htng

MOVING HOSPITALITY FORWARD

FIBER DEEP ALTERNATIVE ARCHITECTURES

1 September 2019

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 DOCUMENT PURPOSE

Fiber-based local area networks (LAN) are gaining acceptance, and thus accelerating in deployments in the hospitality industry. All types of hospitality properties, from metropolitan high-rise hotels to sprawling resort style locations, can benefit by promoting the use of optical cabling versus copper cabling for their IT infrastructure. It is more often that hotelier's leverage Passive Optical LAN (POL) architecture for Fiber-To-The-Room application to deliver guest services such as voice, video and Internet connectivity.

There are many advantages of single mode fiber over category copper such as CAT 6 and CAT 6a. Most are aware that fiber is much smaller and weighs much less than copper. The speed of single mode fiber is virtually unlimited and the distance limitation for single mode fiber is measured in tens or even hundreds of kilometers compared to just 100 meters for copper. Fiber optic material is much less expensive, and its life expectancy is about ten times that of copper, however, most are not aware that today's single mode fiber is also stronger and more flexible than copper. For example, the tensile strength of fiber is about 67 N/M (Newtons/Millimeter) compared to CAT 6a at 34 N/M and single mode fiber has a bend radius of 5 mm compared to 30 mm for CAT 6a copper. These characteristics help prove the advantages of fiber cabling over copper cabling.

The purpose of this paper is to expand on this topic of fiber connectivity, and its usage beyond the guests' rooms, to expose a wider array of services, devices, rooms, buildings and campuses that can benefit from convergence onto an optical LAN.

While over 75 companies participate in the HTNG Fiber to the Room Workgroup, this document's primary authors include Greg Dawes (Willard Solutions International), Steve Letke (Corning), Anurag Jain (Furukawa OFS), John Hoover (Tellabs, Inc.) and Ronald Tellas (Belden).

2 Fiber Optic Deployments

2.1 Floor Distribution of Fiber

Indoor fiber distribution in a building requires riser and floor cabling to pass each end point. Since every building architecture is different (low to high rise, resort or garden home style structures, number of floors, number of end points per floor, availability of telecom closet space, amenities, distribution topology, etc.), many factors must be considered to choose the right solution.

2.2 Pain Points

As the hospitality industry investigates a variety of these solutions including optical fiber, a few key issues for consideration are as follows:

- Engineering time including consulting and surveying
- Installation time
- Discreteness of cabling
- Non-disruptive installations
- Quick service turn-up
- Support of consumer multiple platforms

2.3 Building Distribution Topology

A network topology choice is the first step when installing fiber inside a hotel. As fiber is distributed to a number of guestrooms, an incoming fiber from the outside plant or riser fiber goes through splitting in a fiber distribution terminal. Therefore, it is necessary to decide on the following topologies:

- **Centralized Splitting**: The fiber distribution terminal is installed in the basement telecom closet, where all splitters are installed. From here, either individual cables can be taken up the riser or more commonly, a higher fiber count fiber cable can be taken to the floors to a) pass through each guest room or b) breakout the fibers to distribute to each guest room. The splitters installed in the terminals are usually a 1:16, 1:32 or sometimes 1:64 configuration.
- **Distributed Splitting**: In this design, splitters are installed into fiber distribution terminals in the telecom closet for each floor or group of floors. A single high-density riser cable or multiple riser cables connect into these terminals for splitting the fibers in order to distribute across the guest rooms on the floor. Usually these splitters are a 1:16 or 1:32, and sometimes 1:64. Distributed splitting is very common for hospitality structures in the United States.
- **Distributed Cascaded Splitting**: In this scenario, the fiber distribution terminal in the basement telecom closet has a splitter with another splitter installed in the floor distribution terminal. Usually, the cascaded splitters are a combination of 1:2, 1:4, 1:8, and 1:16 in each of the terminals.

Based on the building architecture and network topology using splitters, the following scenarios provide guidance to install cable in risers and distribute fiber along the hallway to each end point.

2.3.1 Dedicated Riser Fiber Cables

The following drawing in Figure 1 shows a dedicated riser fiber cable to each telecom closet where fiber patch panels and splitters are located. From each telecom closet there is a dedicated fiber cable running to each room, housing an optical network terminal (ONT). Depending upon the type, these cables can be laid above the ceiling, secured to raceways as well as managed with extra length (slack).

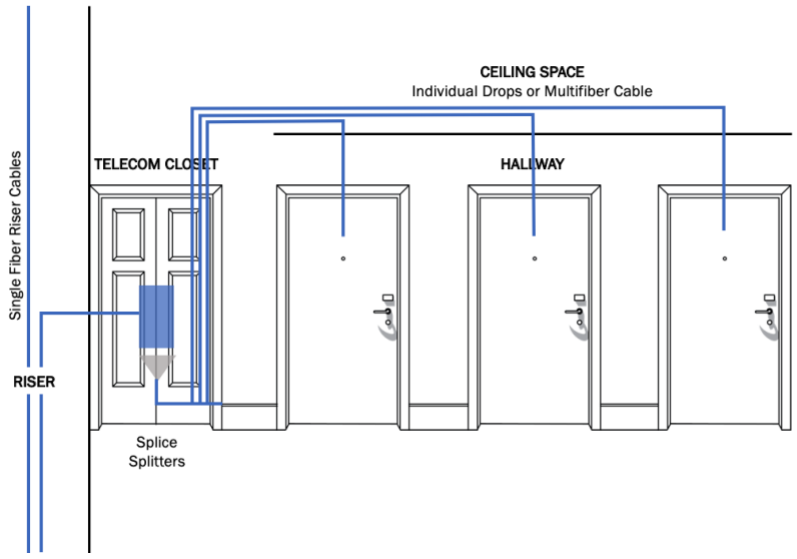

Figure 1: Dedicated Riser and Horizontal Fiber Cabling

2.3.2 Shared Horizontal Fiber Cable Diagram

The following drawing in Figure 2 shows a dedicated riser fiber cable to each telecom closet where fiber patch panels and splitters are located. From each telecom closet there is a shared, multi-fiber cable ran in the horizontal pathways where individual fibers are peeled out and spliced to individual fiber runs, connecting to each room housing an ONT. The module placed above each room allows for slack storage as well as simplified plug and play with the individual fiber run.

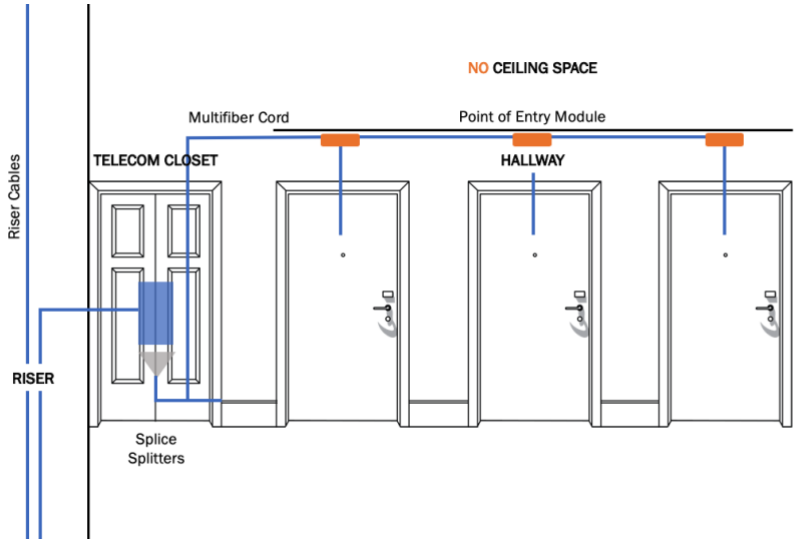

Figure 2: Dedicated Riser with Shared Horizontal Fiber Cable

2.3.3 Dedicated Horizontal Fibers

This drawing in Figure 3 shows a shared multi-fiber riser cable to each telecom closet where fiber patch panels and splitters are located. The required fibers for that floor are terminated in that closet while the rest of the fibers pass through to the next telecom closet. From each telecom closet there is a horizontal dedicated fiber cable run to each room housing an ONT. Depending upon the type, these cables can be laid above the ceiling, securing the cables as well as managing extra length (slack).

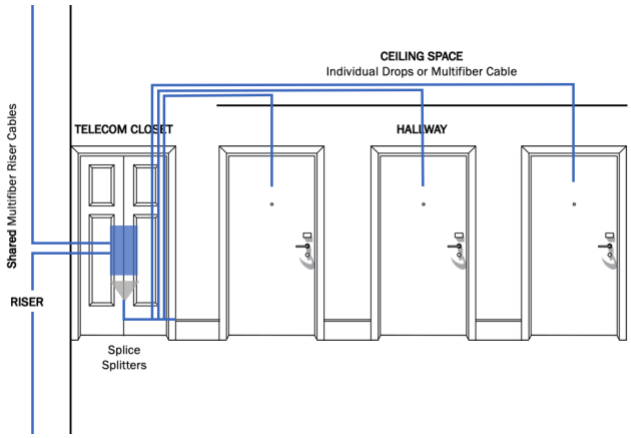

Figure 3: Shared Riser with Dedicated Horizontal Fibers Diagram

2.3.4 Centralized Splitter with Dedicated Fibers to Each ONT (Home-Run Fibers)

This drawing in Figure 4 shows a centralized splitter model using a multi-fiber riser cable to each floor with dedicated fibers for each ONT. Extra cable can be spooled in the telecom closet and then run in the horizontal pathways where individual fibers are split out and spliced to individual fiber runs connecting to the ONT in each room. The module placed above each room allows for slack storage as well as simplified plug and play with the individual fiber run. This model is ideal for low-rise buildings.

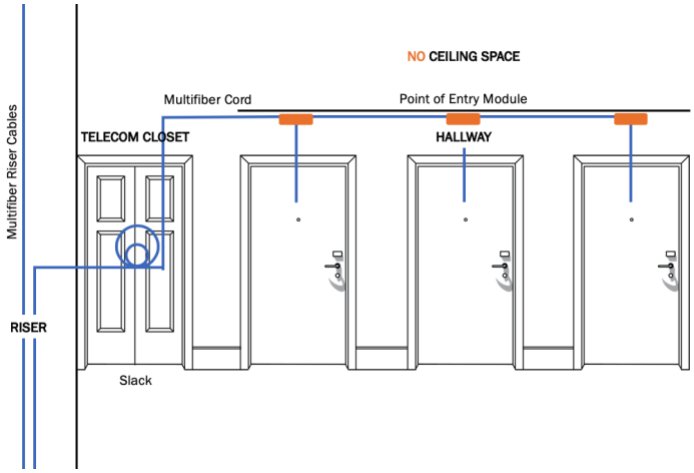

Figure 4: Centralized Splitter with Dedicated Fibers to Each ONT (Home-Run Fibers)

3 Property Types

3.1 High-rise

Extended connectivity across a POL makes it possible to deliver connectivity 12-18 miles over a passive infrastructure. For tall downtown high-rise buildings, a powered switch or repeater every 300 ft is not needed (unlike it is with copper), thus with a POL architecture telecom closet IDFs can be reduced or even eliminated. In addition, the reduced IDFs and POLs centralized management offer operational efficiencies for the IT staff.

3.2 Resorts

Again, extended reach of POL allows for voice, video, wireless and data services to be delivered over a 12-18 mile passive indoor and outdoor network. For sprawling resorts with multiple buildings (e.g. pools, club houses, restaurants, bars, multiple towers, etc.), there is no need for a powered switch or repeater every 300 ft, nor do resorts need to rely on microwave wireless (subject to weather conditions). Again, by eliminating MDFs and reducing IDFs in remote towers/buildings, plus POLs centralized management, all of the above amplify operational efficiencies for the IT staff tasked with maintaining connectivity across these far-reaching, expansive properties.

3.3 Seaside Resorts

Often waterfront resorts deal with high corrosion and lightning hazards. It behooves hoteliers to minimize electronics and copper cabling at these waterfront or tropical resorts where thunderstorms, high humidity and salty environments are prevalent.

3.4 Villas/Casitas

Since this technology was born from residential Fiber-to-the-Home application, POL is ideal for cabins, cabanas, ranch style properties and cottage style properties as environmentally hardened ONTs can be mounted on the outside of the specific buildings they serve.

3.5 Retail

The US Department of Defense was the early adopter of POL technology because it provides a more secure network infrastructure. Fiber cabling is inherently more secure than copper for the following reasons:

- POL architecture reduces points of vulnerability in MDFs and IDFs
- ONTs don’t have local management access
- ONTs don’t store user or network information and are fundamentally more secure than traditional switches
- POL centralized management assures security policies and procedures are administered consistently with reduced human touch and reduced human error

For these reasons, POL is ideal for retail where PCI compliance is critical.

3.6 Gaming

Once again, the more secure architecture of POL makes it appealing for gaming and casino properties. Fiber cabling is inherently more secure than copper for the following reasons:

- POL architecture reduces points of vulnerability in MDFs and IDFs

- ONTs have no local management access, stores no user or network information
- POL centralized management assures global security policies and procedures are adhered to consistently reduce human touch and error

The regional gaming commission may need to get involved in each locale to confirm acceptance.

3.7 Multi-brand, Single Complex

When a single hotel has multiple hotel brands on one property, one POL system can connect all of the properties. Thus, one management console and one OLT can serve all endpoints within a 12-18 mile reach over a passive infrastructure. This can eliminate telecom closets (IDFs) and even main data centers (MDFs) in the connected buildings.

3.8 Historic properties

Historic properties have a hard restriction for renovations impacting the walls and ceilings, which makes network upgrades difficult. POL's fiber cabling infrastructure saves space in risers, pathways, telecom rooms and data centers. Furthermore, there are fiber cabling solutions that offer small, nearly invisible fiber and there are other fiber cabling solutions that can be hidden inside the wall and ceiling moldings.

3.9 Sports Complex, Public Use, Mixed Space

For all the reasons listed above (e.g. extended reach, availability, indoor and outdoor connectivity, synergies with wireless, security, operational efficiencies, high network availability, etc.), there are many real estate companies deploying POL systems that have been leveraged at large hotel properties connected to sports arenas, stadiums, public venues, business offices, residential units and mixed-use complexes.

4 Guest Room Architectures

The following section shows multiple architectural options inside a hotel that can be used for different Fiber to the Room (FTTR) scenarios. The idea is to show the topology that shows the network head end, typically located in the MDF, the IDF or TR rooms where the optical splitters are located, and then finally the side of the room where the ONT is mounted.

We will show multiple scenarios that are all valid depending on the network requirements of the hotel and the applications supported. These include:

- One ONT per room
- One ONT per two rooms
- One ONT per two rooms with using an enclosure to house the ONT
- One ONT per three or four rooms
- One ONT per two rooms with ONTs in the IDF that serve the hallway applications.

All cases show FTTR scenarios that support multiple applications such as, IPTV, CATV, VOIP phone or analog phone, Wi-Fi as well as applications in the hallways. These hallway applications can vary depending on certain needs. Some common hallway applications include: surveillance, building management controls, remote key door access and elevator lobby phones.

4.1 One ONT per Room

The first topology in Figure 5 shows one ONT per room. This scenario is probably the most “future ready” option available to the hotelier. Having fiber right to the room allows the capability to support the number of applications today as well as tomorrow. It also allows for increased bandwidth to the room as that demand rises. This results in less additional cabling since the fiber is brought all the way to the room.

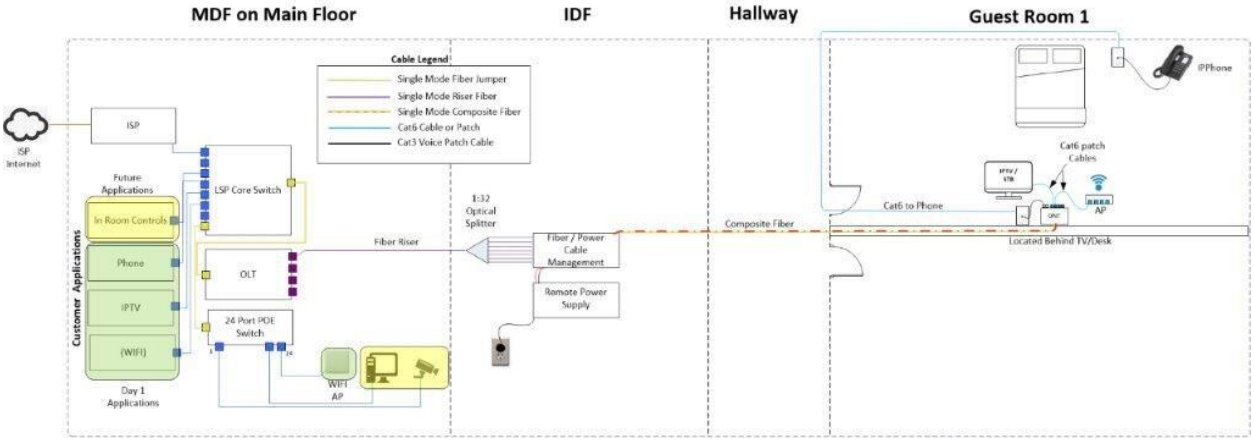

Figure 5: One ONT per Room

The above diagram shows the ONT located in the room. It is connected by a composite fiber cable that has both single mode fiber as well as copper conductors in the same cable. A single fiber connects to the ONT and the copper conductors connect to the 48VDC power connection on the ONT. While the ONT GE (Gigabit Ethernet) port count can vary, this scenario shows a 4-port ONT with one Cat6 jumper to the IPTV or IPTV STB (Set Top Box) and one jumper to the Wi-Fi Access Point. Another Cat6 cable run, typically under 35’, is extended to a wall plate by the bed; this port is used for the phone. The ONTs can optionally provide Power-over-Ethernet (PoE) to the AP and the phone.

From the room, the composite cable is run back to an IDF closet where it is terminated into fiber patch panels. This scenario shows the remote power supply that injects the 48VDC power into the composite cable for the ONT. Typically, one IDF can serve multiple floors of a hotel. This is done to save space in the hotel for other needs and to reduce the amount of IDF build-out required. Normally, 1:32 optical splitters are used in the IDF and the quantity used depends on the split ratio and how many ONTs/rooms are served from that IDF.

A single fiber is used from the optical splitter to patch over to the riser fiber. The riser fiber is installed from the IDF to the MDF where it then patches to a single GPON port on the OLT. This is the location where all of the applications are uplinked, typically from the main core switch to the OLT. This example shows the following applications: Wi-Fi, IPTV, IP phone, and in-room controls. The MDF location also shows the option of a 24-port switch that is connected to the main core switch. It should be noted that this could also be a 24-port ONT connecting to an OLT port through a smaller split ratio and then to a GPON port. It is common to serve local lobby ports from the MDF location since there are a high density of ports on that level.

4.2 One ONT for Two Rooms

The second topology shown in Figure 6 is one ONT per two rooms. This scenario is the next best option to the one ONT per room option. It is used to save costs on electronics and get the fiber just outside of the room. It is typically recommended to use some sort of flex duct (aka: inner duct) from the hallway to the TV and phone locations in the room. This option still allows you to be future ready and ONTs can be changed out in the future if port quantities change or applications change.

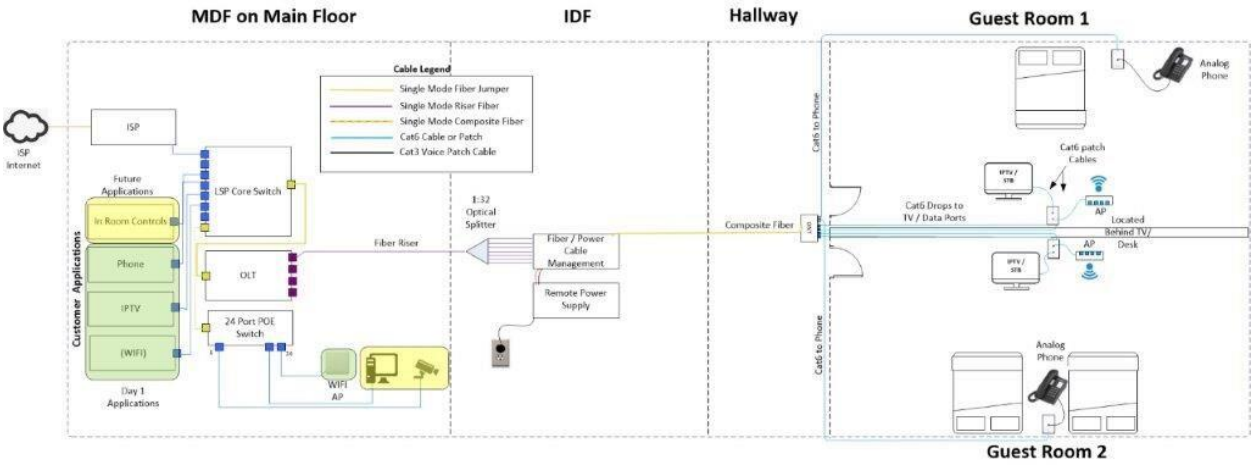

Figure 6: One ONT for Two Rooms

The above diagram shows the ONT located in the hallway above the ceiling between two rooms. It is connected by a composite fiber cable that has both single mode fiber as well as copper conductors in the same cable. A single fiber connects to the ONT and the copper conductors are connecting to the 48VDC power connection on the ONT. While the ONT GE (Gigabit Ethernet) port count can vary, this scenario shows 4 gigabit ethernet ports, 2 plain-old-telephone-service (POTS), ONT with two Cat6 cables to a wall plate with two RJ45 connections for the IPTV or IPTV STB (Set Top Box) and one port for the Wi-Fi Access Point. Another Cat6 cable run, typically under 35', is extended to a wall plate by the bed; this port is used for the analog phone. The ONTs used provide POE to the AP. Essentially there are a total of six

relatively short Cat6 cables from the ONT to the two rooms. NOTE: Potentially, one Cat6 cable could extend to one port by the TV location and feed an AP that also has switch ports on the bottom, which would allow one to feed the IPTV/STB.

The rest of the topology is the same as the ONT per one room.

4.3 One ONT per Two Rooms with Media Enclosure

This scenario is the same as the previous example, but the difference is that the ONT is mounted inside a media enclosure in one of the rooms but on a shared wall. In some cases, the ceiling in the hallway is not a drop ceiling and accessing the ONT for future upgrades/maintenance could be difficult, so this option still allows easy access to the ONT.

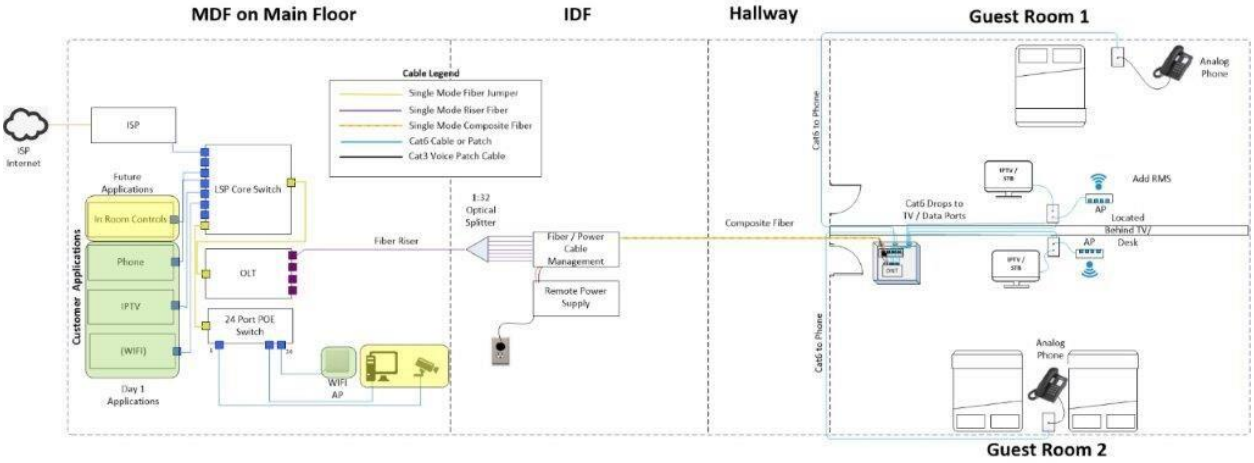

Figure 7: ONT & Media Enclosure

Figure 7 shows the ONT per two rooms with the ONT inside a media enclosure. The typical size of an enclosure is 14”x14”x 3.68”. It is recommended to have a ventilated locked door on this enclosure to allow ventilation and reduce tampering. The composite fiber can be terminated into keystones on a media bracket inside the enclosure. That same media bracket can be used for the Cat6 cable distribution from the ONT as well. The different wall plates are connected the same way as the previous description. This example shows six cables leaving the media enclosure to six different keystones in the two rooms. There is one AP, one IPTV and one analog phone per room. Depending on the hotel type or layout, the media enclosure can be located in various areas that are most suitable for the property. In many cases, the enclosure is mounted inside of a clothes closet, but it could also be located behind a bed, bathroom or in another place. In villas, the enclosure could be placed in a mini-IDF or in a closet.

The rest of the topology is the same as the previous examples.

4.4 One ONT per Three or Four Rooms

This scenario is used in many cases where a single application is being added to the property (for example, a Wi-Fi upgrade). Or, this topology is used as another economic way to still take fiber to the zone and serve three or four rooms from one location. This topology requires a good understanding of what specific applications and quantities per room are needed. A POE budget is also key to make sure enough power can be supplied to the ONT through a 48VDC connection as well as in-room applications.

If analog phones are used, the ONT type should also ensure that it has enough analog ports to serve three to four phones.

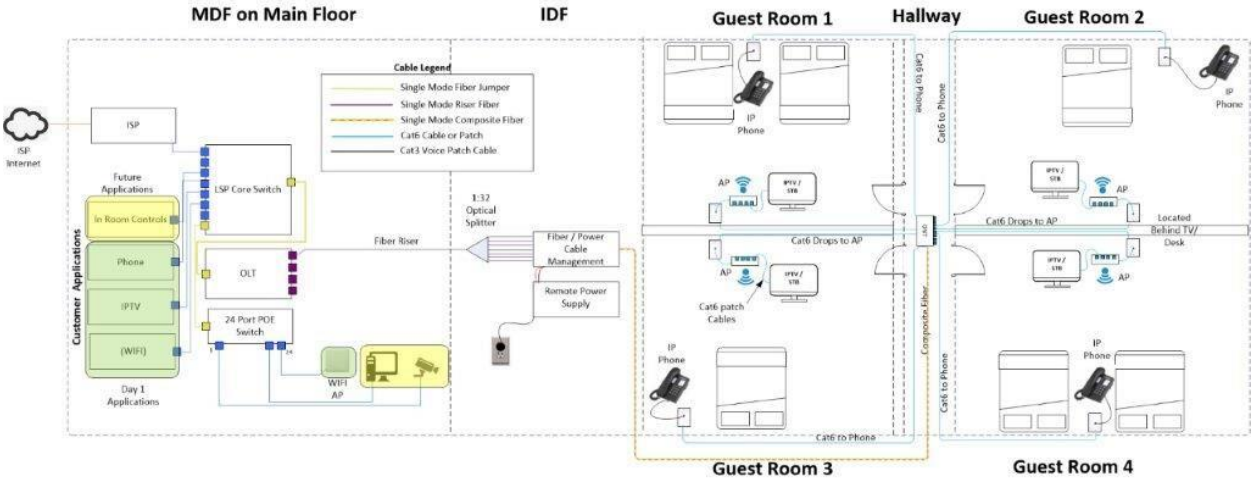

Figure 8: ONT per Three or More Rooms

Figure 8 shows one 8-port ONT mounted in a hallway between four different rooms. This scenario shows two Cat6 cables being installed from the ONT location to each room. One Cat6 cable to a wall plate by the IP phone and one Cat6 to an AP location behind the TV. It is assumed that the Wi-Fi AP is a model that has ethernet ports on board. One of those AP ports will connect to the IPTV/STB. If an AP per room is not required, a data port could be used for the IPTV/STB, therefore reducing the AP count. (NOTE: AP density should meet brand standards.)

Utilizing the one ONT per four rooms (or even two rooms) also reduces other components in the FTTR network. Splitters are typically reduced which also reduces OLT GPON ports. All of this combined should reduce costs. Note that the amount of copper cables is increased in this scenario. The ONT location should be located in a place that is centralized to the three to four rooms it serves.

Essentially, the rest of the network description is the same or similar to the previous descriptions above.

4.5 One ONT per Two Rooms & Hallway Applications

This scenario is very similar to the ONT per two rooms scenario but the difference shows ONTs mounted inside the IDF and also the hallway to provide connectivity (Ethernet and POE) to applications required in the hallways. These applications can vary, but some of the most common are security cameras by exits, hotel elevator lobby phones, Zigbee access controllers and Building Management System (BMS) controllers. The importance of being able to provide this connectivity reduces the need of adding parallel switched networks in the property by taking advantage of the fiber network.

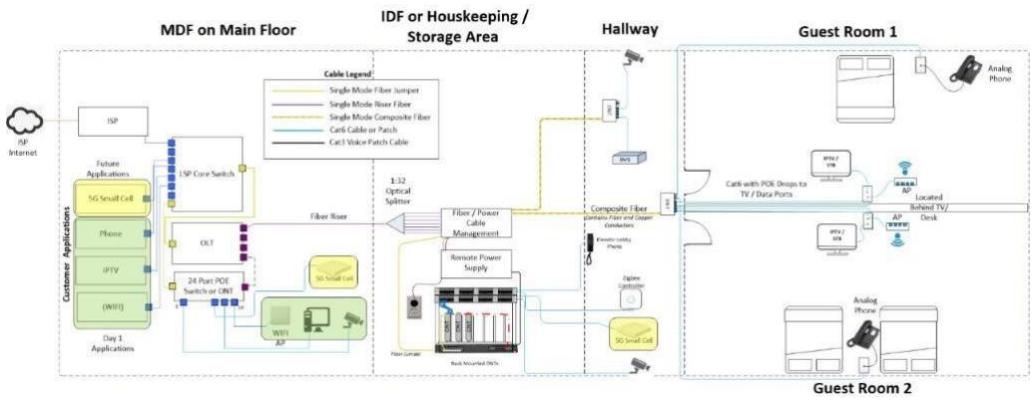

Figure 9: Hallway Applications

Figure 9 shows the same layout as the ONT per two rooms, but now also shows hallway applications being served by ONTs installed in two different locations. One ONT location shown is in the hallway. This ONT is connected with a composite fiber which provides remote power as well as the single fiber connection. That ONT now can connect to a camera as well as BMS or other similar POE enabled applications. The other location common in hospitality is when the ONTs are placed in a shelf inside the IDF. These ONTs are still connected to the 48VDC power supply and patched to the optical splitters located here. Short Cat6 jumpers to a patch panel are typical; from the patch panel, a Cat6 cable is installed to the wall plate or surface jack where the application is required. This scenario shows a hallway phone, Zigbee controller and security camera connected to these ONTs in the shelf.

The rest of the network is essentially the same as previous descriptions.

The housekeeping and storage areas are noted in this diagram as a potential location for an 'IDF.' Some hotels upgrading their networks find they don't have additional telco rooms or IDF closets with available space to mount a rack or a wall mount rack. If approved, these areas can work out just fine. It is important to ensure there are pathways for cabling (riser and horizontal) into these rooms. In addition, space and adequate AC power are available for equipment and potential 48VDC power supplies.

4.6 Caveats when Sharing an ONT

Infrastructure planners must check the ONT port counts to make sure there are enough ports available:

- Are analog phones required? Are there enough RJ11 ports on the ONT to support multiple rooms?
- Will the APs being used have data ports on them? Will they be used to connect applications?
- Is there one AP per room or two rooms?
- What are the POE requirements? Can the 48VDC power plant provide enough wattage?

The location of the ONT could cause the structured cabling to cost more than dedicated ONTs. Hoteliers need to understand the ONT may be located in one room but serving an adjacent room as well. If maintenance is required, it may be required to wait until one room is empty to gain access.

5 Common Areas

5.1 Lobby Floor

The following diagram, Figure 10, depicts a Fiber-to-the-Zone architecture on a typical hotel lobby floor. The fiber type here would be a composite fiber that not only connects the ONT in the zone to the network but also powers the device. This allows up to a 1Gbps POE connection to the required applications in that zone. The ONTs used in this zone architecture are either 8-port or 4-port versions. The applications required can vary from house phones to security cameras, to Wi-Fi APs or printer ports.

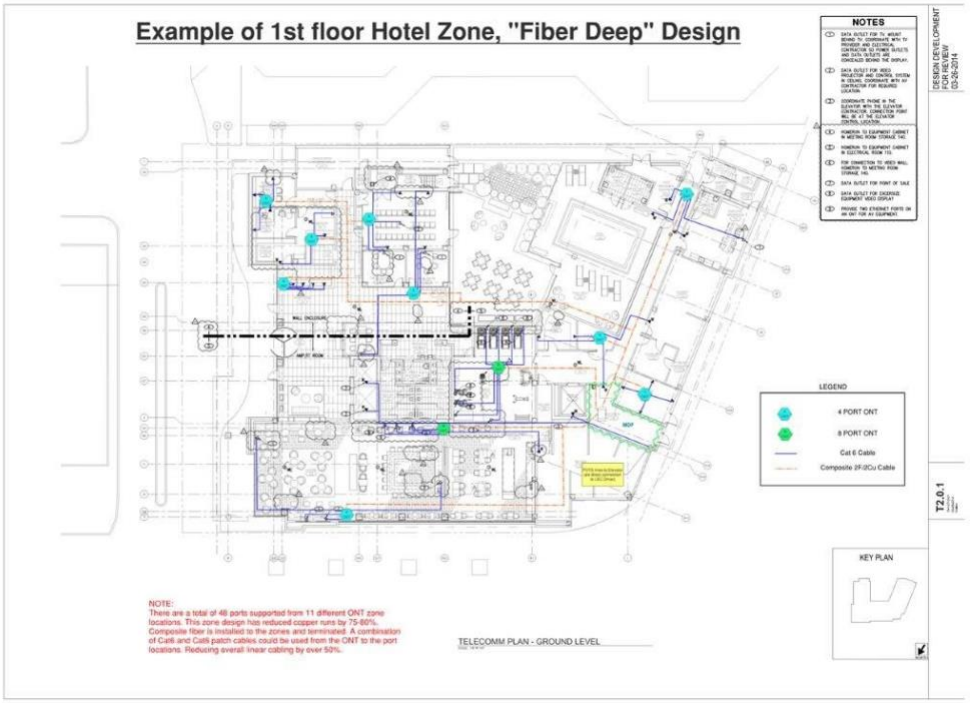

Figure 10: Lobby Level Zone Deployment

The following 3 diagrams are a zoomed-in view of the previous Lobby Level floor to show a closer look at the diagram and how the ONTs are connected with composite fiber and then shorter Cat6 patch cables to the nearby data ports.

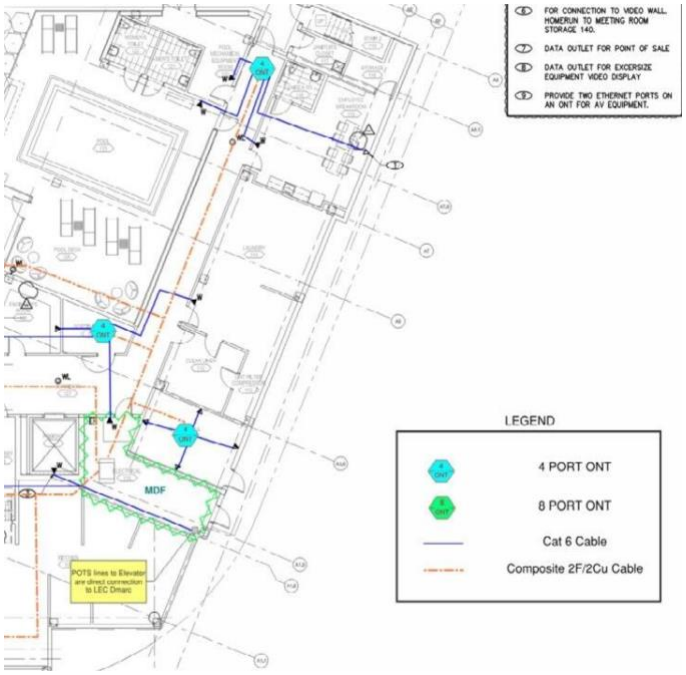

Figure 11: Lobby Level Section One

There are three 4-port ONTs feeding 11 data ports in this Lobby Level Section One image, Figure 11..

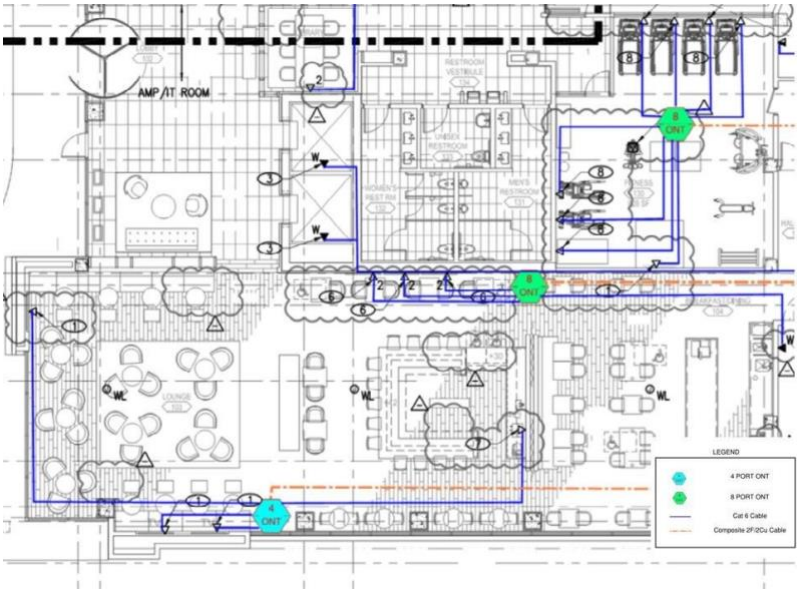

Figure 12 Lobby Level Section Two

Figure 12, Lobby Level Section Two shows one 4-port ONT and two 8-port ONTs serving 20 data ports.

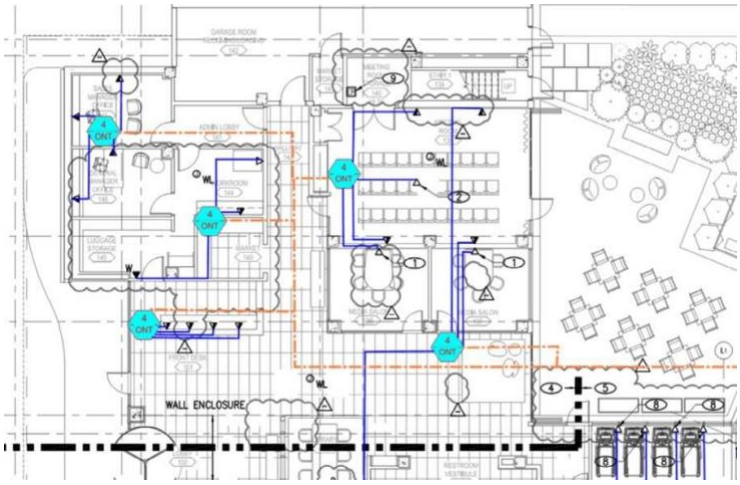

Figure 13: Lobby Level Section Three

Figure 13, Lobby Level Section Three shows five 4-port ONTs serving 19 data ports.

5.2 Lobby & Dining Area

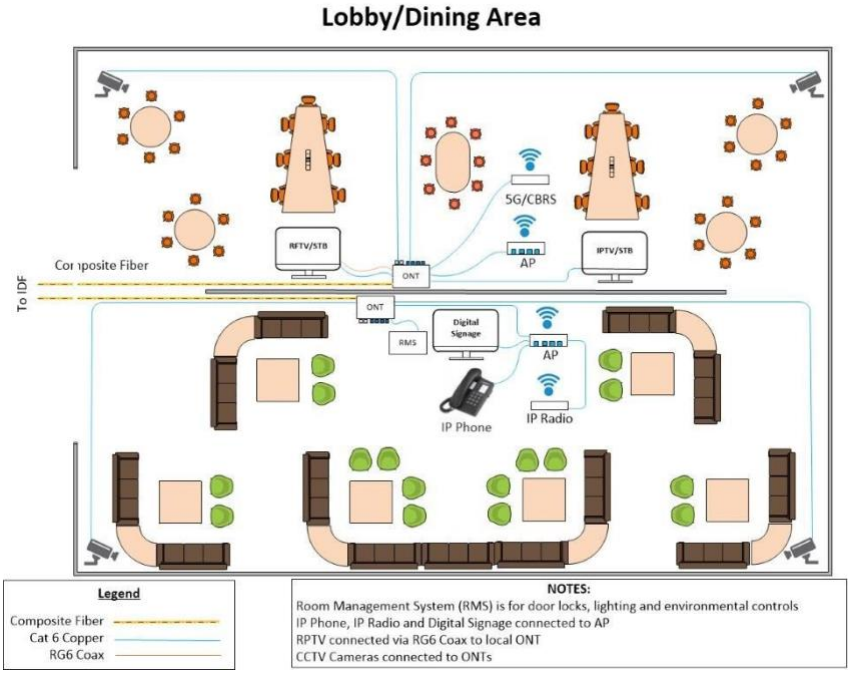

Figure 14: Lobby & Dining Area

Figure 14: The lobby and dining areas can take advantage of the extended reach of POL, allowing for voice, video, wireless and data service connectivity to be delivered across thousands of feet. For large hotels with multiple common areas and dining choices, both inside and out, this fiber-based architecture

eliminates the need for a powered switch or repeater every 300 feet. Virtual LAN (VLAN) tagging separation partitions data, services, devices and users into isolated protected flows.

Lobby and dining area connected end-devices, services and user, typically include:

- Room Management System (RMS) for door locks, lighting and environmental controls
- IP phone, IP radio and digital signage connected to AP
- RFTV connected via RG6 coax to local ONT
- CCTV cameras connected to ONTs

5.3 Exercise Room (Various Deployment Types)

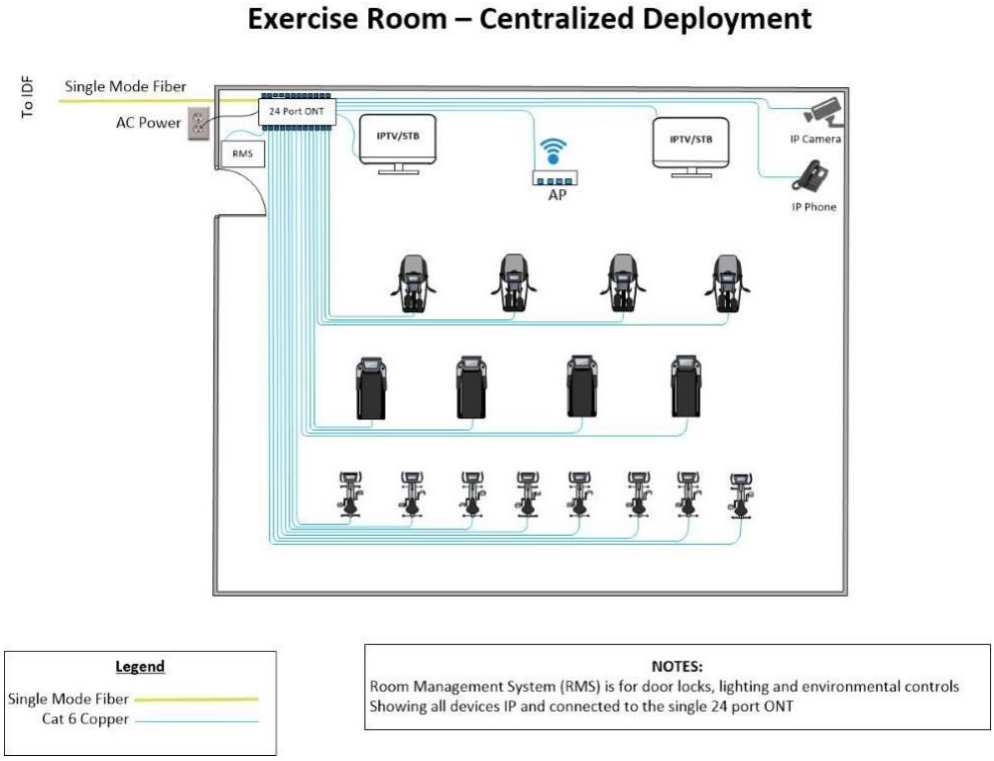

Figure 15: Exercise Room (Centralized Deployment)

A centralized design (Figure 15), or closet-based Optical LAN, best replicates traditional LAN architectures as high-density ONT (e.g. 24-port, 48-port) to directly replace workgroup switches inside the telecom closets (IDF) and the last 300' of CATx copper cabling is leveraged. The benefit of this architecture is that it provides a graceful migration to deep fiber architectures, where existing horizontal copper cable drops may be reused and centralized management can be taken advantage of. For these exercise rooms, sports facilities and club houses, VLANs partitions data, services, devices and users into isolated protected flows.

Exercise room (centralized deployment) connected end-devices, services and user, typically include:

- RMS for door locks, lighting and environmental controls
- All IP devices connected to the single 24-port ONT

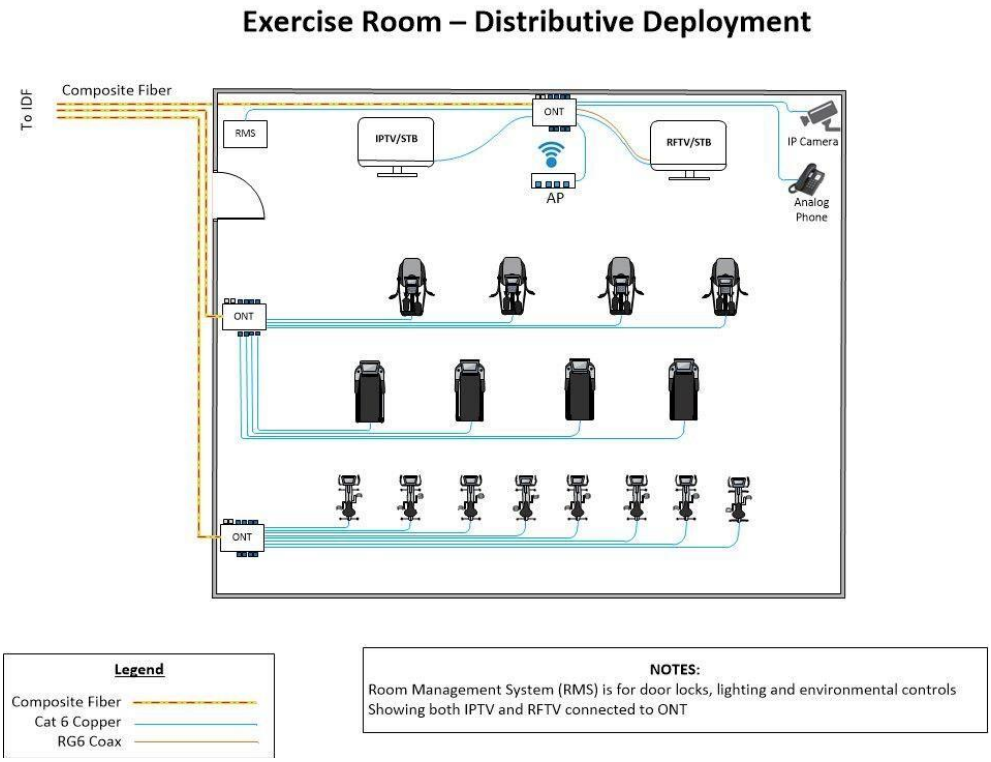

Figure 16: Distributive Deployment

A distributed design (Figure 16), or deep fiber optical LAN, removes the switching equipment from the telecom closets (IDF) by positioning the ONTs as close to the end-device and end-user connectivity as possible. This architecture provides full recognition of all of the benefits of single mode fiber cabling, it has a better day-one capital expense savings percentage and the best year-over-year operational savings. For these exercise rooms, sports facilities and club houses, VLAN partitions data, services, devices and users into isolated protected flows.

Exercise room (distributed deployment) connected end-devices, services and user, typically include:

- RMS for door locks, lighting and environmental controls
- Showing both IPTV and RFTV are connected to the ONT (4-port or 8-port)

5.4 Outdoor Pool Zone

The following diagram, Figure 17, shows an example of an outdoor area around a large resort pool area. The main building, F, is the location of the Optical Line Terminal. This pool area has four separate smaller buildings and a stage that all require multiple data ports and phones. In addition, there are needs for access points and security cameras which surround the area. The distances from the main building F are all over 500'. The fiber used will require indoor/outdoor rated fiber. In this case, indoor/outdoor composite fiber was used to provide power to the ONTs.

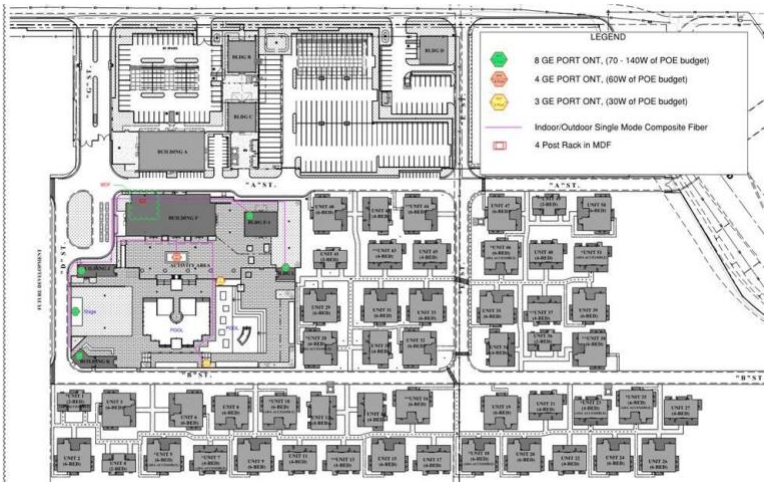

Figure 17: Resort Map

The above diagram is a high-level overview of the property layout. The subsequent diagram details the pool area and related amenities.

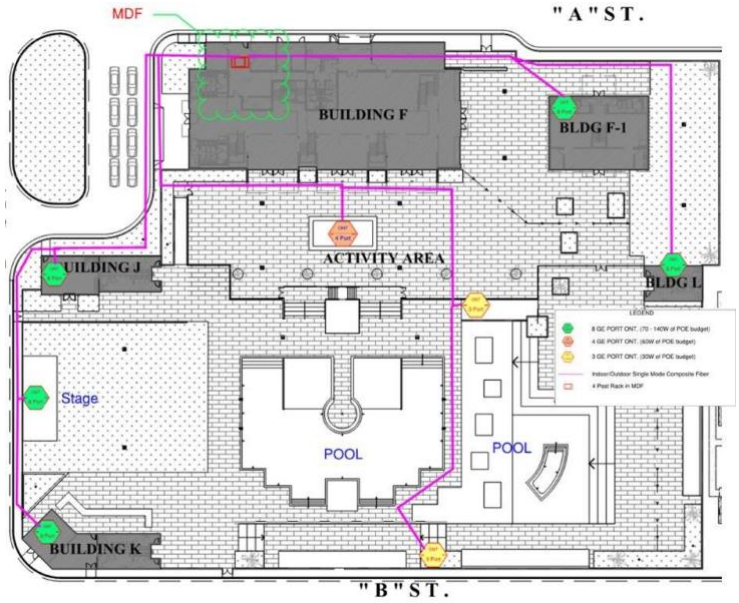

Figure 18: Resort Area Section One

Figure 18 above depicts eight different indoor/outdoor composite fiber installations to endpoints. The four buildings and the stage each receive an 8-port ONT that will provide up to eight data ports for those locations. The Activity Area Zone receives a 4-port ONT and two light pole locations receive a 3-port ONT, which is assumed to be mounted inside a NEMA cabinet. From this location, Wi-Fi APs will be connected for additional outdoor wireless coverage.

5.5 Gaming & Casinos

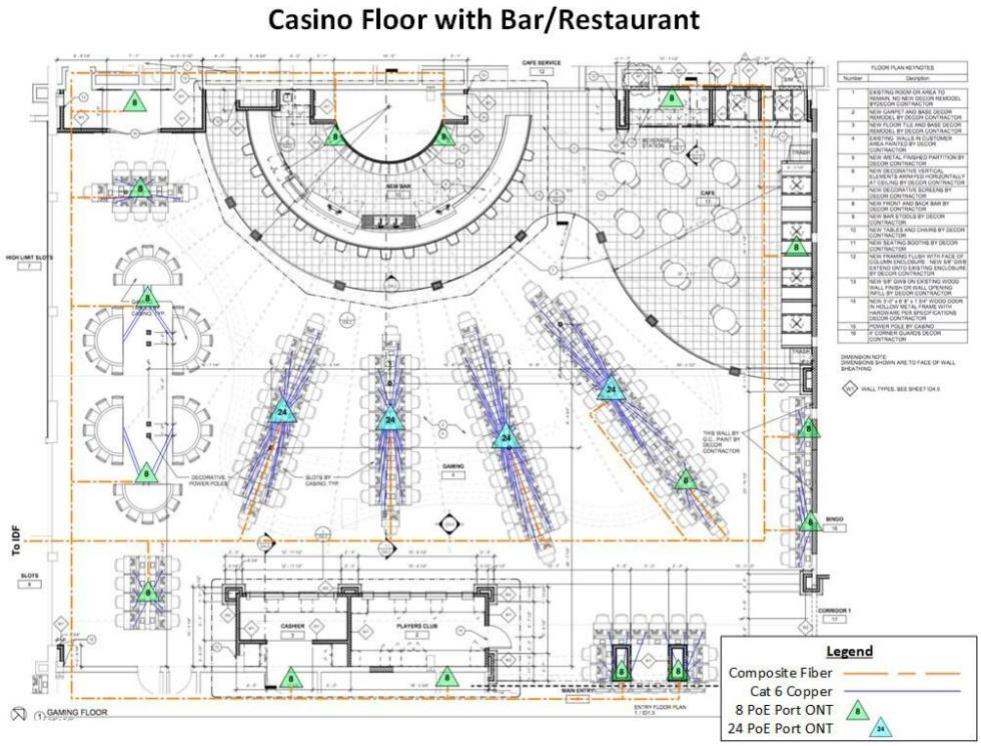

Figure 19: Casino Floor Layout

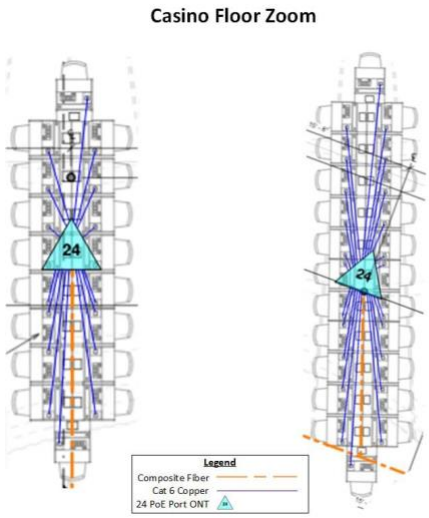

Figure 20: Zoomed-In Casino Floor Gaming Banks

Figures 19 and 20 above, are an overview of the gaming floor and distributed, mixed port count ONTs throughout the floor and slot banks.

The gaming industry is regulated very carefully by governing authorities in the respective region. Security is of utmost importance for the safety of guests as well as for the integrity of gaming. Fiber optic networks are inherently more secure than a copper network. Snooping the data on a fiber optic cable is very difficult to do without being detected, whereas data on copper cables can be snooped from a distance. A POL is an ideal solution for this type of network not only due to the security of the fiber optical cable, but technologies such as GPON, XGPON, etc. can employ a 128-bit AES encryption. Additionally, the fiber optic cable network with POL lends itself well to be moved around as the casino floor layout changes during periodic remodeling. This is especially true when comparing a POL to a traditional copper switched network. The copper network will require multiple Cat6 cables for each gaming pod area verses one single mode fiber cable with one or two fiber strands.

The gaming floor, bar and restaurant connected devices typically include:

- All electronic gaming machines such as slot machines
- Wireless access devices
- IP telephones, computers, POS devices, IP TVs, digital signage
- Security cameras

5.6 Back of House

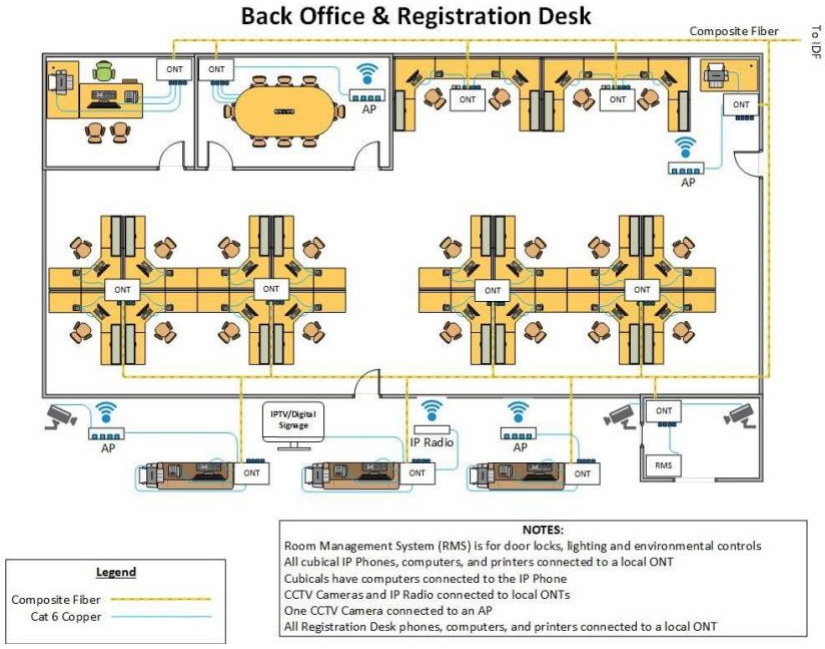

Figure 21: Back Office & Registration Desk

Back office and registration desk hotel operations can be securely supported on the same POL system delivering guest services. In fact, this has been an accepted practice in other markets for a decade where security classifications (e.g. classified, unclassified) for different groups of workers need to be kept separate across a common infrastructure. Separation through logical Layer-2 Ethernet mechanisms, using VLAN tagging, partitions data, services, devices and users into isolated protected flows. This also enables strong traffic management policies to be established for each end-point device and each traffic flow. This is also a way to protect credit card transactions and meet Payment Card Industry (PCI) compliance.

Back office and registration desk connected end-devices, services and users, as shown in Figure 21, typically include:

- RMS for door locks, lighting and environmental controls
- All cubical IP phones, computers, and printers connected to a local ONT
- Workstations have computers connected to the IP phone
- CCTV cameras and IP radio connected to local ONTs and one CCTV Camera connected to an AP
- All registration desk phones, computers and printers connected to a local ONT

5.7 Business Center & Retail Shop

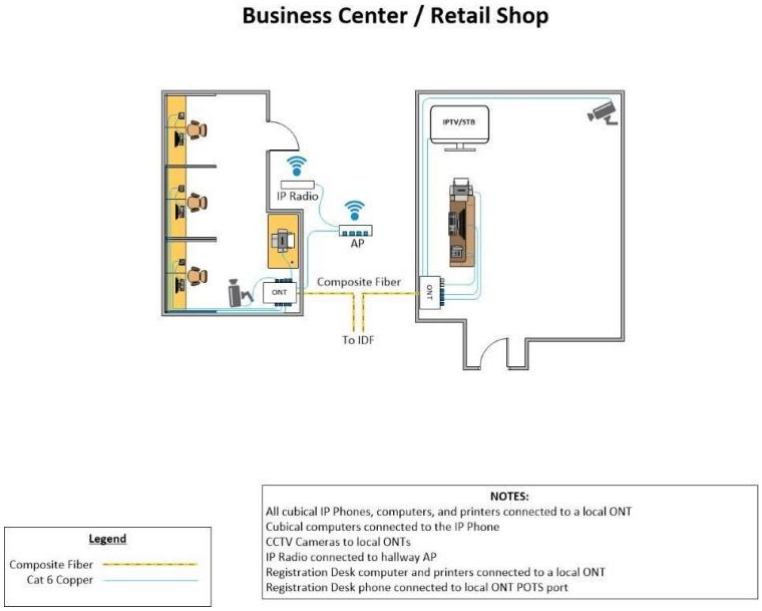

Figure 22: Business Center & Retail Shop

Business center and retail shops benefit from the fact that fiber cabling is inherently more secure than copper. Furthermore, Optical LAN architecture reduces points of vulnerability in MDFs and IDFs. ONTs have no local management access. ONTs store no user or network information and are fundamentally more secure than traditional switches. POL centralized management assures security policies and procedures are administered consistently with reduced human touch and reduced human error. For these reasons, POL is ideal for retail where PCI compliance is critical.

Business center and retail shops connected end-devices, services and users, as referenced in Figure 22, typically include:

- All cubical IP phones, computers and printers connected to a local ONT
- CCTV cameras to local ONTs
- IP radio connected to hallway AP
- Registration desk computer and printers connected to a local ONT registration desk phone connected to local ONT POTS port

5.8 Conference Space

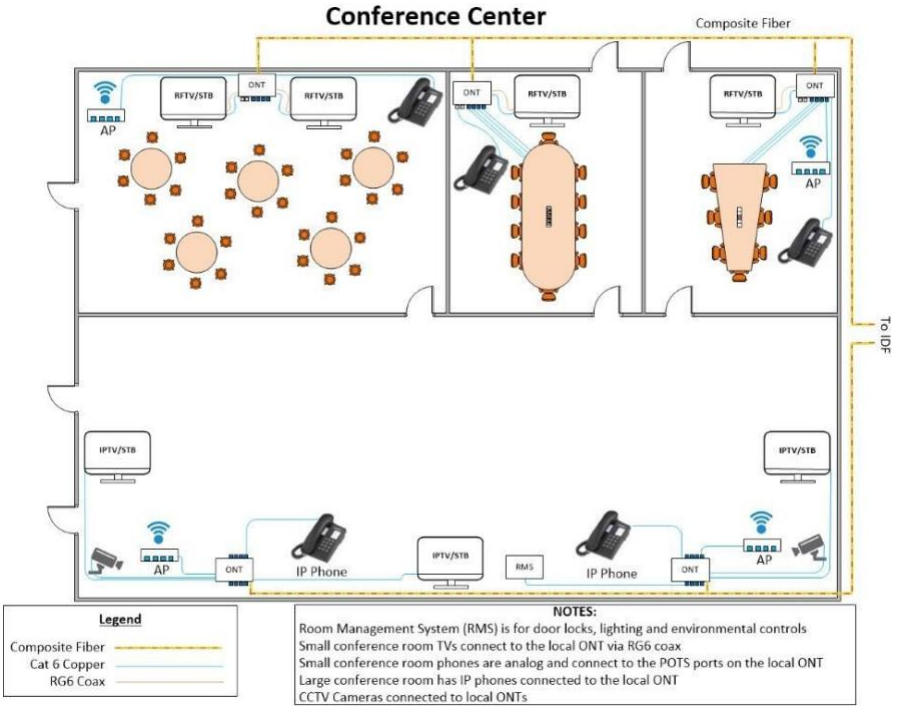

Figure 23: Conference Space

Whether a hotel's conference center is in the main building or a remote building, the extended reach of POL allows for voice, video, wireless and data service connectivity to be delivered over a 12-18 mile range both indoor and outdoor. For large conference centers, this eliminates the need for a powered switch or repeater every 300 feet. All of the conference center's data, services, devices and users can be partitioned by VLAN's into isolated protected flows.

Conference center connected end-devices, services and users, as referenced in Figure 23, typically include:

- RMS for door locks, lighting and environmental controls
- Small conference room TVs connect to the local ONT via RG6 coax
- Small conference room phones are analog and connect to the POTS ports on the local ONT
- Large conference room has IP phones connected to the local ONT
- CCTV cameras connected to local ONTs

6 Copper Vs. Fiber Optics

In order to show some comparisons between a FTTR and a copper to the room solution, it is important to consider how many ports per room are required for today's needs as well as the future. It is common to go back to older hotels and add additional ports for new applications or to upgrade to the latest bandwidth and POE requirements. A FTTR solution will allow the option to increase ports in the room without having to add additional cables.

The following diagrams are comparing data closets (also known as MDF and IDFs) as well as the number of cables and cable types in the horizontal space to the guest room.

To get started, look again at a typical room comparison that shows four applications inside the room as shown in Figure 24. There is a way to connect those applications all with multiple copper cables back to a telco room or IDF closet. You can see 3-5 copper cables per room that are required back to an IDF closet. The FTTR option shows one cable to the room which connects to a 4-port ONT. The ONT is powered via the copper conductors inside the composite fiber which then provides power to the ONT and in turn provides POE power to the Wi-Fi access point and phone in the room.

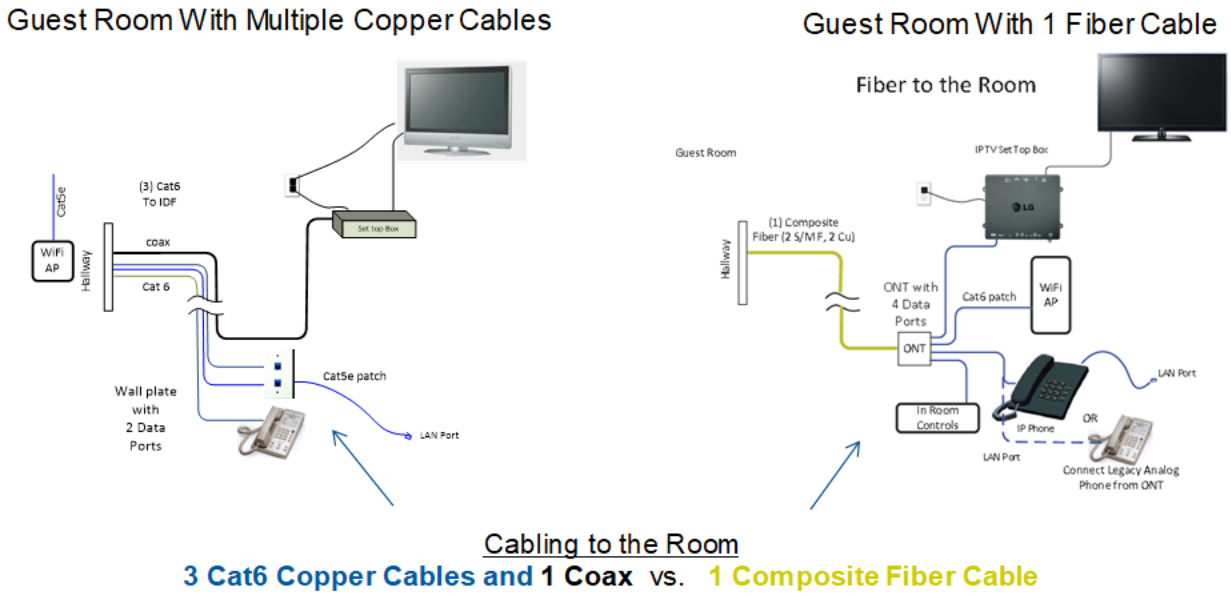

Figure 24: Copper vs. Fiber

6.1 Rack Elevation Comparison

The space inside Telco Rooms and IDFs can be limited, and the distance from this IDFs to the rooms can vary depending on the building and floor layout. It is possible to serve an entire hotel from one room in many cases since fiber travels well beyond the 100m rule of copper cabling. The following scenario is pretty even when it comes to distance to the guest room. Two IDFs serve approximately 60 rooms and one of them serves about 32 rooms. It should be noted that the FTTR option includes remote power, which is consistent with this document. If you removed the remote power option, the rack space in the closets for the FTTR option would be significantly reduced by approximately 50%.

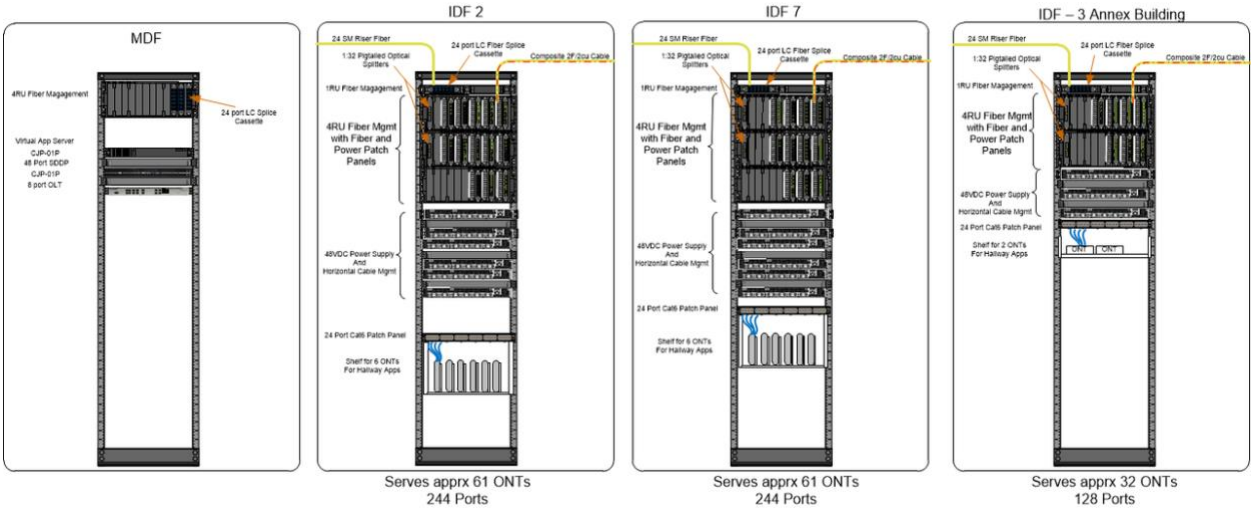

Figure 25: Rack Elevation for Fiber Optics

Figure 25 shows one MDF that connects to three IDFs via a 24SMF connection. The IDFs show fiber and power patching management along with remote power supplies to support the 61 ONTs per 244 ports or 32 ONTs per 128 ports.

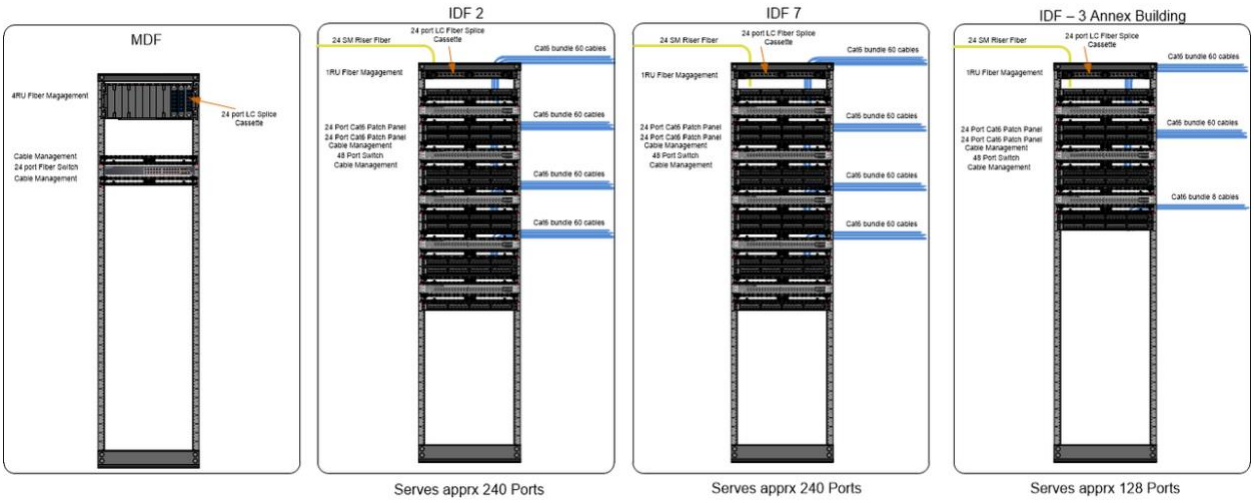

Figure 26: Rack Elevation Diagram for Copper

Figure 26 is a traditional switched copper solution that shows one MDF connecting to three IDFs via a 24SMF connection. The IDFs show a 24-port fiber connection along with 48-port POE switches, copper management and 24-port patch panels. There are enough ports to support 240 ports or 128 ports depending on the closet.

While the rack space could be fairly close inside the MDF or IDFs, the amount of cables out of these IDFs to the rooms are significantly different. As discussed previously, four times the amount of copper cables leaving these IDFs to the rooms are needed in comparison to the FTTR option. Figure 27 below helps illustrate these comparisons.

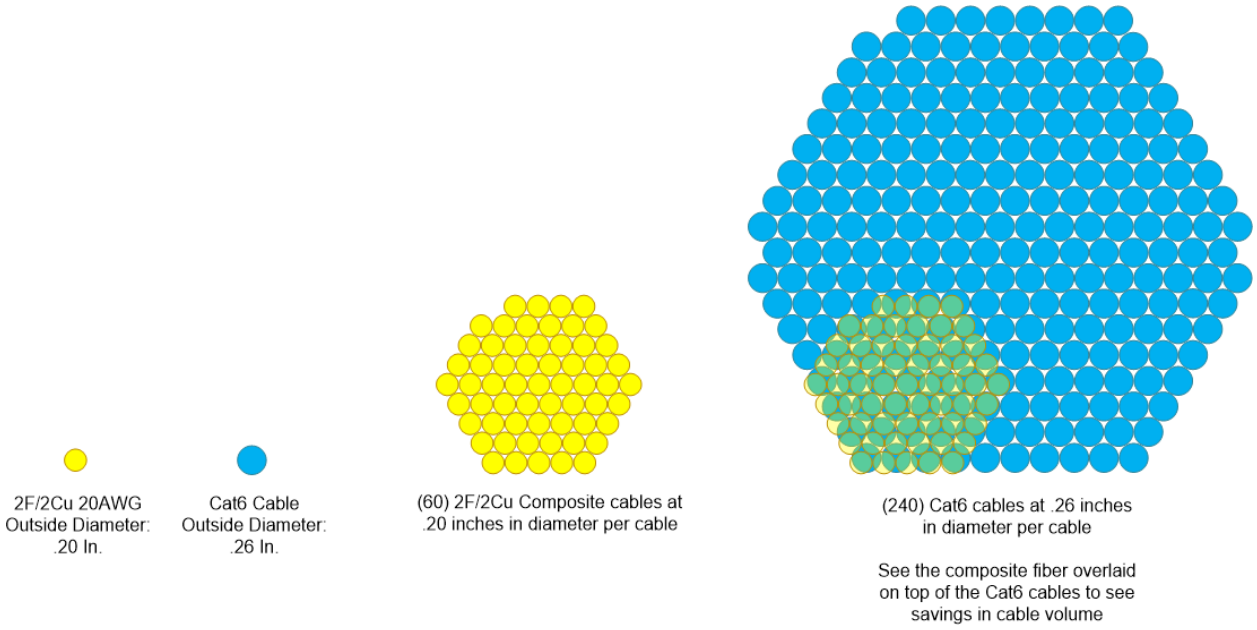

Figure 27: Fiber Optics Vs. Copper Cross Section Sizing

The above diagram, Figure 27, shows a cross-sectional diagram of a single composite cable (two fiber per two copper 20AWG) at .20 inches in diameter and a single Cat6 cable at .26 inches in diameter. It then shows what 60 composite fibers bundled together to serve 60 rooms and a bundle of 240 Cat6 cables in contrast to serve those same 60 rooms. If you overlay the 60 composite fibers over the bundle of 240 Cat6 cables, you can see the amount of space savings achieved out of that IDF. It is assumed that the maximum cable distance is still under 100m for either scenario but should be noted that the composite fiber can exceed that distance if needed.

The reduction of cables that are installed from the IDF closet to the room translates into a reduction of core drills, conduits, conduit size and cable trays.

One composite fiber cable has the ability to connect to 1 ONT that has multiple ports (one to eight for example with up to 60W of POE) and the ability to provide 1Gbps or 10Gbps today. This fiber cable then has the ability to provide up to 40Gbps or 100Gbps in the future.

7 Appendix

7.1 Factory or Field Termination

Choosing factory terminated cables or un-connectorized cables requiring on-site field termination need to be considered. These along with the type of topology will define the cable type to be used for efficient building and floor distribution.

7.2 Spliced at Both Ends

Cables with a different number of fibers are installed in the riser. The following list provides a few types of cables installed in buildings. Usually these cables will be spliced into a termination closure in the basement telecom closet. On each floor or between floors, several fibers can be extracted from the cable and spliced into a floor distribution terminal.

7.2.1 Dual-ended Factory Termination

Many operators prefer factory terminated cables for plug and play installations to simplify and speed up the deployment process. In this case, the cables with various fiber counts are connectorized at both ends at the supplier factory. These cables are similarly installed in the riser connecting directly into the basement telecom closet and the floor distribution terminal. In some cases, the cables can directly pass and connect at the end point.

7.2.2 Single-ended Factory Termination

Similarly, in this case the cable is factory terminated on one end chosen by the installer. This can either be the floor telecom closet or at the basement telecom closet with a splice operation performed. Usually, the splice is performed at the basement telecom closet depending upon the type of closure used there (full splicing, splitters, slack storage availability, etc.).

7.3 Cable Solutions

The types of cables used in building distribution are summarized below. It is beyond the scope of this section to describe each cable due to several manufacturer products and their ranging advantages or disadvantages. However, a brief description provides a quick overview of the installation method, as they may or may not need ducts (conduits).

- **Air Blown Fiber Cables:** Air blown cables are very popular in Europe since they can be pre-connectorized and are blown using air blowing equipment from each living unit. However, these cables require existing or new ducts installed.
- **Pushable Fiber Cables:** Pushable cables are similar to air blown cables but have low friction properties allowing them to be pushed through existing or new ducts when installed. The distance over which these cables can be pushed is far less than air blown cables. Like air blown fiber, these cables also require existing or new ducts installed.
- **Loose Tube Fiber Cables:** A variety of pre-connectorized and un-connectorized cables are available with multiple fiber densities. Depending upon the manufacturer, some of these cables can also be installed in the riser. In addition, some cables may have aramid (Kevlar) armor for extra ruggedness.
- **Assemblies:** Usually, 12 fiber assemblies in various defined lengths are installed along the hallway to connect each guest room or end-point. Each individual cord connects directly to an ONT.

- **Track Systems:** These solutions consist of a raceway into which a 12-fiber cord is installed to connect each guest room or end-point with a dedicated point of entry module. These provide connectivity to a single fiber system and then to the ONT. On the other end, the cord connects into a floor terminal.
- **Adhesive Systems:** These solutions contain one to sixteen fibers in a cord but do not require a track or raceway. Instead, adhesive is used to glue the cord to the ceiling, wall molding or base board to each room with dedicated point of entry modules. This solution "hides" the fiber cables in plain sight.
- **Micro Module Cables:** Micro module cables are a single high-density cable installed in the riser across all the floors. Each fiber is terminated into a floor terminal for distribution.
- **Composite Fiber:** These solutions include both fiber and copper conductors in the same jacket. This type of cable eliminates the need to install separate power and fiber cables to the endpoint, or room. Depending on manufacturer, there can be different versions of this cable that contain different fiber counts or types and different conductor counts and gauges. There can also be different jacket types to address armored, plenum, or indoor/outdoor scenarios.