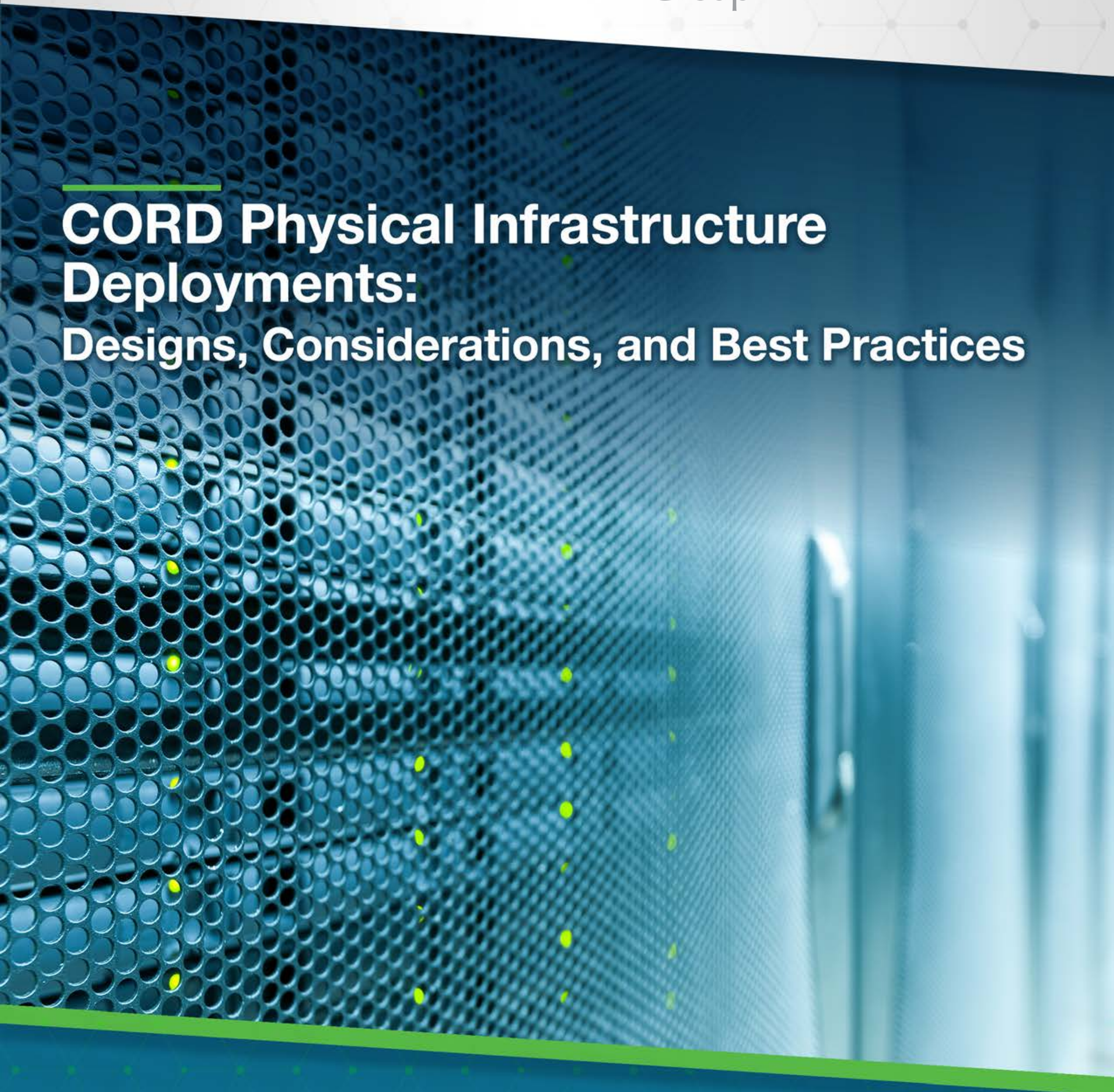
CORD Physical Infrastructure Deployments:

Designs, Considerations, and Best Practices



WHITE PAPER

Panduit and Prysmian Group have collaborated to clarify how to effectively deploy physical infrastructure for Central Office Re-architected as a Data Center (CORD). Both companies bring expertise in the enterprise, data center, and Telco marketplaces to contribute to the development of the CORD initiative. This paper is the second of a three paper series on CORD deployments.

We will address the challenges that Telco Operators will need to consider as they transition from a Traditional CO (Central Office) to a Re-architected CO. Topics include the following transitions: from single use to a multi-tenant space, from Telco equipment and cabling to Enterprise style equipment and LAN cabling, and from CO to considerably more conditioned data center space. In addition, we discuss the challenges with connectivity and standards that can occur. The final paper in the series will examine the physical infrastructure products from Panduit and Prysmian Group that are essential to the adoption of a successful CORD solution, as well as how to efficiently install and utilize the products.

Transition to Multi-Tenant Data Center Space

Traditionally CO's are mostly occupied by one company that controls all access to the facility and restricts access to employees and a few contractors. In addition, these facilities have monitored the bandwidth and power consumption at a high level. With a shift to a multi-tenant data center (MTDC) model, a lot of standard operating procedures will need to change. Security procedures will need to be adjusted to allow for employees and contractors of tenants to have access to the facility. Bandwidth and power monitoring will need to be far more granular in nature, allowing for measurements at the cabinet level.

Security

Security is a major challenge in any data center, but it's especially challenging in a MTDC. Traditionally CO's are occupied by one company that has tightly restricted access to the building. In a MTDC situation, access still must be restricted but also will be required to accommodate individuals who will need access to the CO's data center to work on their equipment located on the data center floor. Background checks, holding photo identification as collateral, access badges, man traps, and multiple layers of security are all strategies that MTDCs employ to maintain a high security level.

There are six basic layers of security in an MTDC. Layer one is the outside perimeter, which is usually made up of fencing around the whole property, with cameras and an entry gate of some kind. Layer two is the outside common space, which is made up of cameras and sensors that monitor the parking lot and common space around the outside of the building. Layer three is the security/reception area. This area is where tenants check in, provide a photo ID, and have their identity confirmed. Layer four is the man trap. The man trap is an area where entry/exit is slowed by doors that open one at a time. Layer five is the data center room door. This is the door that allows access into the data center room and this usually has card and/or biometric access control. The sixth and final layer is the locked cabinet door on the cabinet itself. This prevents unrestricted access to the equipment within the cabinet. Figure 1 shows examples of the levels of physical security used in a multi-tenant data center.

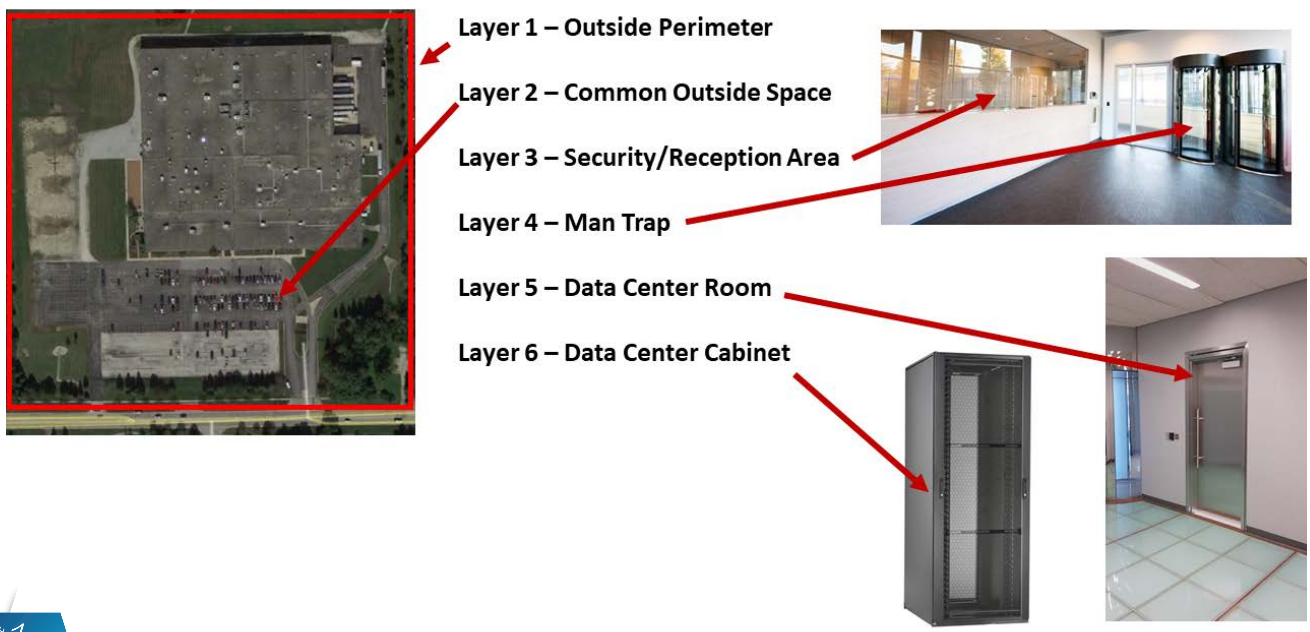


FIGURE 1 The Six Layers of Security

Power Monitoring

Traditional Telco Power Monitoring is limited to their own DC power through Battery Distribution Fuse Bays (BDFBs) and Battery Distribution Circuit Breaker Bays (BDCBBs) to deliver power to their equipment. As they transition into the CORD model the power will change to mostly AC utilizing UPS's that incorporate battery plants with associated Switch Gear Panels and Circuit Breaker Distribution Panels which feed rack mounted Cabinet Power Distribution Units (CPDUs).

With the transition to an MTDC, facility power will need to be monitored at a more comprehensive level. In this scenario all the equipment panels need to be monitored, from the Main Circuit level all the way down to the Branch Circuit level and even individual equipment plug locations in a server rack. This is much more complex than what a typical Central Office would need. This level of granularity offers the Data Center Operator the capability to ensure the level of power being used is what has been agreed to be delivered to the end customer.

Bandwidth Monitoring

Bandwidth keeps us all linked together in this connected world. Bandwidth monitoring is not a new concept for CO operators, but rather it's the granularity of bandwidth monitoring that will be the adjustment. Most CO operators are familiar with monitoring the bandwidth down to a room or distribution switch level. In a MTDC situation, bandwidth needs to be monitored down to an access switch port level to accurately bill tenants for their bandwidth usage. 95 percentile bandwidth measurements are the industry standard for measuring bandwidth within data centers.

Transition from Traditional Telco Equipment to Enterprise Equipment

CORD is the response to low-latency needs. CORD will be based on existing Central Offices/Points of Presence (POP) facilities transitioning to more data center-like facilities. Central Offices will experience consolidation and network evolution. The evolution of network architecture (Figure 2) leads to a reduction of 30%-50% of current central offices and the new central office infrastructure will be more “data center and enterprise-like”. Both active and passive components will be impacted by the new CORD architecture, including requirements for new cables, connectors and accessories. Network management cost reductions and increases in performance are the key drivers of the transition from Traditional Telco equipment to data center-like equipment which includes racks and cabinets, cooling infrastructure, power infrastructure, power suppression, and grounding and bonding.

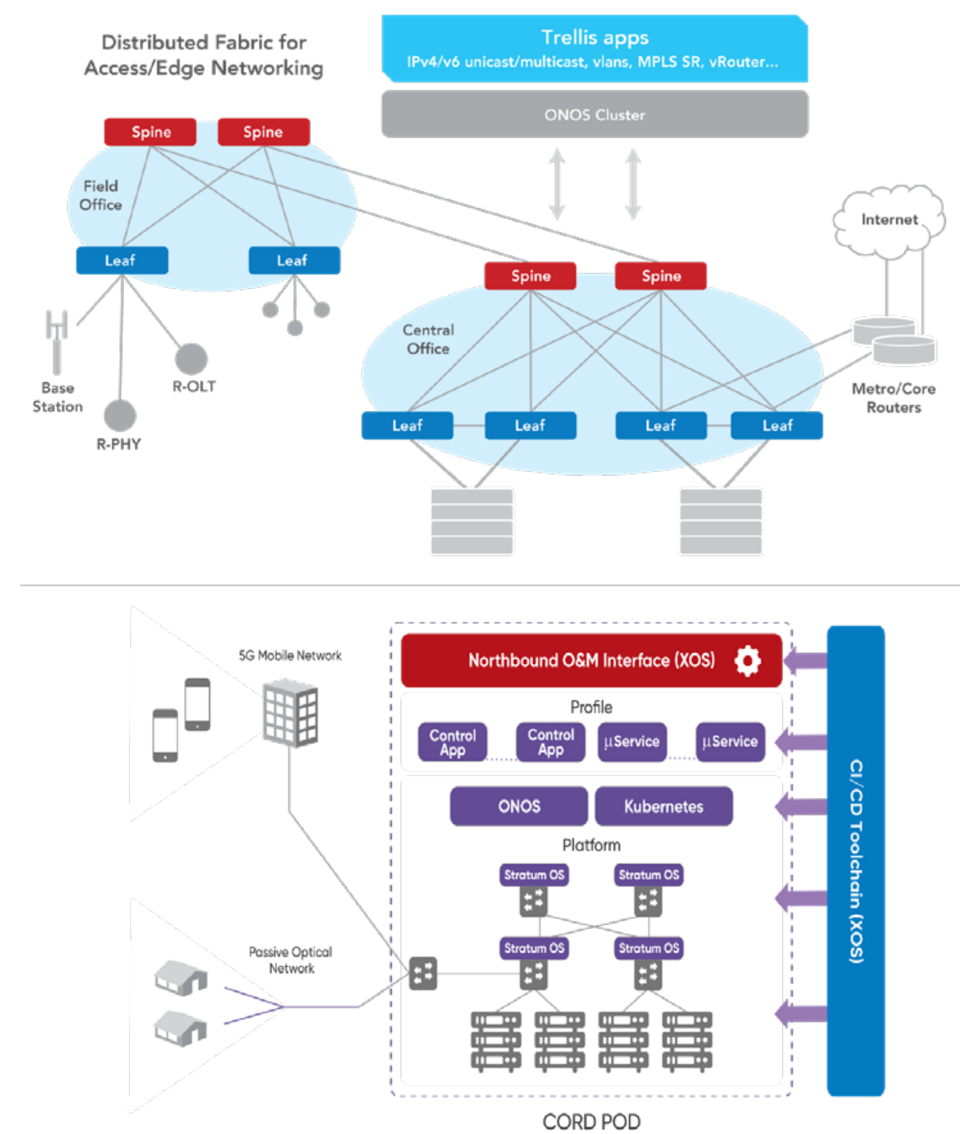


FIGURE 2 Transition from Traditional CO. to CORD CO.

FIGURE 3
Network Cabinet
(Courtesy of Panduit Corporation)

Rack and Cabinets

Data center automation is a well-refined operation that focuses on efficiency. In many data centers, entire cabinets of equipment are operated securely with little or no human interaction. Cloud-scale equipment puts cloud-like operational economics within reach for the Telco industry.

There are two different types of Cabinets: Server and Network. These two types of cabinets are similar in terms of outside dimensions, but are quite different in internal layout and function. Racks are usually of a 2-post variety and 4-post open frame (no sides, doors, top).

Network Cabinets

Network cabinets are typically 42 RU and 84" in height with a width of 28" to 32" and a depth of up to 32", and normally house switches, routers, and patch panels. The rails in a network cabinet are set back several inches from the front of the cabinet to provide space for cable management. Figure 3 shows what a network cabinet looks like.

FIGURE 4
Server Cabinet
(Courtesy of Panduit Corporation)

Server Cabinets

Server cabinets are typically 42 RU and 84" in height with a width of 30" to 34" and a depth of up to 42" and normally house servers, controllers, and vertical power delivery strips. The rails in a server cabinet are pushed all the way to the front of the cabinet to allow for maximized space in the back of the cabinet for cable management and CPDUs. Figure 4 shows what a server cabinet looks like.

FIGURE 5 **Data Center 4-Post Rack**
(Courtesy of Panduit Corporation)

Racks

Racks can be either 2-post and 4-post. 2-post racks are usually used for patch panels or fiber distribution panels, small 1U switches or horizontal rack mount PDU's. Components typically do not have a footprint of more than 24" in depth. 4-post racks are used for larger switches and equipment. Figure 5 shows what a 4-post rack looks like.

CO Transition to More Conditioned Space

Central offices were originally designed with minimal cooling due to the high tolerance of the equipment used. The next generation central offices will need to address high heat load situation at lower temperatures. From a power perspective, central offices were originally designed using -48 V DC power backed by a battery plant that could support more than 48 hours without utility power. The CORD conversion of central offices will require a shift to the use of -48 V power, (the standard in Telco equipment) AC power is the predominant source required for data center equipment.

Cooling Infrastructure

Telecommunication equipment can work in a wide range of temperature and humidity while operators traditionally interested in the most economical methods for cooling. As traditional telco equipment is being replaced by common servers, the method of cooling needs to follow data center standards. In a CORD environment, data center cooling methods like chilled water and refrigerant cooling systems are going to be used.

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Cooling Methods

Chilled Water — A chilled water data center cooling system is commonly utilized by mid-sized to large data centers. It employs chilled water supplied by a water storage unit located on the data center site to cool air being brought in by computer room air handlers (CRAH) units. More information about the chilled water cooling method is provided below in the Equipment for Cooling section.

Refrigerant Cooling Systems — A refrigerant data center cooling system employs air conditioners similar to household air conditioners. Air is cooled by being drawn across refrigerant-filled coils. More information about the refrigerant cooling systems is provided below in the Equipment for Cooling section.

Equipment for Cooling

Water Chiller Plant (Chiller) — A water chiller is a mechanical device used to facilitate heat exchange from water to a refrigerant in a closed loop system. The refrigerant is then pumped to a location where the waste heat is transferred to the atmosphere, generally from an evaporator on the roof of the data center.

Computer Room Air Handler (CRAH) — A CRAH unit is a part of a wider system involving a chiller elsewhere in the facility. Cold water flows through a cooling coil within the unit, which then uses fans to draw air from outside the facility. By using chilled outside air, CRAH units are much more efficient when used in locations with colder climates.

Compute Room Air Conditioner (CRAC) — CRAC units are similar to air conditioners used in your home. They are powered by a compressor that draws air across a refrigerant-filled cooling unit. They are less efficient in terms of energy usage, but the equipment is generally cost-effective.

Alternative/Auxiliary Cooling Methods

Free Cooling — Free cooling is a cost-effective way to cool a data center. When this method is used, the energy expended for cooling is reduced and thus it reduces the overall expenditures for cooling. This technique consists of two systems: air-side economization and water-side economization. Air-side economization uses air from the outdoors to regulate the data center temperature. Water-side economization uses the evaporative cooling capacity of a cooling tower to produce chilled water and can be used instead of the chiller during the winter months. Both air-side economizers and water-side economizers work best in climates were the temperature is lower than 55°F for 3,000 hours or more.

Liquid Cooling Systems — Liquid cooling system is a technique used to control a computer processor's temperature by using a dielectric liquid as the cooling source. The dielectric liquid is run through a closed system to the processor, where it draws the heat from the processor and transfers it through the dielectric liquid to an outside source. This cooling style provides efficient cooling and helps to minimize the noise generated by fans used to cool processors in more traditional data center.

Power Systems – UPS, Generator Power – Battery Plants

As CORD is designed to follow data center architecture, next generation of Central Offices should be designed to meet certain power requirements. Without reliable, uninterrupted power supply, the facility will experience downtimes that risk disrupting all its operations, as CORD will handle various mission critical applications that are sensitive to latency. Loss of power, even for a few seconds, can cause massive losses. There are numerous options of power and electrical infrastructure or equipment to choose from. The key is to ensure that the equipment is reliable and provides adequate security just in case of power failure in the locality.

Power Chain Infrastructure Equipment

Automatic Transfer Switches

An automatic transfer switch (ATS) is a piece of equipment that automatically transfers the power supply from its primary source to a backup source when it detects a failure in the primary source. Once a failure in the primary power is detected, the ATS activates a short-term backup power source. An example of a short-term backup power source would be an uninterruptable power supply (UPS). Subsequently, when the UPS is activated, the ATS can also notify a long-term backup power source such as a diesel generator to start up to provide power until the primary source is restored.

UPS

The Uninterruptable Power Supplies (UPS) are critical short-term backup sources that are utilized in the data center. The UPS provides short-term power to bridge the gap between the loss of utility power and activation of generator power. There are three different types of UPS: Standby, Line Interactive and Online Double Conversion.

Standby UPS

A standby UPS operates in two modes. Under normal power operation, the input power is directly fed to the output power with no filtering. When normal power operation is lost, a switch within the UPS transfers the load to a battery source.

Line Interactive UPS

A line interactive UPS operates similarly to a standby UPS but also can adjust the output power in response to an over or under voltage situation without switching the power source to the battery. When normal power operation is lost, a switch within the UPS transfers the load to a battery source.

Online Double Conversion UPS

An online double conversion UPS uses double conversion electronics. This type of UPS is always connected and does not require switching to the energy storage source. During normal power operation, power flows through a rectifier, which charges the energy storage source, and then through an inverter to the output. When normal power operation is lost, the energy storage source engages automatically. Many of these UPSs also have a bypass source system. This allows for maintenance to be performed on the UPS safely and without disruption to service.

Generator

Generators are an important part of the operation of a data center. They provide backup power within minutes, if not seconds of the loss of normal power supply. There are several types of generators that can be utilized, but most are powered by diesel fuel or natural gas.

Power Distribution

Data Center Power Distribution Units (DCPDU)

Data Center Power Distribution Units (DCPDU) are generally placed outside of the data center room. DCPDUs are large industrial power distribution units and should not be confused with the cabinet PDUs (CPDU) that power individual data center cabinets. They take the power from the UPS and transforms the power from 480 volts AC to either 400 volts AC for most new data centers or 208 volts AC for older data centers.

Remote Power Panel (RPP)

Remote Power Panel (RPP) are the circuit breaker panels used in data centers. They provide the flexibility to cut or restore power to individual circuits and mitigate damaging surges. Some models also allow for Branch Circuit Monitoring.

Branch Circuit Monitoring (BCM)

The Branch Circuit Monitoring (BCM) provides users with power metering on individual circuits from the RPP to the CPDU. This allows the data center operator to have visibility to the power usage on each of the circuits and see power imbalances at the cabinet level, on a data center wide view.

Cabinet Power Distribution Units (CPDU)

Cabinet Power Distribution Units (CPDU) distribute the power to IT equipment within each cabinet. During typical operation, each CPDU carries no more than 50% of the IT load. Therefore, two CPDUs are used in each cabinet to accomplish power distribution redundancy (A and B power feeds). In case of power path failure, a single feed is capable of delivering 100% of the cabinet load.

CPDUs can come in many forms with many different levels of intelligence and monitoring.
Some of the different levels are listed below:

- Basic CPDU – No monitoring of power usage, no remote power cycle access. Only provides power.
- Monitored Input (MI) CPDU – Monitoring of the power usage at CPDU level.
- Monitored Switched (MS) CPDU – Monitoring of power usage at CPDU level and remote power cycle access at the outlet or group of outlets level.

Fire Suppression

Traditional Telco fire suppression is a standard pressurized water system that does not have the requirement for dense coverage of more modern data center systems required for coverage and flow. Data centers not only use water for the fire suppression, but it is usually a dry charged system with sprinklers, dual stage, with a more dense emitter layout. Hybrid systems may also use gas type chemicals like Halon or FM2000 as well as dielectric fluids that are emitted under high pressure as a fine mist rather than a spray like water based systems.

Grounding and Bonding

The telecom grounding system is an active functioning system designed to maximize equipment safety and uptime, maintain system performance, and protect equipment as well as personnel. Proper grounding and bonding steps are essential for efficient data center equipment performance. The purpose of the grounding system is to create a robust path for electrical surges and transient voltages to return either to their source power system or to earth while not being introduced to the main building power system after the Mesh Common Bonding Network (MCBN). Lightning, fault currents, circuit switching, activation of surge protection devices (SPD) and electrostatic discharge (ESD) are common causes of these electrical surges and transient voltages. An effective grounding system can minimize or eliminate the detrimental effects of these events.

A MCBN is generally a 2 AWG, bare, code conductor that is installed in the data center. The MCBN is bonded to a Telecommunications Grounding Busbar (TGB) installed inside the data center. This TGB is then bonded to the building's main grounding electrode system. The MCBN is supported and attached to the access floor pedestals using a series of access floor grounding clamps. These clamps not only support the MCBN conductors but also bond the pedestals themselves.

All metallic components within the data center infrastructure (including IT equipment, cabinets, pathway elements, mechanicals, etc.) must be bonded to the grounding system using proper wire size, H-Taps or C-Taps. For example, IT equipment is bonded to the cabinets in-rack ground bar, the ground bar is connected to the in-room halo ground which is connected to the in-room grounding busbar then connected to the TGB. All components in the data center that bond to the MCBN ultimately bond to this same building electrode system.

Chart of conductor size, by allowable length, for grounding cables is shown in Table 1:

TBB/GE linear length m (Ft.)	TBB/GE size (AWG)
less than 4 (13)	6
4 — 6 (14 — 20)	4
6 — 8 (21 — 26)	3
8 — 10 (27 — 33)	2
10 — 13 (34 — 41)	1
13 — 16 (42 — 52)	1/0
16 — 20 (53 — 66)	2/0
20 — 26 (67 — 84)	3/0
26 — 32 (85 —105)	4/0
32 — 38 (106 — 125)	250 kcmil
38 — 46 (126 — 150)	300 kcmil
46 — 53 (151 — 175)	350 kcmil
53 — 76 (176 — 250)	500 kcmil
76 — 91 (251 — 300)	600 kcmil
Greater than 91 (301)	750 kcmil

Table 1: Grounding Cables by conductor size and length

Challenges with Connectivity

CORD cabling is critical to a data center's performance. There are a number of ways to optimize CO cabling infrastructure as well as potential problems to be aware of. Whether it's an incorrect cable type, reversed polarity or poor physical installation and management, a poorly implemented cabling infrastructure can impact cooling, cause increased downtime and affect long-term data center cable management.

A CO should use the highest-grade copper or fiber (Singlemode and Multimode) cables to meet today's specifications and those of the future (AOCs, Direct Attached & Structured Approach). Some older fiber cables won't tolerate the reduced bend radius required in today's CO. The economics of using older cabling is alluring, but it will wreak havoc and result in increased installation time and a much higher cable failure rate.

Meet-Me Room (MMR)

Traditional colocation data centers with carrier hotels use MMR to control and manage connections for customer to customer and Telco providers to customer in the data center. The customers can be cage or private rack customers that will have a connection from their space (cage, rack, or suite) to the MMR where the colocation data center operator manages the requested connection. Telco providers also have connections to the MMR so they too can provide transit connections.

Data Center Connectivity

Cloud and Edge data centers have been upgrading fabric serial lane rates to 400Gbps ('19 onward) and evaluating Very Short Reach (VSR) lower cost, multimode fiber-based (<100m), multi-lane technology for Switch to Server and Leaf/Spine interconnect.

Category cabling, Direct Attach Copper (DAC) cabling and Active Optical Cabling (AOC) currently present the lowest cost 'fixed' option for switch to server interconnect at current server NIC lane rates (@ 10/25G).

These will move towards 50G NICs (and eventually 100G) as 400G MMF VSR SR8 optics are mainstreamed as low-cost options vs DR4 for short reach. Figure 6 displays the progression of higher speeds through the IEEE.

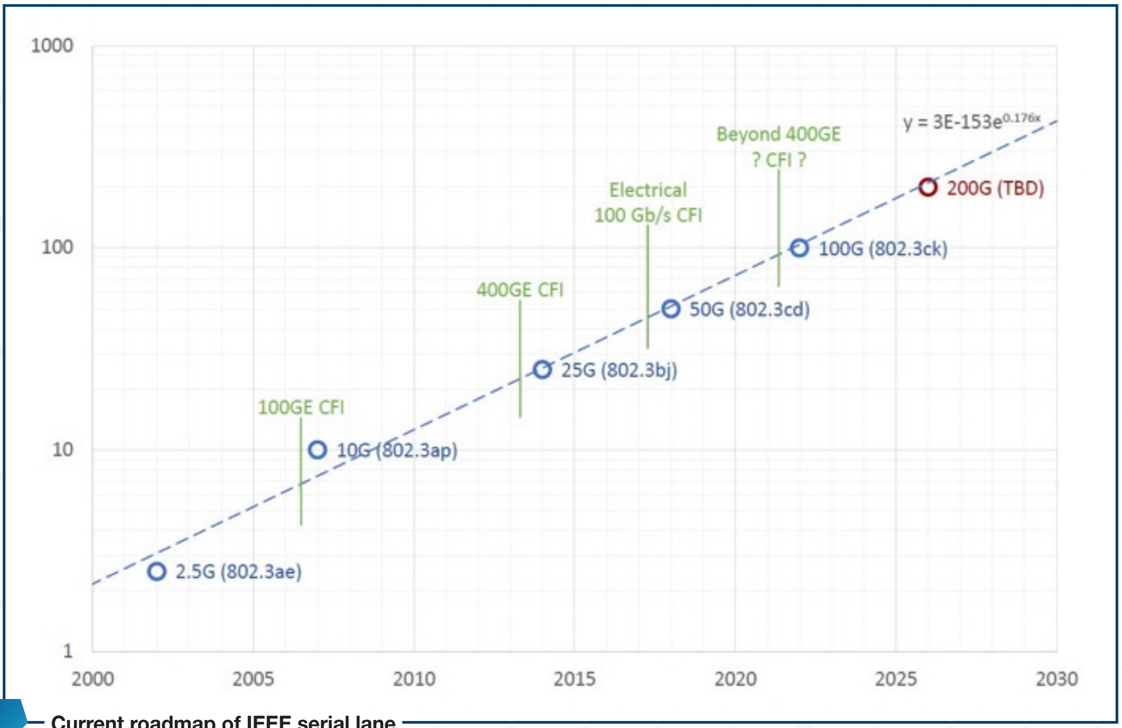

FIGURE 6 Current roadmap of IEEE serial lane

Category Copper Cabling

TIA and ISO standards group cables and connecting hardware into different performance categories. These standards specify intrinsic bandwidth and data rate capability for each category.

These specifications include a number of electrical performance parameters and are tested within a specific electrical frequency range or bandwidth. The table below (Table 2) highlights bandwidth limits for the various categories of twisted pair copper cable and applicable Ethernet protocols.

Category	ISO Channel Class	Maximum Bandwidth	Maximum Ethernet Data Rate	Cabling System	Connector Type
5e	D	100MHz	1000Mbps	Unshielded or Shielded	RJ45
6	E	250MHz	10Gbps	Unshielded or Shielded	RJ45
6A	EA	500MHz	10Gbps	Unshielded or Shielded	RJ45
8	8.I and 8.II	2000MHz	25Gbps/40Gbps	Shielded only	RJ45

*Category 7 and 7A are not recognized by ANSI/TIA-568.3-D

Table 2: Category Cabling Standards

Category Cabling Application Reach

The table below (Table 3) indicates expected reach (in meters) for a two-connector channel for various copper category cabling systems against IEEE 802.3 transmission standards.

Ethernet Data Rate	IEEE 802.3 Standard	Maximum Channel Length (meters)			
		5E	6	6A	8
1Gbps	1000BASE-T	100	100	100	–
10Gbps	10GBASE-T	37–55*	37–55*	100	–
25Gbps	25GBASE-T	–	–	–	30
40Gbps	40GBASE-T	–	–	–	30

*Reach depending on crosstalk when transmitting 10Gbps

Table 3: Category Cabling Reach

Direct Attached Copper (DAC)

Direct attached copper cable is a type of copper cable that has factory terminated transceiver connectors on each end. DAC cables are used to connect network equipment, generally switches, routers and other network equipment, as well as to connect servers to switches or storage equipment. DAC cables are constructed from shielded copper cable that generally ranges from 24 to 30 AWG. They are fixed length cables and come in two different types, active and passive. Active cables are powered and can achieve longer distances, generally up to 15m (for in-row applications like middle of row (MoR)/end of row (EoR)). Passive cables are non-powered and can generally only achieve distances of up to 5m (for in-cabinet applications like Top of rack (ToR)). DAC cables are used for higher speed connection and are available in 10Gbps, 25Gbps, 40Gbps, and 100Gbps.

Fiber Cabling

There are several recognized horizontal fiber cabling media solutions applicable to CORD implementations.

- 850nm Laser-Optimized 50/125µm multimode fiber cable OM3 or OM4 (ANSI/TIA-568.3-D), with OM4 recommended; OM5 fiber solutions to support SWDM applications
- Singlemode optical fiber cable (ANSI/TIA-568.3-D)

Fiber cabling systems deployed today should be selected to support future data rate applications, such as 100G/400G Ethernet and Fibre Channel ≥32G. For multimode solutions, OM3 is a starting point. In addition to being the only multimode fibers included in the 40G and 100G Ethernet standard, OM3 and OM4 fibers provide high performance as well as the extended reach often required for structured cabling installations in the data center. The table below highlights bandwidth limits for the various classes of multimode and singlemode cable and applicable Ethernet protocols.

Fiber Type	ISO Cable Designation	Maximum Bandwidth	Target Ethernet Data Rate*	Target Cabling Types*	Connector Type
50/125µm MM	OM3	2000MHz.km	10/40/100Gbps	IO & Premise	SC, LC, MPO & others
50/125µm MM	OM4	4700MHz.km	40/100/400Gbps	IO & Premise	SC, LC, MPO & others
50/125µm MM	OM5	500MHz	40/100Gbps	IO & Premise	SC, LC, MPO & others
9/125µm SM	OS1/OS2	–	>10Gbps	OSP & ISP	SC, LC, MPO & others

*Target data rates & cabling types shown as 'typical' applications

Table 4: Fiber Cabling Standards

Fiber Cabling Application Reach

The table below indicate expected reach (in meters) for a two-connector channel for various fiber cabling systems against IEEE 802.3 transmission standards.

Ethernet Data Rate	IEEE 802.3 Standard	Maximum Channel Length (meters)			
		OM3	OM4	OM5	OS1/OS2
10Gbps	10GBASE-SR 10GBASE-LR	300	400-550*	400-550*	10,000
25Gbps	25GBASE-SR 25GBASE-LR	70	100	100	10,000
40Gbps	40GBASE-SR4 40GBASE-LR4	100	150	150	10,000
50Gbps	50GBASE-SR 50GBASE-LR	70	100	100	10,000
50Gbps	100GBASE-SR4 100GBASE-LR4	100	150	150	10,000
400Gbps	400GBASE-SR8 400GBASE-FR4	70	100	100	2,000

*Depending on module type & capability

Table 5: Fiber Application Reach

Active Optical Cable (AOC)

Active Optical Cable (AOC) is a type of fiber cable that has factory terminated transceiver connectors on each end. AOC cables are used to connect network equipment, generally switches, routers and other network equipment, as well as to connect servers to switches or storage equipment. AOC cables are fixed length cables and can achieve longer distances, generally up to 100m (although generally supplied as <30 meters for in-row and between-row applications). AOC cables are used for higher speed connection and are available in 10Gbps, 25Gbps, 40Gbps, and 100Gbps.

Cabling to Support Pod-Based, Leaf-Spine Architecture

With the change to leaf-spine architecture (from hierarchical star), the copper and fiber cabling infrastructure has changed, based on the transition to EoR or MoR leaf switch deployments.

In this design, leaf switches are placed in MoR/EoR cabinets and connected to ToR access switches (or directly to servers for smaller deployments) across an entire row using SR4 transceivers/multimode cabling or AOCs. Both MoR and EoR deployments may require cabling distances of 15-30 m to reach TOR switches (or servers) in the row and as such category cabling is not practical for data rates above 10G.

Spine switches are collapsed into a remote Intermediate Distribution Frame (IDF) row and can be interconnected to leaf switches with multimode SR4 optics or longer reach singlemode optics such as LR4.

The figure below attempts to indicate the current and future state interconnect for these cabling elements.

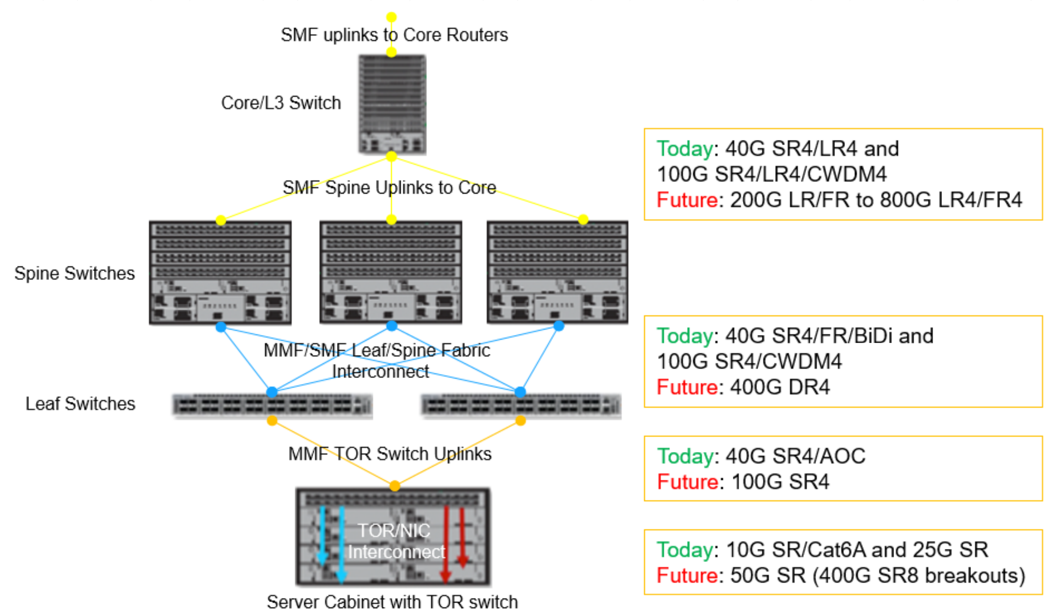

FIGURE 7 **Physical Infrastructure Options for a Spine-Leaf Architecture**

Traditional CO vs. Data Center Standards

This discussion outlines standards and best practice documents to be followed when building, deploying and cabling within the DC portion of the Central Office. This does not necessarily apply to any carrier cages (AGN, LNS, RBOCS, LECs or TELCO cages). Historically, these portions of the CO are beholden to Telcordia requirements.

Telcordia Guidance for Central Offices

For operators, the invaluable reference source for interface specifications, equipment capabilities and performance/reliability characteristics is the Telcordia Generic Requirements, which includes lesgacy Technical Advisories (TAs) and Technical References (TRs), as well as the extensive list of Generic Requirements (GRs). These documents provide implicit guidance for new, as well as existing, technologies or services for COs.

These documents are widely utilized/referenced by carrier COs in addressing transport, routing, switching, and signaling technologies and services including engineering, reliability, operations and maintenance. Telcordia also issues Special Reports (SRs), discussing general topics of interest around a range of relevant technologies.

Guidance for MTDC, Hyperscale, Edge and On-premise/Customer-owned Data Centers

Relevant data center design and infrastructure standards developed for this industry include:

Uptime Institute's Tier Standard — The Uptime Institute (for-profit certifying entity) was the first group to measure and compare DC reliability. Its performance-based methodology for DCs during design, construction, and commissioning phases determines facility resiliency with respect to four redundancy/reliability Tiers. These Tiers are illustrated in greater detail in their "Tier Classifications Define Site Infrastructure Performance".

TIA DC Standard — "Telecommunication Industry Association for DC Infrastructure Design Standards": Developed by TIA TR-42.1.1 subcommittee with participation of design firms, consultants, end-users and manufacturers.

The purpose of the standard is to encourage early participation of telecom designers in DC design process and to provide standards for planning of DCs, equipment rooms, and similar spaces. The TIA 942 DC standard is a tool to evaluate existing DCs and to communicate design requirements. Included in this are specs for DC telecoms pathways/spaces and recommendations on structured cabling media/distance vs. application.

A significant portion of TIA 942 deals with facility specifications (telecommunications, architectural, electrical, and mechanical system ratings) and includes infrastructure redundancy/reliability concepts based on Uptime Institute's Tiers. TIA has a certification system in place to provide facility certification.

ANSI/BICSI 002-2014 — "Data Center Design and Implementation Best Practices" - DC planning, build and operation guide covering the major aspects of design, construction, and commissioning of the MEP (Mechanical, electrical, and plumbing) DC systems as well as IT installation, fire protection systems and maintenance. BICSI-trained/certified professionals can validate reliability rating/class of DC designs per this document.

EN 50600 International Standard — CENELEC, (European Committee for Electrotechnical Standardization) develops standards that reflect those developed by the International Electrotechnical Commission (IEC). These standards mirror UI, TIA, and BICSI standards. Applicable Data Center CENELEC Standards include:

EN 50173 series: "Information technology — Generic cabling systems"; EN 50174 series: "Information technology - Cabling installation" and EN 50600 series: "Information technology - DC facilities and infrastructures design".

Regulatory Standards — Government regulations applicable to DCs hosted within a CO depend on the nature of the business transacted therein and may intersect with HIPPA (Health Insurance Portability and Accountability Act), SOX (Sarbanes Oxley) 2002, SAS 70 Type I or II, GLBA (Gramm-Leach Bliley Act), as well as new regulations that may be implemented depending on the business and security requirements present or planned in the CO.

Operational Standards — These are standards guiding day-to-day processes/SOPs in active DC operations:

- Uptime Institute: Operational Sustainability (with and without Tier certification)
- AMS-IX - Amsterdam Internet Exchange - Data Center Business Continuity Standard
- SOC, SAS70 & ISAE 3402 or SSAE16, FFIEC (USA) - Assurance Controls
- ISO 14000 - Environmental Management System
- ISO 27001 - Information Security
- PCI - Payment Card Industry Security Standard

Applicability of these standards vary based on the nature of the business transacted in the DC portion of the CO and include guidelines associated with operations/maintenance procedures for all the DC active hardware.

Sample Physical Infrastructure Layouts

Network Cabinet

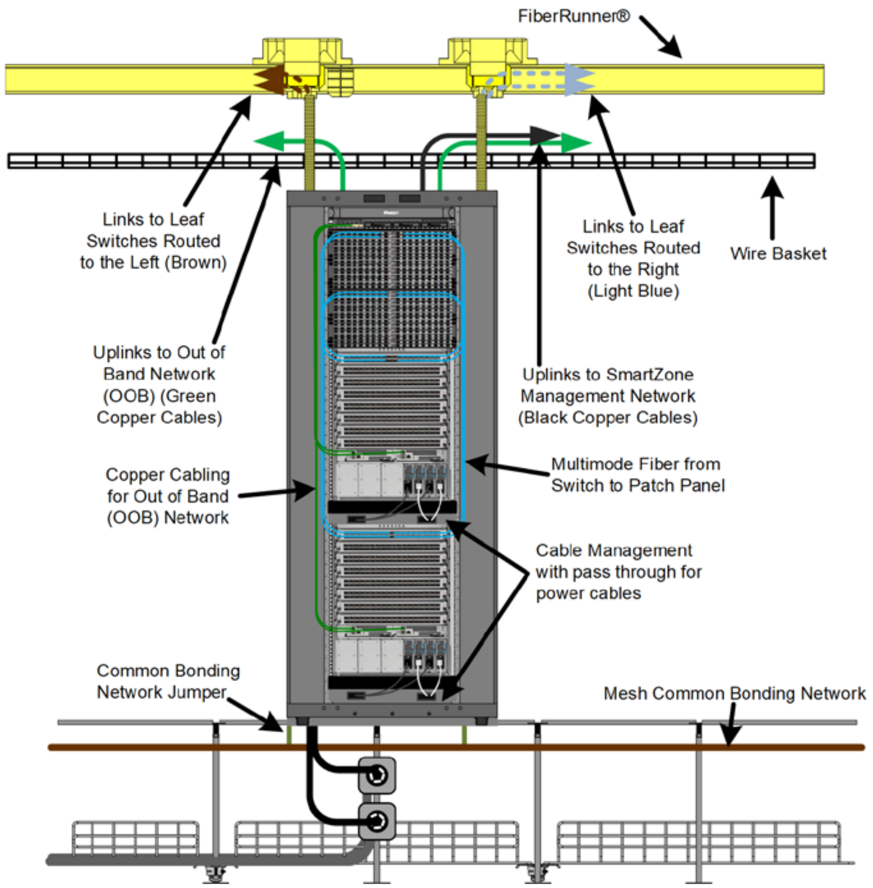

FIGURE 8 Physical Infrastructure for a Network Cabinet on a raised floor

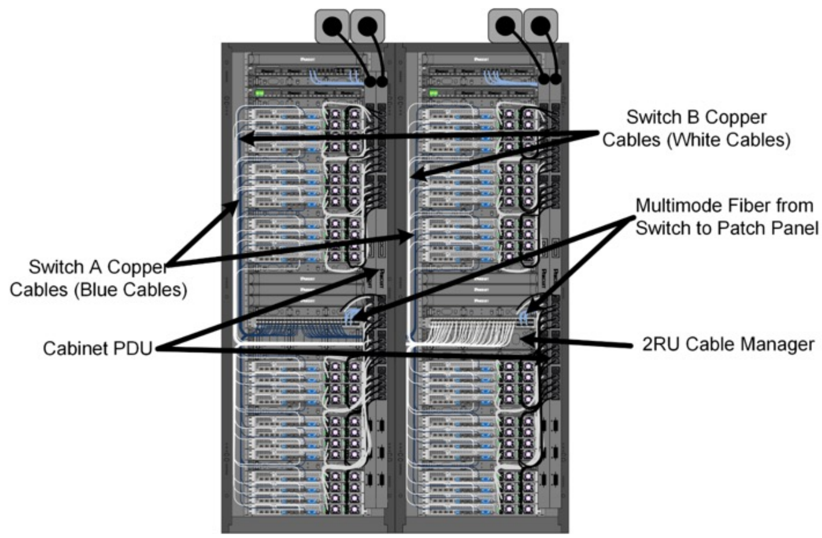

FIGURE 9 Physical Infrastructure for a Server Cabinet on a slab floor

Conclusion

Panduit and Prysmian Group have been collaborating to discuss CORD. This paper is the second in a series to support CORD deployments. The intention of this paper is to examine the challenges with transitioning from a Traditional CO to a Re-architected CO. We reviewed the transitional considerations, such as moving toward a multi-tenant space, shifting from Telco equipment to Enterprise equipment, leaf and spine architecture and providing more conditioned data center space. We also described some of the challenges with connectivity solutions that can occur. The next and final paper in the series, will discuss the products that are needed to have a successful CORD physical infrastructure solution, as well as how to effectively install and utilize the products.

Authors

Brian L. Kelly — Manager, Network Architecture Research for Panduit's Corporate Research and Development Team

Brian manages a team of engineers that develop new physical infrastructure products/solutions used in data center, enterprise, and industrial segments. He has worked in the Telecom/Data Center industry for over twenty years at companies like Cable & Wireless, XO Communications (now Verizon), SBC (now AT&T), and Server Central, prior to starting at Panduit in 2012.

Ilham Nandana — Telecom Strategy Manager at Prysmian Group

Ilham is a strategy manager with global experience and proven track record in new business development and strategy projects.

Robert Reid — Sr. Technology Manager for Panduit's Data Center Connectivity Group

Robert currently defines product development direction for Panduit's fiber optic structured cabling product line. He has been active in the fiber optics industry for over 35 years, in the development of passive optical components, optoelectronic, and specialty optics systems.

John Shuman — Global Product Manager Telecom and Data Center at Prysmian Group

John has over 25 years experience in data center design and construction, Telecom networks, and passive optical distribution component design.

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Prysmian Group is world leader in the energy and telecom cable systems industry. With almost 140 years of experience, sales of over €11.5 billion, about 29,000 employees in over 50 countries and 112 plants, the Group is strongly positioned in high-tech markets and offers the widest possible range of products, services, technologies and know how. It operates in the businesses of underground and submarine cables and systems for power transmission and distribution, of special cables for applications in many different industries and of medium and low voltage cables for the construction and infrastructure sectors. For the telecommunications industry, the Group manufactures cables and accessories for voice, video and data transmission, offering a comprehensive range of optical fibers, optical and copper cables and connectivity systems. Prysmian is a public company, listed on the Italian Stock Exchange in the FTSE MIB index. Additional information is available at prysmiangroup.com.

PRYSMIAN US/CANADA
na.prysmiangroup.com
Phone: +1.859.572.8000

PRYSMIAN HQ/EUROPE
Milan, Italy
prysmiangroup.com
Phone: +39.02.6449.1

PRYSMIAN ASIA
cn.prysmiangroup.com
Phone: +86.400.1011.831

PRYSMIAN APAC
prysmiancable.com.au
Phone: +61.1300.300.304

PRYSMIAN LATIN AMERICA
br.prysmiangroup.com
Phone: +55.15.3235.9000

For more information

Visit us at www.prysmiangroup.com

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Since 1955, Panduit's culture of curiosity and passion for problem solving have enabled more meaningful connections between companies' business goals and their marketplace success. Panduit creates leading-edge physical, electrical, and network infrastructure solutions for enterprise-wide environments, from the data center to the telecom room, from the desktop to the plant floor. Headquartered in Tinley Park, IL, USA and operating in 112 global locations, Panduit's proven reputation for quality and technology leadership, coupled with a robust partner ecosystem, help support, sustain, and empower business growth in a connected world.

PANDUIT US/CANADA
Phone: 800.777.3300

PANDUIT EUROPE LTD.
London, UK
cs-emea@panduit.com
Phone: +44.20.8601.7200

PANDUIT SINGAPORE PTE. LTD.
Republic of Singapore
cs-ap@panduit.com
Phone: +65.6305.7575

PANDUIT JAPAN
Tokyo, Japan
cs-japan@panduit.com
Phone: +81.3.6863.6000

PANDUIT LATIN AMERICA
Guadalajara, Mexico
cs-la@panduit.com
Phone: +52.33.3777.6000

PANDUIT AUSTRALIA PTY. LTD.
Victoria, Australia
cs-aus@panduit.com
Phone: +61.3.9794.9020

For more information

Visit us at www.panduit.com

Contact Panduit North America Customer Service by email: cs@panduit.com
or by phone: 800.777.3300

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