bandwidth * 2000G throughput (RFC2544) * 160W max power consumption | Exact BRCM Tomahawk chip TBD. Exact specifications need to be reviewed | Design |
| 5-3: Ethernet Switch packet throughput | The Ethernet switch shall have a packet throughput capacity of at least 2000Gbps |  | Design |
| 5-4: Switch Modes | The Ethernet switch shall be able to be operated in an oversubscribed or a non-oversubscribed manner | System software will control client port population to ensure host capacity does not exceed 800 Gbps in non-oversubscribed mode | Design/Test |
| 5-5: No Frame Loss | When operated in a non-oversubscribed manner, at full line rates, and any frame size from 64 bytes to 9212 bytes, the switch shall demonstrate zero frame loss results when tested according to RFC2544 | Client frequency offset from nominal TBD  Possible reduction from full line rate to 95% to meet this requirements | Design/Test |
| 5-6: Line Interface | The Line interface shall consist of   1. Line protocol: two by 4x100GE 2. Electrical interface: CAUI-4 3. SERDES compliant to CEI-28G-SR or better | 800Gbps to two AC400 subsystems | Design/Test |
| 5-7: Client Interface | Each 100GE client interface shall consist of   1. Client protocol: 4x25GE 2. Electrical interface: CAUI-4 3. SERDES compliant to CEI-28G-VSR or better | Number of client interfaces determined above | Design/Test |
| 5-8: 4x10GE Client Mode | Each client interface shall be able to be operated in a 4x10GE mode   1. Client protocol: 4x10GE 2. Electrical interface: CAUI-4 3. SERDES compliant to CEI-28G-VSR or better |  | Design/test |
| 5-9: No Client Port Restrictions | Client interfaces shall be selectable for each port with no restrictions |  | Design/Test |
| 5-10: 100G Port Mapping | 100G host (client) and network ( line) ports shall be mapped across the BRCM SERDES according to the following table   |  |  |  | | --- | --- | --- | | Set | Host SERDES | Network SERDES | | 1 | 0,1,2,3 (4,5) | 6,7 | | 2 | 8,9,10,11 (12,13) | 14,15 | | 3 | 16,17,18,19 (20,21) | 22,23 | | 4 | 24,25,26,27 (28,29) | 20,31 | | Assumes 12 client ports. If 16 client ports are designed, then values in parenthesis “()” are also used). TBC with Broadcom |  |
| 5-10: Client Port Monitoring | Ingress and egress client performance monitoring shall make per channel statistics counters available in integrated Ethernet MACs including   1. IEEE 802.3 clause 30, Basic, mandatory, and recommended options 2. RFC 2665 (MIB) 3. RFC 2819 (RMON) | See Appendix G for detailed PM description | Design/Test |
| 5-11: PRBS Generation | All SERDES must be capable of generating and detecting unframed PRBS-7, PRBS-23 and PRBS-31 patterned on outgoing data stream |  | Design/Test |
| 5-12: Line Loopbacks | Line Loopbacks: All SERDES must be capable of line (or facility) loopbacks, in which a received signal can be looped back towards its corresponding transmitter. |  | Design/Test |
| 5-13: Diagnostic Loopbacks | Diagnostic Loopbacks: All SERDES must be capable of diagnostic loopbacks, in which a transmitted signal can be looped back towards its corresponding receiver. |  | Design/Test |
| 5-14: LLDP Snooping | The switch shall support LLDP snooping, specifically   1. Snoop and Forward 2. Snoop and Drop | See Appendix E for detailed Snoop and Drop Requirements | Design/Test |
| 5-15: Switch Management | All provisioning, performance, and monitoring functions must be available from the local and remote management interfaces |  | Design/Test |

## Coherent Optical Subsystem Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| 6. Coherent Optical Subsystem Requirements | | | |
| ID | L3 Requirement | Rational/Comment | Verification |
| 6-1: Acacia AC 400 Specifications | The transponder shall use two (2) Acacia AC400 Modules. All specifications for the AC400 module shall apply to this requirements document.   1. See Acacia AC400 hardware specification Version AC400-001-290 2. See Acacia AC400 Software specification 1.0 |  | Design |
| 6-2:Number of AC 400 Subsystems | The transponder shall meet all requirements (except line side capacity) if populated with one AC 400 subsystem. The transponder shall not require both AC 400 subsystems to be populated | A transponder should be able to be manufactured and tested with a single AC 400 populated | Design/Test |
| 6-3: Host Control | The AC400 shall permit full host control for turn-up or autonomous control (no host control) for turn-up | See Appendix C | Design/Test |
| 6-4: AC400 Management | The AC400 shall be controlled via the MDIO Bus and the discrete control and alarm pins |  | Design/Test |
| 6-5: AC 400 Management | All coherent optical module provisioning, performance, and monitoring functions must be available from the local and remote management interfaces |  | Design/Test |

## Main Board Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| 7. Main Board Requirements | | | |
| ID | L3 Requirement | Rational/Comment | Verification |
| 7-1: Overall | The main board shall house the client optic cages, the Ethernet switch subsystem and the Coherent optical subsystems, as well as provide interfaces to the COM-E board and the BMC board | Client optic cages should be thermally enhanced | Design |
| 7-2: Power Requirements | The main board shall provide secondary power to the subsystems with necessary voltages, stabilities, in-rush currents, and start-up sequences, meeting Level 4 specifications for each subsystem.  AC400 requires a single 12V bus with detailed power specifications contained in the AC400 specification | Detailed design requires review of component specifications for power and in-rush current | Design/Test |
| 7-3: I2C Bus | The main board shall have an I2C bus for communicating with all I2C components as per their Level 4 requirements |  | Design |
| 7-4: MDIO Bus | The main board shall have an MDIO bus for communicating with all MDIO components as per their Level 4 requirements. |  | Design |
| 7-5: AC400 Interface | The main board shall provide interfaces to all the AC400 low speed control and alarm pins. There are eight (8) non-MDIO control pins and thirteen (13) non-MDIO Alarm Pins | See AC400 HW and SW specification | Design |
| 7-6: AC400 OHIO Interface | The main board shall provide a HW interface to the AC400 OHIO interface, but logic in FPGA or CPLD main be omitted | TBC. FB does not expect to use the OHIO interface in initial releases of Voyager | Design |

## System Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| 8: System Requirements | | | |
| ID | L3 Requirement | Rational | Verification |
| 8-1: Cold Start | The transponder module shall meet all requirements within 2 minutes after power-up from cold start |  | Design |
| 8-2: Reset Timing | The transponder module shall have an active reset capability and all requirements shall be met within 60 seconds of de-assertion of a reset event |  | Design/Test |
| 8-3: Firmware Upgrade | The transponder module firmware shall be in-service upgradable with no impact to the data bearing signal traffic. Necessary alarm masking and OAMP (FCAPS) functionality must be disabled during the FW upgrade process. |  | Design/Test |
| 8-4: AC400 Firmware Upgrade | AC400 shall permit firmware-software upgrade. This may or may not be service affecting. Necessary alarm masking and OAMP (FCAPS) functionality must be disabled during the FW upgrade process. |  | Design/Test |
| 8-5: Broadcom Tomahawk Firmware Upgrade | Broadcom shall permit firmware-software upgrade. This may or may not be service affecting. Necessary alarm masking and OAMP (FCAPS) functionality must be disabled during the FW upgrade process. |  | Design/Test |
| 8-6: Firmware Update Timing | All software-firmware updates must take place within 2 minutes |  | Test |
| 8-7; Internal Polling | Internal polling of all monitoring and control points shall exceed the control actuator requirements by at least 4x |  | Design/Test |
| 8-8: Diagnostic States | The transponder shall be able to placed into a diagnostic state for debugging that selectively disables various control loops and alarm functionality. This is not intended to be used as an operational mode, but for troubleshooting and test and turn-up |  | Design/Test |
| 8-9: Fault Monitoring | Within the transponder there will be various performance monitoring and fault monitoring points. All diagnostic monitors shall use some approach to reduce unwanted false alarms. A adjustable de-bouncing strategy shall be employed to mitigate marginal readings on monitoring points (such as requiring 3 consecutive poor readings). |  | Design/Test |

## Control Plane Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| 9-1: COM-E Requirements | | | |
| ID | L3 Requirement | Rational/Comment | Verification |
| 9-1-1: COM-E Server | Transponder shall use a COME server design based on Intel Broadwell-DE processor |  | Design |
| 9-1-2: COM-E Server Part Number | COME server design shall use the following part  Intel part # D1517/25W/4 core/8thread/1.6GHz base Frequency/2.2GHZ Turbo Frequency/LLC 6 MB |  | Design |
| 9-1-3: COM-Server Form Factor | COM-E server design shall be able to use either the Basic or Compact form factor |  | Design |
| 9-1-4: COM-E SSD | The COME Server design shall use a pluggable SSD, part number M.2, 128GB SLC/TLC SSD |  | Design |
| 9-1-5: COM-E Server TPM Interface | COM-E server design shall have an external TPM interface with I2C bus SLB9645 |  | Design |
| 9-2. Board Management Controller Requirements | | | |
| 9-2-1: BMC Chip | The BMC design shall use the Aspeed AST2520 | Same as used in Galaxy CMM | Design |
| 9-2-2: BMC TPM Interface | The BMC design shall have an external TPM interface with I2C bus SLB9645 |  | Design |

## Application Software Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| 10. Software Requirements | | | |
| ID | L3 Requirement | Rational/Comment | Verification |
| 10-1: State and Mode Requirements | | | |
| 10-1-1 | Module shall support operational (in-service) and administrative (out of service) states. |  | Design |
| 10-1-2 | Module shall support either AC400 (there are two) to be independently in-service or Out of service |  | Design |
| 10-1-3 | Module shall support minor and major alarm states |  | Design |
| 10-1-4 | Module shall support operation in “Transponder Mode” or “Regenerator Mode”  Transponder Mode: Data plane subtends client port and network ports  Regenerator Mode: Client ports are ignored and network port is looped back at network facing BCRM SERDES |  | Design |
| 10-1-5 | A detailed state diagram shall be constructed | See Appendix C | Design |
| 10-2: Firmware and Software Upgrade-Downgrade | | | |
| 10-2-1 | FW and SW upgrades shall be able to be performed in operational and administrative states |  | Design |
| 10-2-2 | FW and SW upgrades shall be conducted through local management port and northbound interface |  | Design |
| 10-2-3 | Module shall always store two (2) complete SW package revision images |  | Design |
| 10-2-4 | Any new FW-SW image may or may not include AC400 and/or BRCM Tomahawk changes |  | Design |
| 10-2-5 | Module shall confirm proper download of new SW image. Module shall confirm that SW image is compatible with module |  | Design |
| 10-2-6 | Module shall permit automatic and manual upgrade options for good download image |  | Design |
| 10-2-7 | Module shall support manual downgrade to last known good image if problem with upgrade |  | Design |
| 10-2-8 | Upgrade process shall take < 2 minutes |  | Design |
| 10-2-9 | Module shall have ability to restore to factory defaults |  | Design |
| 10-3. Security | | | |
| 10-3-1 | The transponder shall provide 3 tiers of access, with configurable user rights and capabilities   1. System administrator 2. Privileged User access 3. User Access |  | Design |
| 10-3-2 | The transponder shall provide secure access to its applications, including but not limited to User access profiles, User ID/s and Passwords, and a mechanism to restrict users to the data and transactions necessary |  | Design |
| 10-4. Startup Modes and Host Control | | | |
| 10-4-1 | The transponder shall support power-on (or Cold restart) and Warm restart modes | See Appendix C | Design |
| 10-4-2 | The module shall support full host control of the AC 400 coherent optical subsystems | See Appendix C | Design |
| 10-4-3 | The module shall support no host control (autonomous operation) of the AC 400 coherent optical subsystems | See Appendix C | Design |
| 10-5. Configuration Management | | | |
| 10-5-1 | Equipment Inventory may be performed in Operational and Administrative State |  | Design |
| 10-5-2 | Transponder module inventory/configuration management parameters shall include: Name, Vendor, PN, SN, HW version, FW Version FPGA version, and any other necessary parameters |  | Design |
| 10-5-3 | Client interface optic inventory/configuration management parameters shall include: populated/not populated, Name, Vendor, PN, SN, HW version, FW Version and any other necessary parameters |  | Design |
| 10-5-4 | Coherent Optical subsystem Inventory parameters shall include: populated/not populated, Name, Vendor, PN, SN, HW version, FW Version and any other necessary parameters |  | Design |
| 10-5-4 | Transponder Module shall have inventory fields to denote location in chassis, shelf, rack, row, section of data center (overall location) |  | Design |
| 10-6. Performance Management | | | |
| 10-6-1 | There shall be 3 classes of Performance Management parameters with different measurement interval, measurement reporting, and storage requirements |  | Design |
| 10-6-2 | PM Class A shall support   1. Measurement interval: 1 second 2. Measurement reporting: Max, Min, Ave 3. Storage: real time or 24 hours | See Appendix D | Design |
| 10-6-3 | PM Class B shall support   1. Measurement interval: 15 Minutes 2. Measurement reporting: Max, Min, Ave 3. Storage: 24 hours | See Appendix D | Design |
| 10-6-4 | PM Class C shall support   1. Measurement interval: 24 hours 2. Measurement reporting: Max, Min, Ave 3. Storage: 365 days | See Appendix D | Design |
| 10-6-5 | The transponder shall support Client interface PM’s outlined in Appendix D | See Appendix D | Design |
| 10-6-6 | The transponder shall support network interface PM’s outlined in Appendix D | See Appendix D | Design |
| 10.7. Alarm Management | | | |
| 10-7-1 | Transponder shall support alarms at each layer and each interface as indicated in Appendix F | See Appendix F | Design |
| 10-8. Flight Recorder | | | |
| 10-8-1 | The transponder shall support a Flight Recorder log in which entries by users, configuration changes, and all PM’s and alarms are recorded |  | Design |
| 10-8-2 | The Flight Recorder log shall store up to 365 days of data and shall be downloadable via the local console or northbound interface |  | Design |

## Regulatory and Compliance Requirements

These requirements do not have to be fully tested and formally certified in Phase 1.0 of this program

|  |  |  |  |
| --- | --- | --- | --- |
| 11: Regulatory and Compliance Requirements | | | |
| ID | L3 Requirement | Rational | Verification |
| 11-1: NEBS GR-1089-CORE | The Transponder module shall meet the following requirements   1. GR-1089 Section 7: Electrical Safety 2. GR-1089 Section 9: Bonding and Grounding |  | Test |
| 11-2: NEBS GR-63-CORE | The Transponder module shall meet the following requirements   1. GR-63 Section 2: Spatial Requirements 2. GR-63 Section 4.2: Fire Resistance- Component 3. GR-63 Section 4.2: Flame Spread 4. GR-63 Section 4.3: Handling and transportation 5. GR-63 Section 4.5: Airborne contaminants 6. GR-63 Section 4.7: illumination |  | Test |
| 11-3: GR-78-CORE | The Transponder module shall meet all requirements outlined in GR-78-CORE |  | Test |
| 11-4: Laser Safety | The Transponder module shall meet the following requirements:   1. Laser Safety: the overall system shall be classified as Class 1M and compliant with the following laser safety regulations 2. IEC/EN 60825-1: 2007 3. IEC/EN 60825-2: 2004 + A1 + A2 4. ANSI Z136.2 5. FDA 21 CFR 1040: Performance Standard for Light Emitting Products |  | Test |

## Reliability and Quality Assurance Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| 12: Reliability and Quality Assurance Requirements | | | |
| ID | L3 Requirement | Rational | Verification |
| 12-1: No Epoxy in Optical Path | No components used in the Transponder shall contain epoxy in the optical path |  | Design |
| 12-2: Life expectancy | The Transponder shall have a product life expectancy of 5 years |  | Analysis |
| 12-3: FIT Rate | The Vendor shall compute the FIT rate of the Transponder based on Telcordia SR-332 at nominal expecting operating temperatures and 60% confidence intervals |  | Analysis |
| 12-4: Qualification Strategy | The vendor shall outline a product qualification strategy and EVT-DVT-PVT verification strategy |  | Analysis |
| 12-5: AC400’s fail separately | Failure of one AC400 module shall not affect the other AC 400 module | Failures must be isolated | Design/Test |
| 12-6: FMEA | The vendor shall perform a detailed FMEA during the design phase of this program, outlining critical potential failure modes and impacts on module performance, alarm indications, and corrective actions. | TBD | Analysis |

## Transponder Performance Testing

Performance testing requirements encompass the testing that will determine if the fundamental data carrying capability of the transponder is adequate. These tests are performed after subsystem and EVT is complete. This is not meant to outline all testing to all requirements, but fundamental performance parameters. These are effectively criteria to shipment to Facebook

|  |  |  |  |
| --- | --- | --- | --- |
| 13: Performance Testing Requirements | | | |
| ID | L3 Requirement | Rational | Verification |
| 13-1: Snake Test | A snake test shall be performed under the following conditions with no packet loss as per RFC2544:   1. Minimum, ambient, and maximum temperature conditions 2. Tested with both AC and DC power supplies and with voltages at minimum, normal, and maximum allowable voltage levels 3. AC400 set at minimum, average and maximum receive optical powers 4. Ethernet switch configured in a non-oversubscribed mode 5. Tested for 24 hours 6. AC400 modules all in WDM loop back mode | Four corners testing at temperature, time, and voltage TBC  Test to be performed at ODM | Test |
| 13-2: OSNR Test | The transponder BER vs. OSNR performance shall be characterized under the the following conditions.   1. Minimum, ambient, and maximum temperature conditions 2. Tested with both AC and DC power supplies and with voltages at minimum, normal, and maximum allowable voltage levels 3. AC400 set at minimum, average and maximum receive optical powers 4. OSNR loading with laboratory equipment 5. No additional TX to RX transmission impairments   The BER vs. OSNR performance of the transponder shall be within 0.5 dB of the bare AC 400 subsystem when tested on its evaluation board. | Four corners testing at temperature and voltage TBC  Test to be performed at Facebook | Test |
| 13-3: Burn-In Test | The transponder BER performance shall be characterized under the following conditions.   1. Maximum temperature conditions 2. AC400 set at minimum receive optical powers 3. OSNR loading to 18 dBm\*0.1 nm 4. 96 hour test 5. No additional TX to RX transmission impairments   The Pre-FEC BER, the Post FEC-BER, and # of uncorrected and corrected frames shall be characterized for a minimum of 96 hours | Performance test to be performed at Facebook  OSNR loading and time-temperature conditions to be confirmed | Test |

# Appendices

## WEDGE100 Design Specifications

The following are the list of WEDGE100 design specifications

* Design specification document
* Electrical schematics for both main & fan board
* Electrical BOM for both main & fan board
* PCB Board files for both main & fan board
* PCB Gerber files for both main & fan board
* Mechanical 3D & 2D files for the complete product
* Top level BoM with mechanical & electrical components

## Wavelength Grid

The wavelength grid is the standard ITU grid on a 50 GHz spacing, shown below. Since this requirement is for 96 channels, and 100 channels are listed below, there is a slight amount of flexibility about defining the first channel.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **100 GHz Grid** | | **50 GHz Offset** | |  | **100 GHz Grid** | | **50 GHz Offset** | |
| **CH #** | **nm** | **THz** | **nm** | **THz** | **CH #** | **nm** | **THz** | **nm** | **THz** |
| 1 | 1528.77 | 196.10 | 1529.16 | 196.05 | 26 | 1548.51 | 193.60 | 1548.91 | 193.55 |
| 2 | 1529.55 | 196.00 | 1529.94 | 195.95 | 27 | 1549.32 | 193.50 | 1549.72 | 193.45 |
| 3 | 1530.33 | 195.90 | 1530.72 | 195.85 | 28 | 1550.12 | 193.40 | 1550.52 | 193.35 |
| 4 | 1531.12 | 195.80 | 1531.51 | 195.75 | 29 | 1550.92 | 193.30 | 1551.32 | 193.25 |
| 5 | 1531.90 | 195.70 | 1532.29 | 195.65 | 30 | 1551.72 | 193.20 | 1552.12 | 193.15 |
| 6 | 1532.68 | 195.60 | 1533.07 | 195.55 | 31 | 1552.52 | 193.10 | 1552.93 | 193.05 |
| 7 | 1533.47 | 195.50 | 1533.86 | 195.45 | 32 | 1553.33 | 193.00 | 1553.73 | 192.95 |
| 8 | 1534.25 | 195.40 | 1534.64 | 195.35 | 33 | 1554.13 | 192.90 | 1554.54 | 192.85 |
| 9 | 1535.04 | 195.30 | 1535.43 | 195.25 | 34 | 1554.94 | 192.80 | 1555.34 | 192.75 |
| 10 | 1535.82 | 195.20 | 1536.22 | 195.15 | 35 | 1555.75 | 192.70 | 1556.15 | 192.65 |
| 11 | 1536.61 | 195.10 | 1537.00 | 195.05 | 36 | 1556.55 | 192.60 | 1556.96 | 192.55 |
| 12 | 1537.40 | 195.00 | 1537.79 | 194.95 | 37 | 1557.36 | 192.50 | 1557.77 | 192.45 |
| 13 | 1538.19 | 194.90 | 1538.58 | 194.85 | 38 | 1558.17 | 192.40 | 1558.58 | 192.35 |
| 14 | 1538.98 | 194.80 | 1539.37 | 194.75 | 39 | 1558.98 | 192.30 | 1559.39 | 192.25 |
| 15 | 1539.77 | 194.70 | 1540.16 | 194.65 | 40 | 1559.79 | 192.20 | 1560.20 | 192.15 |
| 16 | 1540.56 | 194.60 | 1540.95 | 194.55 | 41 | 1560.61 | 192.10 | 1561.01 | 192.05 |
| 17 | 1541.35 | 194.50 | 1541.75 | 194.45 | 42 | 1561.42 | 192.00 | 1561.83 | 191.95 |
| 18 | 1542.14 | 194.40 | 1542.54 | 194.35 | 43 | 1562.23 | 191.90 | 1562.64 | 191.85 |
| 19 | 1542.94 | 194.30 | 1543.33 | 194.25 | 44 | 1563.05 | 191.80 | 1563.45 | 191.75 |
| 20 | 1543.73 | 194.20 | 1544.13 | 194.15 | 45 | 1563.86 | 191.70 | 1564.27 | 191.65 |
| 21 | 1544.53 | 194.10 | 1544.92 | 194.05 | 46 | 1564.68 | 191.60 | 1565.09 | 191.55 |
| 22 | 1545.32 | 194.00 | 1545.72 | 193.95 | 47 | 1565.50 | 191.50 | 1565.90 | 191.45 |
| 23 | 1546.12 | 193.90 | 1546.52 | 193.85 | 48 | 1566.31 | 191.40 | 1566.72 | 191.35 |
| 24 | 1546.92 | 193.80 | 1547.32 | 193.75 | 49 | 1567.13 | 191.30 | 1567.54 | 191.25 |
| 25 | 1547.72 | 193.70 | 1548.11 | 193.65 | 50 | 1567.95 | 191.20 | 1568.36 | 191.15 |

## State Diagram for Transponder Module

The state diagram for the Transponder Module is shown below in Figure 6. The circles represent transition states and the squares represent static states. The blue lines represent transitions that are autonomous to the module and the black lines represent transitions activated by either human or higher-level management protocol interaction. See Reference 1 for more details.



Figure . Transponder module state diagram

**Power-up and Resets**

The Transponder Module main board must support power-on and reset modes. Furthermore, each coherent module must also support power on and reset modes. Hence there are effectively nested loops that denote the status of the overall module main board and its two AC400 coherent optical subsystems.

**Module Power-up**

Upon module power up the coherent optical modules remain off. Once the main board is initialized it enters the Module OOS state. In this state the module is ready to support all functions, but the AC400’s remain powered off.

**Cold Restart**

A cold restart initializes all hardware on the module and is, thus, service-affecting. The following is a list of conditions that result in a cold restart:

* Module power-up
* Manually initiated cold restart by the user
* A software download

After a cold restart, the boot loader performs the necessary tests and initialization of microprocessor, Flash, SDRAM and support devices. When completed the operating system and applications are loaded. Any other start-up or self-test procedures are performed. A cold restart of the transponder module performs the following actions:

* Clears all alarms and logs
* Clears all collected PM data (current and historical)
* Clears all active loopbacks and forced laser settings
* Releases any active PRBS testing or latency measurement
* Resets and initializes all hardware
* Loads and provisions all hardware

Warm Restart

A warm restart initializes all software on the modules and is not considered service-affecting, however, some functions may be interrupted during a warm restart. The following is a list of conditions that results in a warm restart:

* Manually initiated warm restart by the user
* Non-service effecting software downloads
* Software watchdog timeout

A warm restart restarts and initializes the microprocessor and restarts the software. Since no re-loading, re-configuration, or testing of the HW devices are performed, a warm restart is not service effecting. A warm restart of the transponder module performs the following actions:

* Clears all alarms
* Clears all collected PM data (current and historical)
* All TCAs are cleared as a result of clearing the PM data
* Clears all active loopbacks and forced laser settings
* Releases any active PRBS testing or latency measurement
* Resets and initializes the microprocessor
* Loads and provisions the microprocessor



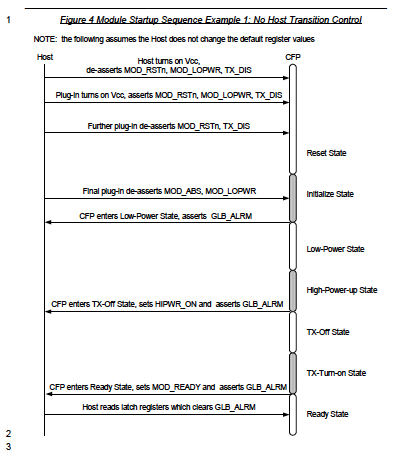


Figure . Host to AC400 module control sequence. This demonstrates full Host control

## Client and Network Interface Transponder Performance Management

This Appendix contained detailed client and network performance monitoring requirements. Performance monitoring provides early detection of service degradation and permits users to take corrective action before a service outage occurs. While the modules that comprise this system are required to have comprehensive performance monitoring capability, it is possible and in fact likely that the application software developed to monitor the entire system and integrate the PM’s into a larger network PM strategy will only monitor a subset of these PM’s. However, the modules themselves need to have comprehensive PM capability.

All measurement interval, measurement reporting, and storage requirements are described below for all clients and network PM’s. These parameters may be set up for each PM.

|  |  |  |  |
| --- | --- | --- | --- |
| PM Configuration | Measurement Interval | Measurement reporting | Storage |
| A | 1 second | Instantaneous | Real time and/or 24 hours |
| B | 15 minutes | Max, Min, Ave | 24 hours |
| C | 24 hours | Max, Min, Ave | 365 days |

Threshold crossing alerts are used to indicate to the user that a PM needs attention. A TCA may or may not trigger and alarm, and alarm setpoints can be different from TCA’s Minor and major alarm thresholds denote actions that would be taken (minor, just assert the minor alarm, major, perhaps turn off the equipment) this is captured in the Fault management section of this requirements document

Transponder Client PM’s

This section assumes client interfaces are QSFP28, and client interface performance management is also documented in Reference 2.

| Layer | Sub-layer | PMs | Thresholds | Config |
| --- | --- | --- | --- | --- |
| Equipment | Pluggable QSFP Module | * Temperature * Voltage | * High and Low * High and Low | * A, B, C * A, B, C |
| Physical layer | TX | * Transmitted optical power (x4) * Laser bias current (x4) * Laser temperature (x4) | * High and Low * High and Low * High and Low | * A, B, C * A, B, C * A, B, C |
| RX | * Received Optical Power (x4)- OMA or Average | * High and Low | * A, B, C |
| Ethernet | PCS- RX | * Errored Seconds * Code Violatiions | * High * High | * B, C * B, C |
| PCS-TX | * Errored Seconds * Code Violations | * High * High | * B,C * B, C |
| MAC/Packet- Received | * Frames * Pause Frames * CRC-Errored Frames * Total Bytes | * None * High * High * None | * B, C |
| MAC/Packet-Transmitted | * Frames * Pause Frames * CRC-Errored Frames * Total Bytes | * None * High * High * None | * B, C |

Transponder Network PM’s (For a single coherent AC400 Modules)

| Layer | Sub-layer | PMs | Thresholds |
| --- | --- | --- | --- |
| Equipment | AC400 Module | * Temperature * Voltage | * High and Low * High and Low |
| Physical layer | Transmit (x2) | * Tx optical power * Tx Laser bias current * Tx Laser temperature | * High and Low * High and Low * High and Low |
| Receive (x2) | * Received Optical Power * Chromatic Dispersion * Differential Group Delay * Carrier Frequency Offset * LO Laser Bias Current * LO Laser Temperature | * High and Low * High and Low * High and Low * High and Low * High and Low * High and Low |
| OTN | FEC | * FEC corrected errors * FEC uncorrected errors | * High * High |
| OTU | * To be determined | * High |



* ACT: Activation (in the TCM ACT byte)
* AIS: Alarm Indication Signal
* APS: Automatic Protection Switching
* BDI: Backward Defect Indication
* BEI: Backward Error Indication
* BIAE: Backward Incoming Alignment Error
* BIP: Bit Interleaved Parity
* BMP: Bit-synchronous Mapping Procedure
* CAUI: (Chip to) 100Gb/s Attachment Unit Interface
* CSF: Client Signal Fail
* DEG: Degraded Defect
* DM: Delay Measurement
* EXP: Experimental
* FAS: Frame Alignment Signal
* FEC: Forward Error Correction
* FTFL: Fault Type and Fault Location
* GCC: General Communication Channel
* GMP: Generic Mapping Procedure
* IAE: Incoming Alignment Error
* LCK: Locked Defect
* LF: Local Fault
* LFOS: Local Fault Ordered Set
* LOAM: Loss of Alignment Marker
* LOBL: Loss of Block Lock
* LOF: Loss of Frame
* LOFLOM: Loss of Frame and Loss of Multiframe
* LOM: Loss of Multiframe
* LOS: Loss of Signal
* LTC: Loss of Tandem Connection
* MFAS: MultiFrame Alignment Signal
* MSI: Multiplex Structure Identifier
* OCI: Open Connection Indication
* ODU: Optical Channel Data Unit
* OMFI: OPU Multi-Frame Identifier
* OPU: Optical Channel Payload Unit
* OTN: Optical Transport Network
* OUT: Optical Channel Transport Unit
* OTUJ: Optical Channel Transport Unit-J
* PCC: Protection Communication Channel
* PCS: Physical Coding Sublayer
* PLM: Payload Mismatch
* PM: Path Monitoring
* PSI: Payload Structure Identifier
* PT: Payload Type
* RES: Reserved for future international standardization
* RF: Remote Fault
* RFOS: Remote Fault Ordered Set
* RS: Reed-Solomon
* SM: Section Monitoring
* STAT: Status Field
* TCM: Tandem Connection Monitoring
* TIM: Trace Identifier Mismatch
* TTI: Transmitted Trace Identifier

## Detailed LLDP Snoop and Drop Requirements

The aggregation subsystem shall have the ability to process LLDP packets in order to assess what client devices (routers) are attached to each optical port. The LLDP protocol is described in IEEE 802.1AB Link layer Discovery Protocol, Reference 3. LLDP agents typically operate in a one of three modes

1. *Transmit-only mode:* The agent can only transmit the information about the capabilities and the current status of the local system.
2. *Receive-only mode:* The agent can only receive information about the capabilities and the current status of the remote systems.
3. *Transmit and receive mode:* The agent can transmit the local system capabilities and status information and receive remote system's capabilities and status information.

Facebook has two required operational modes for LLDP

1. Snoop and Forward
2. Snoop and Drop

A third operational mode is deactivated (or transparent), in which the optical node ignores the LLDP packet. These modes are described in Figure 7.

Snoop and Forward

In this mode a Facebook Router A sends an LLDP announcement, Facebook optical node A will inspect it, store the data for query and pass it on to Facebook Optical Node Z. Facebook Optical Node Z will forward it on to Facebook Router Z. In the reverse direction, Facebook Router Z sends an LLDP announcement, Facebook optical node Z will inspect it, store the data for query and pass it on to Facebook Optical Node A. Facebook Optical Node A will forward it on to Facebook Router A.

Snoop and Drop

In this mode a Facebook Router A sends an LLDP announcement, Facebook optical node A will inspect it, store the data for query and pass it on to Facebook Optical Node Z. Facebook Optical Node Z will drop the LLDP packet. The LLDP packet payload (TLV parameters) will not be forwarded to the 3rd party router Z. In the reverse direction, the 3rd Party Router Z sends an LLDP announcement, Facebook optical node Z will inspect it, store the data for query and pass it on to Facebook Optical Node A. Facebook Optical Node A will forward it on to Facebook Router A.

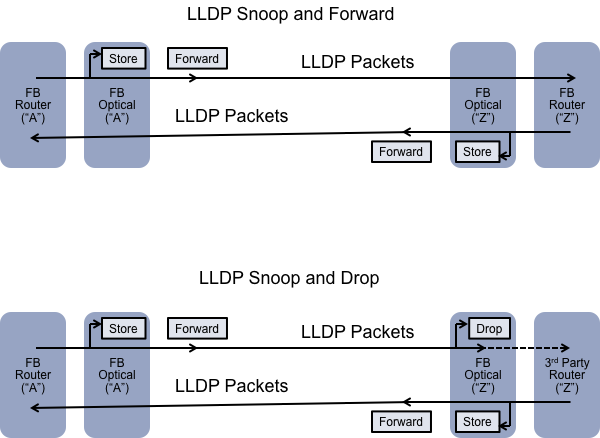


Figure . LLDP packet snooping, showing LLDP Snoop and Forward and LLDP Snoop and Drop

In the case of Snoop and Forward, the network ports are operated in a transparent, or deactivated mode. The host port interrogates the LLDP packet, stores the value in the local optical node, and forwards the LLDP packets to the network port. This information does not need to be stored by the remote optical node Z. However, in a specific design implementation, it remote information from optical node A could be stored in optical node z and vis-a-versa (not shown).

In the case of Snoop and Drop, the network ports are operated in a transparent, or deactivated mode. However, the FB optical Node Z (attached to the 3rd party router) host port is operated in a different state. Now, the in the transmit direction the port is operated in a state where the LLDP packets are dropped, or in a specific design implementation where the TLV payload is set to null values. However, in the receive direction, the host port interrogates the LLDP packet, stores the values in the local optical node, and forwards the LLDP packets to the network port.

LLDP information includes mandatory and *optional* fields listed below:

* System name and description
* Port name and description
* IP management address
* *VLAN name*
* *System capabilities (switching, routing, etc.)*
* *MAC/PHY information*
* *MDI power*
* *Link aggregation*

## Alarm Management



## References

1. CFP MSA Management Interface Specification, Version 2.4 r06b, June 8th 2015
2. SFF-8636 Specification for Management Interface for Cabled Environments, Revision 2.6, June 19, 2015.
3. Acacia AC400 HW specification: AC400-001-290\_ Product\_Facebok\_Config\_Rev0p1, 2016
4. Acacia AC400 Software Specification: AC400\_Software\_Interface\_Specifiction, Document Number 120-0012-00, Nov 5th, 2015