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MOVING
HOSPITALITY
FORWARD

HTNG FIBER TO THE ROOM DAY 2 SUPPORT FOR MANAGED SERVICE PROVIDERS AND HOTELIERS

Version 1.0

About HTNG

Hospitality Technology Next Generation (HTNG) is a non-profit association with a mission to foster, through collaboration and partnership, the development of next-generation systems and solutions that will enable hoteliers and their technology vendors to do business globally in the 21st century. HTNG is recognized as the leading voice of the global hotel community, articulating the technology requirements of hotel companies of all sizes to the vendor community. HTNG facilitate the development of technology models for hospitality that will foster innovation, improve the guest experience, increase the effectiveness and efficiency of hotels, and create a healthy ecosystem of technology suppliers.

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1 Introduction

Hotels of all sizes continue to see the benefit to accelerate their deployments of Fiber to the Room (FTTR) solutions. These technologies include both Active Ethernet as well as Passive Optical LAN solutions (currently based on G-PON1 and XGS-PON technologies) over a fiber deep architecture. FTTR solutions range from metropolitan high-rise hotels to sprawling seaside resorts. In fact, hoteliers have even extended usage of Passive Optical LAN from fiber to the room applications to connecting smart buildings, Internet of Things and wireless technologies.

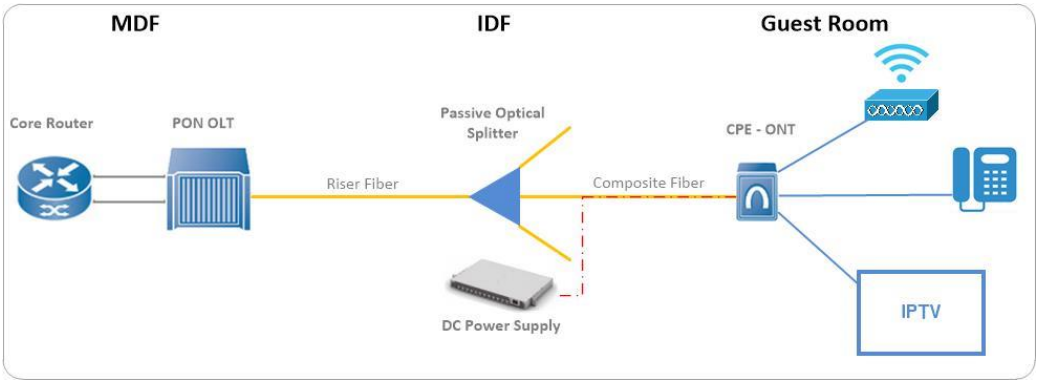

Figure 1 Fiber to the Room PON Topology

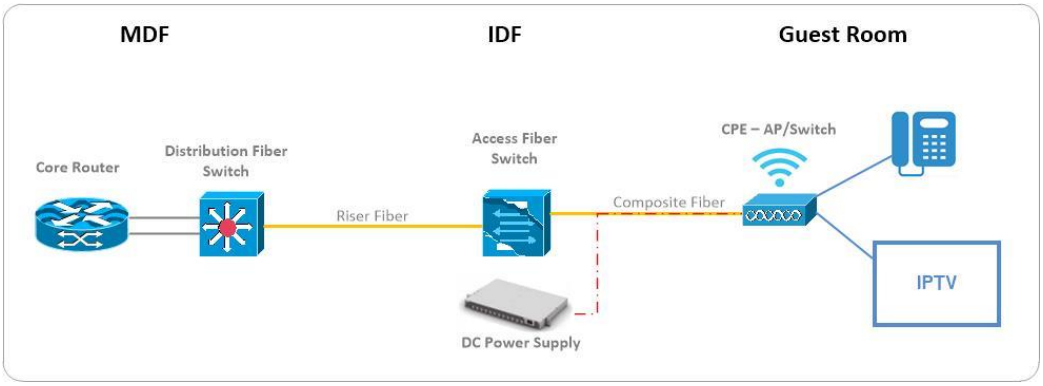

Figure 2: Fiber to the Room Active Ethernet Topology

[1] The term G-PON refers to a specific ITU standard and not to Passive Optical LAN as a whole. With the advent of XGS-PON, NG-PON2 and other standards, the appropriate term is Passive Optical Network (PON) which encompasses the breadth of the Optical LAN standards.

2 Solution Documentation Requirements

Upon completion of a FTTR deployment, or any network deployment for that matter, it is best practice for the network integrator to provide documentation to the owner and/or network management company detailing the specifics about the network at that specific property. The following items are suggested.

2.1 Project Design / As-Builts

Naming conventions, port assignments and dial plan information may vary based on the number of installations. What is important is that the nomenclature is consistent and identifiable, and in many instances is site- or brand-specific. This is a definable structure whose enforcements need be conveyed to and followed by the installing party. The introduction of a FTTR design as the networking system does not change this requirement. Adding on additional fields such as the in-room electronics or Customer Premise Equipment (this would include the AE switch or the PON ONT) serial number is no different than adding any equipment manufacturer's nomenclature to tracking systems. Adding CPE serial numbers to location mapping specifically is a normal function of a FTTR system and should be readily trackable in label fields.

- Naming convention / List of rooms CPE serial numbers and/or FSAN numbers (for PON ONTs)
- Port assignments
- Analog Phone Port assignments and Room Extension List
- Dial Plan information

2.2 Project Design / Topology

Design and topology documentation requirements do not change whether the installed system is an Active Ethernet system or a PON system. What does change is understanding that point-to-multipoint connections exist within the network. These types of connections have been defined for some time and PON systems are implemented using them. This is a matter of training versus changing the way documentation is prepared.

2.3 Project BOM / Material List

This is a list of all of the passive and active components required for the project.

2.4 Spares List

This is common between Active Ethernet systems and PON systems. It is simply a different set of spares between the two designs. AE Switching systems require power supplies, Optical Transceivers (SFP, SFP+, XFP, GBIC, etc. - both 1Gb and 10Gb), patch cords (fiber and category cable), PoE power injectors (in some cases), jack plates and the in-room AE switches. Replacement AE switches may have some configuration on them but will typically require additional configuration to be placed in service. PON systems have the spares listed below, but a big difference is that replacing the parts requires little to no configuration and is capable of being done locally. The PON infrastructure standards define single-mode fiber with SC/APC connectors on the ONT and may vary between LC and SC connectors in the IDF/MDF locations. The OLT fiber connector is defined as single-mode fiber with SC/UPC connectors. This is much simpler than trying to figure out which fiber type was pulled to intermediate closets in the infrastructure, and which type of SFPs were used as required in the active ethernet environment.

Example list of FTTR spares:

- AE switches or PON ONTs
- SFPs
  - Downlink AE SFPs or PON OLT SFPs
  - Uplink 1Gb / 10Gb SFPs
- Fiber patch cables
  - Duplex
  - Simplex
  - Validate termination types (LC APC – SC UPC, for example)
  - Active ethernet has many different possible termination types. In PON, there is one defined termination type of SC/APC with single mode fiber.
- PON Optical Splitter (validate termination types on splitter per system)
  - Termination types will always be SC/APC unless standards are not being followed. The only choice in the splitter is sparing the appropriate size splitter which is normally consistent across an entire install. The very low rate of failure of these devices puts into question the need for sparing. One suggestion is to set-up a testbed with a dedicated splitter which could be used as the spare splitter.
- Power source equipment
  - Local CPE power brick if applicable
  - Remote power supply modules, if applicable

2.5 Manufacturer Installation Guides (and materials including manufacturer SNMP MIB files and Installation Guides for monitoring)

FTTR systems should follow the IETF standard interface and system MIBs, and there should be no additional proprietary MIBs to install unless the system is providing non-standard information. As for all equipment types, there is typically a SNMP Trap MIB which may or may not be included for the various FTTR systems in various SNMP manager software implementations. For each different SNMP manager software implementation, the included MIBs, the method for loading MIBs, and the general requirements and operation of the system may be vastly different and is in no way specific to FTTR systems.

2.6 Manufacturer REST API Info

REST API is simply a programmatic interface into a system. It supports common methods such as POST, GET, and DELETE but does not specify the underlying system names, classes or functionality for example. REST APIs are a step in the SDN direction but are vendor-specific and do not guarantee easier operation within a network. For monitoring purposes SNMP provides essentially the same information. For control, either the vendor's controller or a customized controller is required.

2.7 Cable Testing Results

- These are no different between Active Ethernet and PON systems; testing still needs to be performed the same way. All optical fiber runs should be tested to establish baseline parameters to be used later as a reference.

2.8 Fiber Optical Power Level

This is specific to FTTR systems in the infrastructure. Different manufacturers produce different CPEs and/or SFPs capable of operating over different optical power levels with wider ranges preferred because

they are more forgiving in the infrastructure. Most FTTR equipment manufacturers clearly provide this information in their datasheets.

Also, the acceptable receive power range level threshold per the FTTR equipment manufacturer should be listed.

2.9 Warranty Documentation

Both active and passive equipment should include some type of warranty. Warranties for all equipment should be gathered and stored

2.10 Contact Information

Integrator and/or manufacturer contact information should be available for support and troubleshooting.

3 Troubleshooting

With a Fiber to the Room solution, it is important to understand what type of technology is deployed. For example, does the property have a PON solution deployed or is there an Active Ethernet solution? There are certain high-level steps that can be taken to identify the root cause of the trouble in either case. This section will focus on PON technology first and then Active Ethernet. With either technology, it may be required to troubleshoot the physical layer of the network. The last part of this section will get into those components as well.

3.1 Remote Troubleshooting for a PON Network:

This section assumes that the MSP has identified a potential issue with the PON network.

Questions to ask:

- Is the issue related to specific applications across the entire property or is it isolated to one room or floor(s)?
  - If specific applications, are there any problems specific to that product, or server?
  - Have any settings been changed recently on that application? Upgrades?
- Are applications down across the entire property or are the applications that are down isolated to one room or floor(s)?
- Have there been any recent power outages or surges?
- Has there been any overheating in particular in TR rooms, Main Distribution Frame (MDF) or at the ONT location?
  - This can cause electronics to fail over time.
- What other symptoms does the network have?
  - Are there bandwidth/slow Internet issues?
  - Is there some rogue device flooding the network?
  - Is the IPTV system pixelated or experiencing connection problems?
- Can the MSP log into the PON Manufacturer and control its interface remotely to view system status and log files?
  - If so, can the MSP identify any outages throughout the system at headend or at room level?
  - If so, can the MSP isolate the issue to a specific location?

PON System:

- Are any ONTs showing offline?
  - If so, go to fiber and power sections for further troubleshooting information
  - Check for connectivity and layer 1 issues
- If multiple ONTs are showing they are down (for example, multiple rooms or floors at one time), check PON OLT ports, Main PON Components / Modules, SPF connections, Splitter leg and Riser Fiber patch cables for connectivity issues. See Fiber section.
- If a specific application port is down, can the port or the end device be recycled?
- Can the PON Manufacturer control the interface and identify the optical power levels at each ONT location? Are any of these locations out of spec? If so, go to the physical layer section for troubleshooting fiber.

3.2 PON Software – Configuration Validation

- **Software version updates**
  - Can you revert to a previous version if needed? Is the hardware installed compatible with the latest software or firmware?
- **VLAN settings**
  - Tagging
  - Port configurations: Are the ports / profiles configured to pass certain VLANs?
- **Port settings and profiles**
  - POE settings
  - Validate POE Budget of ONT
  - Validate POE max port setting on profile (for example, 15W or 30W)
- **Multicast settings – IPTV**
  - Validate content provider requirements are met by the equipment manufacturer in system settings.
- **Casting / Streaming TV solutions:**
  - Does the Wi-Fi allow mDNS packets to and from the casting proxy? Please note this is typically not a setting update on the PON Hardware; you may need to double check security filters throughout the network.

3.3 Voice Settings

3.3.1 Analog Phones (i.e. Plain Old Telephone Service (POTS))

The analog telephone service configuration has many parameters and can be one of the most difficult services to get set correctly. This requires an ONT with a POTS port and will have an internal Analog Telephone Adaptor (ATA) which is basically a SIP client like found in an IP Telephone. This client must be compatible with the service providers SIP Server located either onsite or in the cloud. The detailed configuration options are beyond the scope of this document but will contain parameters such as dial plan, compression type, country dial tone type, etc. Testing the telephone service is critical and is more complicated than placing a phone call. To properly test the telephone service, the minimum requirements include:

- Placing and receiving calls
- Two-way voice
- Conference calling
- Call hold/Call transfer
- Hot start/Warm start (automatic dialing when lifting the handset)
- Notification and acknowledgment of voice messages
  - IMPORTANT NOTE: When using an analog telephone on an ONT in the guest room, the phone MUST have the ability to energize the Message Waiting Indicator (MWI) using a special signal called FSK (Frequency Shift Key). This is NOT standard for hospitality phones, however, most hospitality phone manufacturers can modify at least a few of their models to work on an ONT but they must always be ordered with this modification.
- Any additional call features required by the property

3.3.2 IP Phones

For IP Phones connected to an ONT, the FTTR system is typically just providing a data path through the network. There are a few configuration items which must be set properly for this service to function correctly.

- The IP Phone must be compatible with the service providers SIP Server located either onsite or in the cloud.
- For IP Phone startup configuration, most, but not all IP phones expect to receive their configuration from the provider's SIP server. There are typically two options here:
  - Link Layer Discovery Protocol – Media Access Control (LLDP-MED): This is probably the most common way for the phone to be configured. The Ethernet port on the ONT where the IP Phone is connected must be configured with the proper VLAN and SIP server information. During the initial handshake between the IP Phone and the ONT, this information is sent to the phone. Next, the IP Phone will contact the SIP server and download its configuration file. The LLDP-MED parameters must be obtained from the service provider.
  - Bootstrap Protocol (bootp file transfer): Upon powering up, the phone will obtain an IP address and request a configuration file to be downloaded.
- The FTTR system must not only allow a communication path between the phone and the SIP server, but also a path to all of the other guestroom phones. Some FTTR systems have special settings that must be enabled to allow room-to-room communication.

4 Example of MSP PON Troubleshooting Process Flow

Figures 3 and 4 present the details of a troubleshooting flowchart.

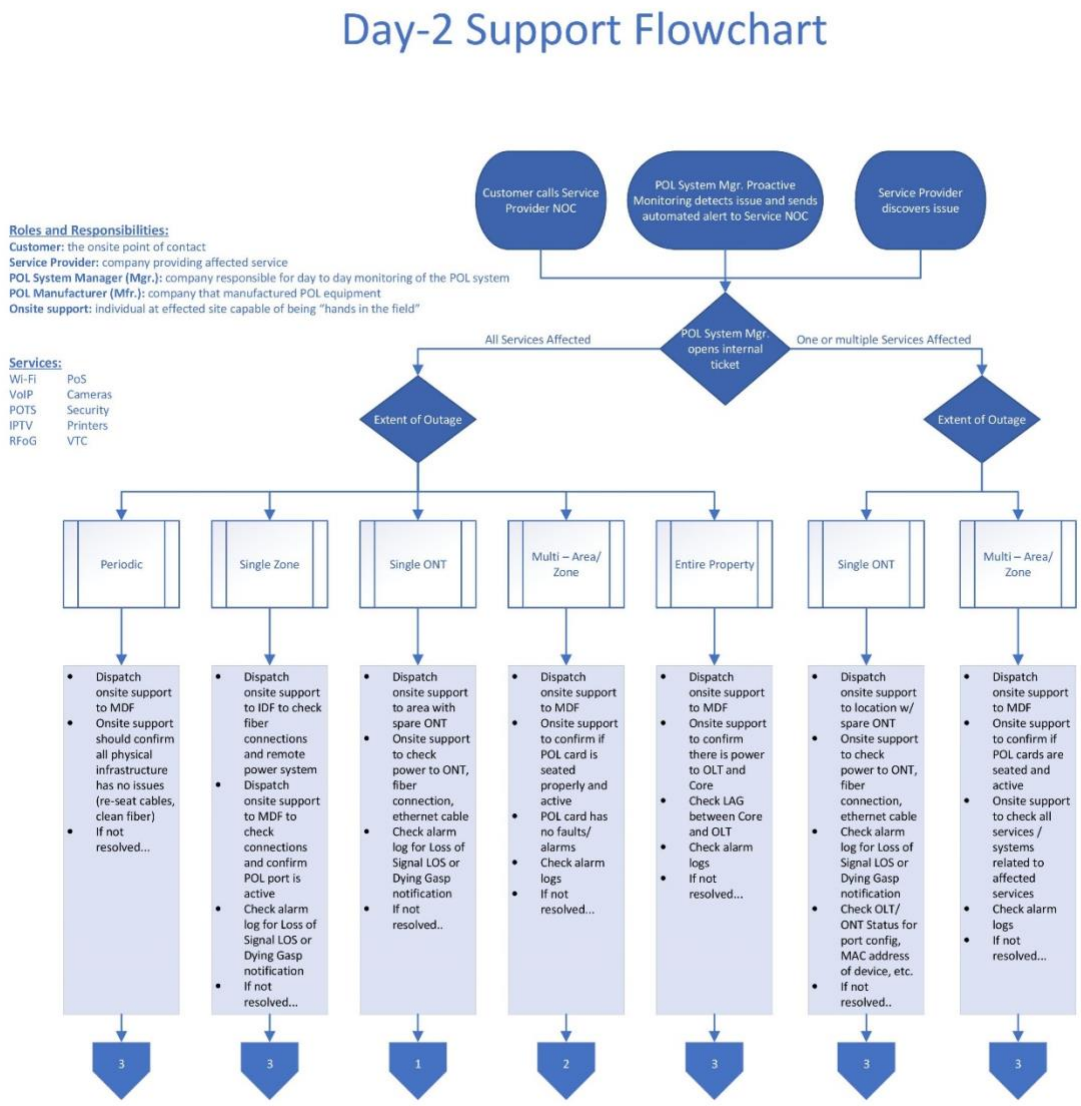

Figure 3: PON Troubleshooting Flowchart

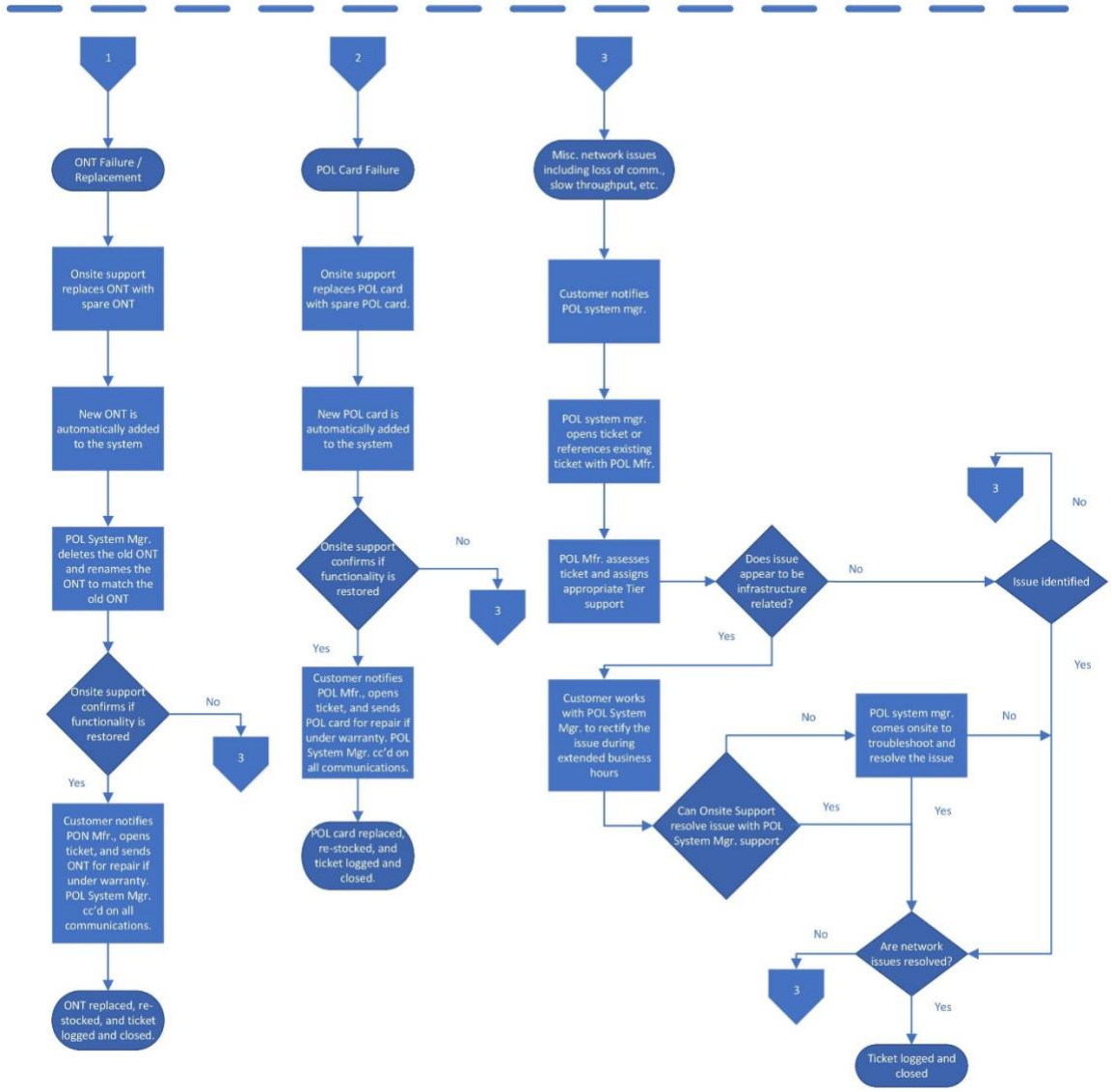

Figure 4: PON Troubleshooting Flowchart

4.1 Active Ethernet Installations

- Active ethernet topologies will most likely follow those of a typical Category (x) twisted-pair copper installation. There will be a core/aggregation switch in the MDF with either single-mode or multi-mode rise fiber to some number of IDFs. From there, there will be fiber switches which will be racked and powered in a traditional way along with fiber patch panels, which terminate fiber to each room or location.
- At the room end, there will be a device which will terminate the active ethernet connection with the appropriate optic; it will likely be a pluggable optic to support multiple fiber media types. This device can be powered locally or through copper cable run along with the fiber. Depending on the scenario, this device may or may not be manufactured by the same vendor as either the fiber switch on the other end, or the device it is serving, such as the Wi-Fi Access Point.
- If a service provider is familiar with running and troubleshooting fiber in a typical copper installation between the MDF and the IDFs, then that is unchanged.
- The fiber run from the IDF to the room will be similar in nature to the MDF/IDF run. However, it can differ depending on if a single strand or double strands are used.

Remote Troubleshooting for Active Ethernet Networks:

- The first thing to do is to check the power of both the IDF device and the end device. The switch in the closet will have LEDs to show that it is up and powered.
- Whether it is a compact switch, or a fiber conversion device in the room, there should be an LED of some sort designating that the device has power. If the device does not have power, refer to the procedure around troubleshooting the power in the generic connectivity section of this document.
- Since fiber switches from a vendor likely work like the copper version of the switch, the same software configuration should work. This means the things like VLANs and ACLs applied to the interface should work the same way.
- If after addressing the software configuration on a port on an active ethernet switch, check the specific interface on the switch corresponding to that room through the vendors' show interface command. This is an industry standard way to check the up/down status as well as if it is reporting errors on the line.
- Active ethernet devices also allow the inclusion of optics that can monitor the strength of the signal coming across the fiber, known as 'optical monitoring.' Most active ethernet vendors support optical monitoring and have a command, such as show optic, that can be issued to the switch on an individual port to see the light levels being received.
- If the optical monitoring values fall out of the specified values, then a technician must be dispatched to clean the fibers or replace the optic or cable.

4.2 Troubleshooting the Physical Layer Connections

- Troubleshoot fiber optical levels and layer 1
    - Identify locations outside of desired power levels
        - Dirty connection – clean
        - Poor connection, not seated properly – re-seat both ends
        - Verify connector is terminated properly – if not, re-terminate
        - Validate fiber is not damaged or kinked at visible points (macro bends)

        - You may need an Optical time-domain reflectometer (OTDR) to identify the fault in fiber if damaged mid-span
    - Verify patching in the correct locations. You may need to shoot a light source to validate correct patch connection in panels as it could be plugged into wrong patch point.
    - For a PON, if multiple ONTs are down:
        - Check optical splitter connections
        - Check riser fiber connections
        - Check PON OLT port or the OLT SFP
    - Validate Application Settings
    - Is the application plugged into the correct port on CPE?

4.3 Power to CPE

- Validate power sources, cables, LED indicators or other power related items to key active components
- Does the CPE have a power LED green light? NOTE: some CPEs are set to turn off the power light in the system after initial setup, such as a 30 second delay
- What is the power source for the CPE?
- Local power brick solution:
    - Validate it is plugged into wall
    - Does the wall outlet have power?
    - Is the power brick functioning correctly?
- Local power with BBU (Battery Backup Unit) solution:
    - Same things apply as above
    - Check the battery (if applicable) to ensure it is functioning and providing correct power to the CPE. Use a Voltmeter to measure the output voltage is within tolerance. For a 48VDC system, this is typically 44 VDC to 56 VDC. Additionally, validate the current is within range while the CPE is powered (NOTE: The current test takes the CPE offline since the Voltmeter must be connected in line with the power supply.)
- Remote power solution (typically a closet location):
    - Validate power connections / patching
    - Look for LEDs on power source and refer to the manufacturer guidelines
    - Check the power output at the power supply module. Use a Voltmeter to measure output voltage is within tolerance for the PSU. Additionally, validate the current is within range while the CPE is powered.
    - Check the power input at the CPE. Use a Voltmeter to measure the voltage is within tolerance for the CPE. For a 48VDC system, this is typically 44 VDC to 56 VDC. Additionally, validate the current is within range while the CPE is powered.

4.4 Moves / Additions / Changes

Moves, additions, and changes may result in an outage of the FTTR connectivity if not performed correctly. This section contains a high-level summary of some possible moves, additions or changes that may result in an outage. Although this list in not comprehensive, it will provide the reader with a summary of some equipment modifications that may result in an outage if not performed correctly.

Before making wholesale changes to the network, it may be best practice to set up a testbed to validate updates to the system prior to rolling out to the entire property. This could be done for one location or one room.

Common changes may include:

- The addition of new ports for new devices
  - What is the process to get these added?
- The need for new service with new drops
  - Depending on the amount of work, an installer may be sub-contracted to do the work. If it is a hardware swap only, MSP may self-perform this.
- Adding VLANs or new functionality
- A specific event or customer that requires new VLANs
  - New SSIDs (for example, customer ABC wants a new SSID called *ABC_CoWIFI)*
  - Local networking between rooms
  - Dynamic VLAN assignments through 802.1x (enabling this could vary based on manufacturer)
- Removal of ports or disconnecting services (for example an office move)
- System software updates to layer 2 network
- Application software updates connected to layer 2 network

In summary, although the above list of possible FTTR changes that may result in an outage, the reader needs to be aware of other possible configuration changes that may also result in an outage. If possible, it is recommended that the hotel's support organization installs a test FTTR environment that would allow moves, additions and changes to be tested prior to implementation into the operational environment.

5 Appendices

5.1 Fiber Testing Methods

This section describes how to test the fiber optic plant and received power at endpoints for Fiber Deep FTTR Actives, Active Ethernet and PON deployments.

There are two recommended testing methods for testing FTTR systems:

- Method A – Power Test
- Method B – Link Loss Test

Method A evaluates the system electronics and typically the power at the CPE is measured with an optical power meter. This method requires that the system be powered on and the electronics to be functioning. This method tests the actual power level at the endpoint device.

Method B uses a typical optical test equipment light source and a power meter. This method tests the loss of the fiber link including all components in the link. A link budget must be calculated and used to determine the specified loss acceptable for the fiber link using the source and meter.

5.1.1 METHOD A – POWER TEST

NOTE: When testing with Method A, make sure the FTTR Head End equipment is connected and functional and all connections up to the endpoint are connected. This method will test the actual power at the endpoint location.

Step 1: Ensure electronics are functional at head end
Step 2: Using the functional optical power meter, set the wavelength to 1490 nm for a PON system or the appropriate wavelength on a AE system, and set this to a dBm measurement
Step 3: Go to the CPE location and plug the CPE connector into the power meter
Step 4: The optical power value should be within tolerance.

5.1.2 METHOD B – LINK LOSS TEST

NOTE: A Method B Link Loss test should be used if electronics are not functional at the time of testing or a link loss measurement is needed to determine the loss of the fiber cable plant. The system can be tested at 1310 nm or 1550 nm, or both for a PON system or the appropriate wavelength for an AE system.

Step 1: Create a link loss budget based on fiber link under test (see example online link loss calculator)
Step 2: Obtain an OLTS (Optical Loss Test Set) that consists of an optical test source and optical power meter
Step 3: Use appropriate test jumpers that match the patch panel connections in the system under test
Step 4: Check test jumpers
Step 5: Perform a reference with the source and meter
Step 6: Connect source test jumper to patch panel
Step 7: Go to the CPE and connect the endpoint connector to the power meter
Step 8: The optical loss level (dB) should be less than or equal to the loss value determined by the link loss budget

5.2 Glossary of Terms

Table 1: Definition of Terms used Throughout the Document

Term	Definition
OLT	*Optical Line Terminal:* A Central Office node that is the interface between the PON and the service providers network services
ONT	*Optical Network Terminal:* An ITU-T term to describe a single-user case of an ONU
ONU	*Optical Network Unit:* Terminates the PON and includes an interface toward the end user, such as coax, multi-service Ethernet, xDSL, etc.
SFP	The small form-factor pluggable (SFP) is compact, hot-pluggable network interface module used for both telecommunications and data communications applications
GBIC	Gigabit interface converter (GBIC) is a standard for transceivers which is commonly used with Gigabit Ethernet and fiber channel.
XGS-PON	XGS-PON is an updated standard for Passive Optical Networking (PON) that can support higher speed 10 Gbps symmetrical data transfer and is part of the family of standards known as Gigabit-capable PON, or G-PON
NG-PON2	Next-Generation Passive Optical Network 2 is a 2015 telecommunications network standard for a passive optical network (PON)
OM1-OM4	OM1 thru OM4 refers to the different types of multi-mode fiber
OTDR	Optical time-domain reflectometer injects a series of optical pulses into a fiber under test and extracts, from the same end of the fiber, light that is scattered or reflected back from points along the fiber
XFP	The XFP (10 gigabit small form factor pluggable) is a standard for transceivers for high-speed computer network and telecommunications links that use optical fiber
FSAN	The Full-Service Access Network (FSAN) Group is a forum for the world's leading telecommunications service providers, independent test labs and equipment suppliers to work toward a common goal of truly broadband fiber access networks
MDF	Main distribution facility
IDF	Intermediate distribution facility
SC/APC	Subscriber connector that is polished with an 8-degree angle
SC/UPC	Subscriber connector is polished with no angle
SIP	Session Initiation Protocol that lets applications easily set up outgoing and incoming voice calls over an IP-enabled network
LLDP-MED	LLDP-MED (media endpoint devices) is an extension to LLDP; LLDP is a vendor neutral link layer protocol in the Internet Protocol suite used by network devices for advertising their identity, capabilities and neighbors on an IEEE 802 wired Ethernet local area network
CPE	Customer Premise Equipment refers to any associated equipment located at a hotel that may be used to connect to a network.

5.3 Referenced Documents

Table 2 presents a list of reference documents that provide the reader with additional information of 2nd day support of PON. (Note: Clicking on the documents will allow the reader to access the actual document. In some case, the reader may be required to log into their HTNG account.)

Table 2: List of PON reference Documents

Document Title (Click on the title to go to the document or webinar)	Date of Publication
Fiber to the Room Design Guide	**2017**
Fiber Deep Alternative Architectures	**2019**
Bandwidth Calculator	**2014**
Fiber 101 Webinar	**2013**
Fiber vs. Copper Cost Comparison Calculator	**2018**
GPON 101 Webinar	**2014**
PON Calculator	**2014**
Fiber to the Room: Alternative Architectures Webinar	**2019**
Fiber to the Room: Power Deep Webinar 1 - Local Power	**2019**
Fiber to the Room: Distributed Power Webinar 2- Distributed Power	**2019**
Fiber to the Room: Centralized Power Webinar 3 - Centralized Power	**2019**