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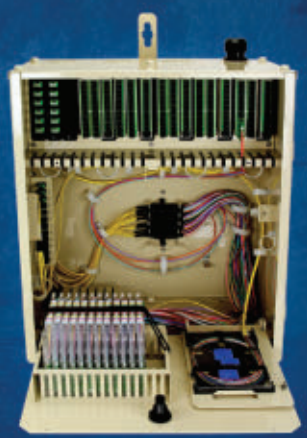

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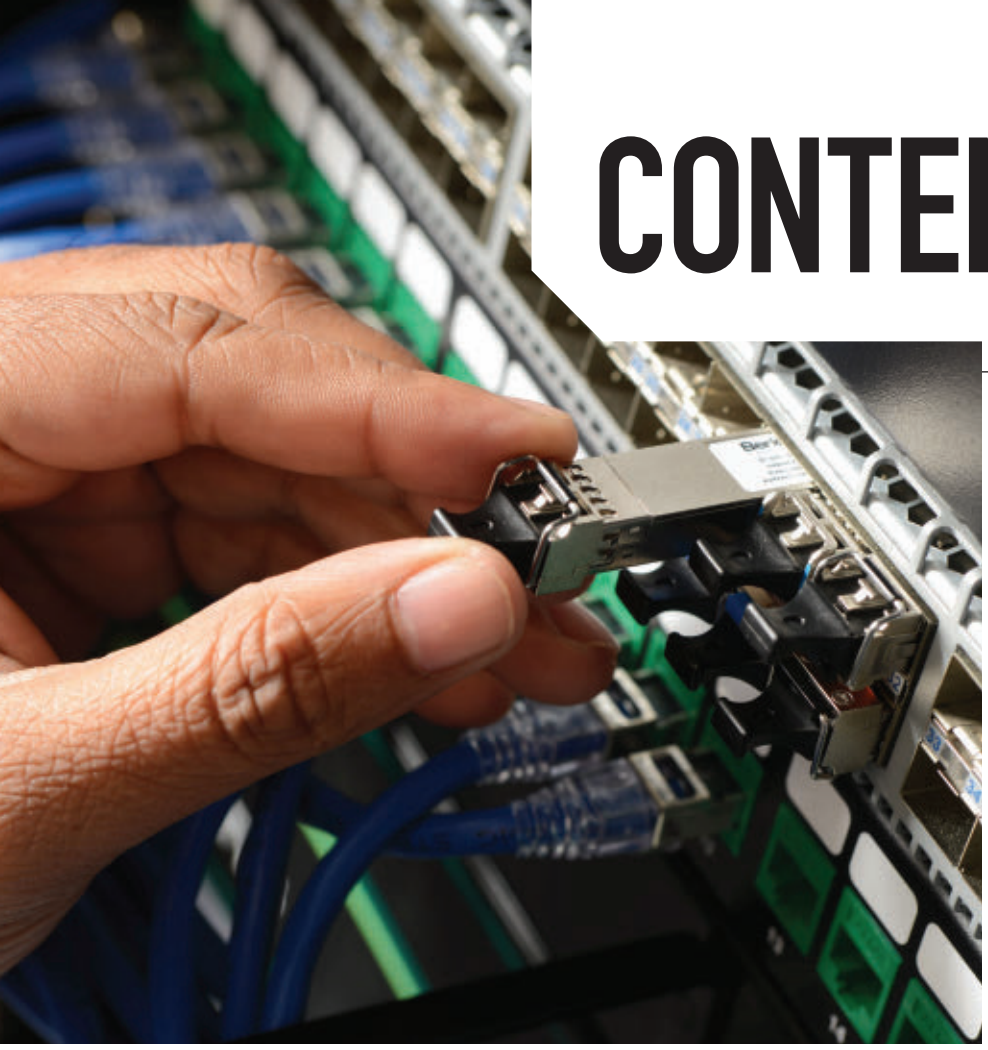

ABOUT THE COVER
The transceiver is part of the OSI Model's Layer 1, the Physical Layer. It's about time for end users to consider the transceiver a part of the cabling system.

SEE ARTICLE ON PAGE 5.

FEATURES

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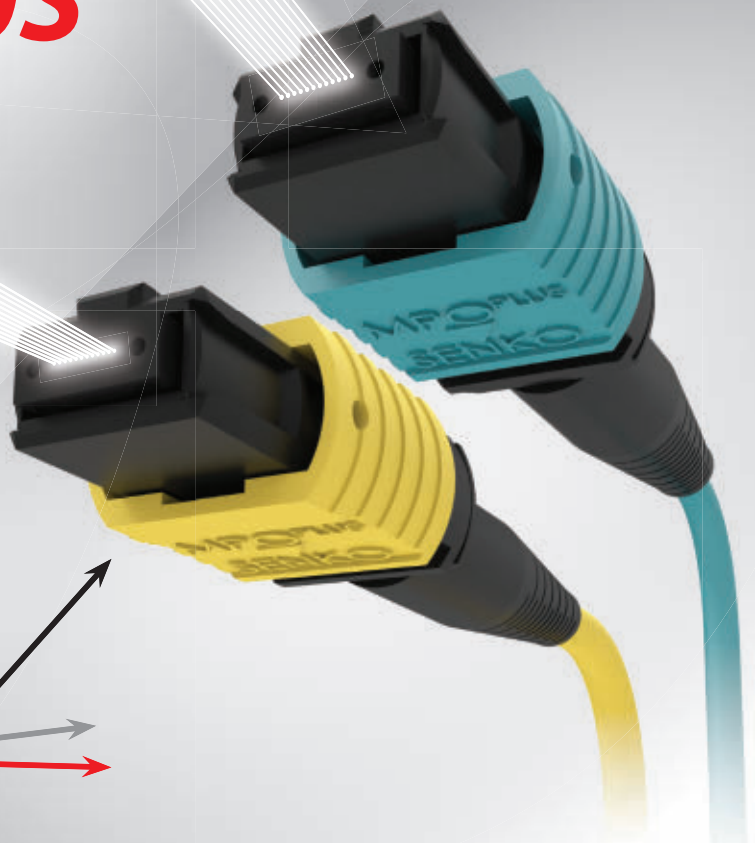

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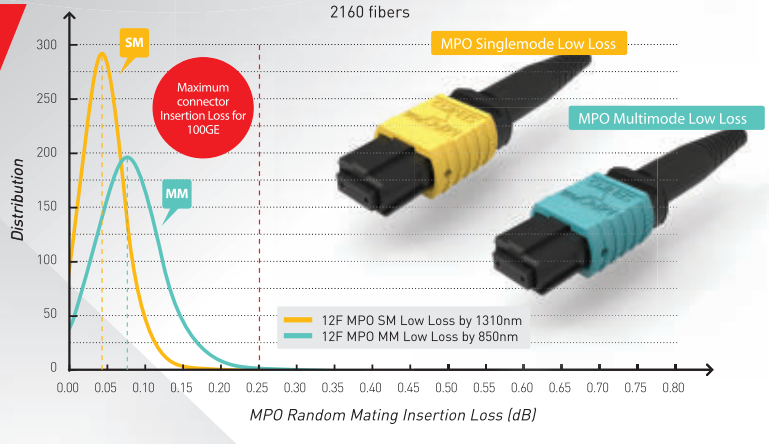

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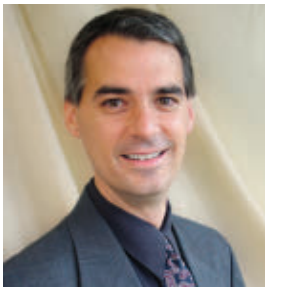
It's getting pretty active for passive (optical LAN)



PATRICK McLAUGHLIN
patrick@pennwell.com

The market intelligence concerning passive optical LANs (POLs) that came from BSRIA earlier this year may prove to be quite prescient. During an invite-only presentation held in February, BSRIA presented its analysis and outlook on several networking and cabling technology areas. Among them was passive optical LAN, and the presentation included the growth chart we've published this month, on page 36 in our "Infrastructure Insights" column. Prior to that February meeting, BSRIA had already stated that the POL market "will only really take off when a big player or several medium-sized players enter the market with a clear go-to-market strategy, as opposed to a me-too approach ..."

What the organization might not have known was that at virtually the same time it was hosting its invite-only presentation, and in the same venue, network vendor Huawei was announcing its entry into the Association for Passive Optical LAN. While it did so, Huawei demonstrated multiple POL systems. Both BSRIA's meeting and the APOLAN demonstration took place at the Rosen Shingle Creek Hotel in Orlando, FL while that venue also hosted the Winter BICSI Conference. A little more than a month later, Huawei officially introduced its AgilePOL system.

Just a few weeks after Huawei's introduction of AgilePOL, Nokia announced its entry into the POL market with introduction of a system that incorporates Alcatel-Lucent network equipment. Alcatel-Lucent and Nokia began operating as a single company under the Nokia name early this year.

Before making that announcement in early April, Nokia said, it successfully deployed POL technology for the hospitality industry in Japan with telecommunications operator KDDI.

As we detail on page 36, BSRIA projects that the POL market is going to weigh in at about $75 million this year. From there, it's a matter of how much it grows. Huawei and Nokia are heavyweights, so in that sense, the market's need for a big player has been met, or exceeded. I, for one, will be particularly interested to see how Huawei and Nokia fare with their go-to-market strategies, which BSRIA also noted would be essential for the POL market to take off.

For a technology that's called "passive" optical LAN, things sure are pretty active. And they promise to be so for the foreseeable future.

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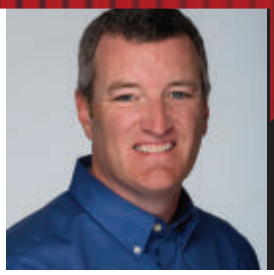


MIKE CONNAUGHTON is data center market segment manager with Berk-Tek (www.berktek.com).

Where's the link?

Why responsibility for Layer 1 needs to include the transceivers

BY MIKE CONNAUGHTON,

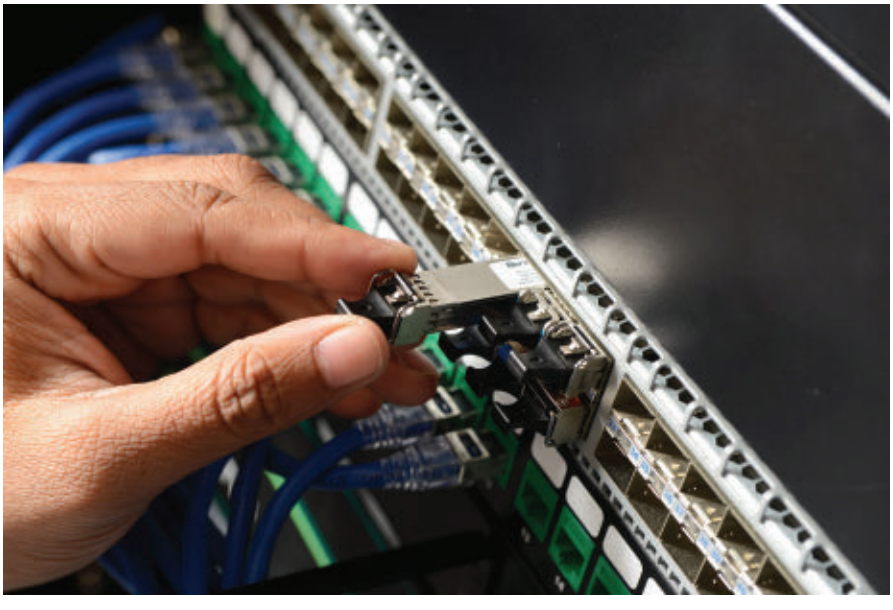
RCDD, CDCD, Berk-Tek a Nexans Company

There was a time when the cabling that connected the computer to its peripherals was considered part of the computer system. Seasoned industry veterans (aka "old people") remember when there were cable products specifically associated with hardware OEMs—the Wang dual coax and the RG58 DEC Cable are examples. If a company was buying or using one of these vendors' products, the matching cables also had to be used. Therefore, whoever was responsible for managing the hardware was also responsible for the cabling used to connect the devices together. This also (not coincidentally) made it difficult for the customer to move from one vendor to another.

This practice was onerous and customers did not like it. Ultimately, the structured cabling industry replaced this with what we experience today. The cabling infrastructure is now viewed as an independent asset separate from the IT hardware. This has allowed companies to make purchasing decisions for IT and cabling without the concern of being locked-in to the other. This didn't happen overnight. It has been facilitated by a number of standards and practices that have been created, developed and adopted by the industry over several decades. For 30-plus years, this model has worked well. But a problem is creeping in. To understand the problem, let's look at how the original challenge was addressed, so that we might see how to proactively deal with the future.

Brief LAN history

As communication links evolved, the method of specification for the various products has also evolved. Instrumental in this was the advent of computer networking, and more specifically, local area networking (LAN). Among the standards developed to define the operation of a LAN was the Open Systems Interconnection Reference Model (OSI Model). Standardized in 1980, the OSI Model defined seven layers of operation. By using the model, the industry could develop networking functions in a modular fashion and still ensure interoperability.



Pluggable transceivers, such as the one shown here, must be included in the OSI Model's Layer 1, the Physical Layer, asserts author Mike Connaughton.

The bottom of the stack is Layer 1, the Physical Layer. Layer 1 includes the cabling that is used to connect the various pieces of equipment together so that the data can be transported. The next step up on the stack is Layer 2, the Data Link Layer. Layer 2 provides for addressing and switching, so that the data can be sent to the appropriate destination. Layer 3 is the Network Layer, where data can be routed to another network. Layers 4 through 7 deal with software implementations.

It is important to note that although we sometimes assign various physical products to one of the layers, they do not always cleanly fit that way. A Category 6 cable plant resides neatly within Layer 1, but a network switch often contains components that span from Layer 1 to Layer 3. It is the *functions* that are standardized in the OSI Model, not the *devices*.

The OSI Model became a powerful tool for customers who had grown tired of the limitations set forth by the single-vendor sourcing model. The new model meant that an end-user could purchase software (Layer 7) and expect it to work on multiple vendors' hardware (Layer 2). And the hardware could be connected using multiple vendors (Layer 1). Structured cabling now had a home within Layer 1.

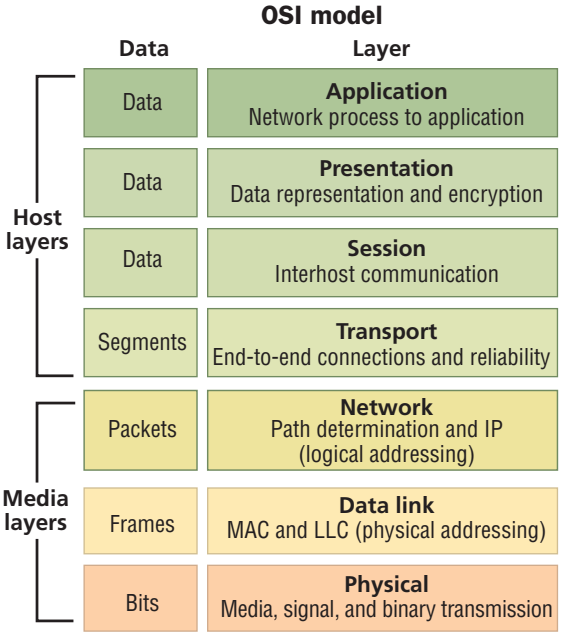
Once the OSI Model had been established, TIA then took the task of defining a standard set of cabling parameters. Category 3 was the first product defined as a data transmission media type within the new TIA standard circa 1990. The connector was standardized on the RJ45 and the maximum channel distance was standardized as 100 meters. Layer 1 products were often sourced during building construction and became associated with the facilities. Since BICSI existed as a resource for best practices in the specification and installation of commercial communications cabling, this also helped lead to their importance and popularity.

At the same time, IEEE was defining the networking standards for Layer 2. One standard being developed was Ethernet. It was originally designed to run over coaxial cable (10Base-5), but it was modified to run on the new Category 3 cable as 10Base-T. It quickly became very popular. At the end-user level, these Layer 2 products (switches, network interface cards, etc.) remained in the domain of the IT department.

Over the years, IEEE and TIA have worked in tandem to develop higher data rates and higher bandwidth cabling, respectively. 10Base-T became 100Base, 1000Base, and today we have 10GBase-T. Category 3 became Category 4, 5, 5e, 6 and today we have Category 6A. Through it all, the part that did not change for copper cabling was the footprint of the connector (RJ45) and the maximum distance of a channel (100 meters).

Another effect of this model was the division of responsibility, for cabling versus network design specifications. The end-user ended up having "cabling people" and "networking people" on their staff. Each group of people used their own set of vendors and supply chains to specify and source their materials. And they each only needed a very basic understanding of what the other people were doing.

This system has worked very well for the enterprise LAN. So what's the problem?



Standardized in 1980, the Open Systems Interconnection Reference Model (OSI Model) became a powerful tool for end-users who had grown tired of limitations inherent in the single-vendor sourcing model.

What's the problem?

The problem started in the 1990s when the bandwidth limitations of an unshielded twisted-pair (UTP) network began to be experienced. Multimode fiber was added to the TIA standard as an option for backbone connections where the extended distances could not be served by copper. Initially the distance limit was 2 kilometers. As time went on, singlemode fiber was added, for still-longer distances, as were various multimode fiber options.

Unlike copper, there was never a fixed standard on the connector type or channel distance. Sometimes it could reach a 500-meter link maximum with SC connectors, and other times it could be a 150-meter link maximum with LC connectors.

In fiber switches, it is common to use pluggable transceivers. This is done for a variety of reasons, but one is cost. If the customer only needs 10 ports, they can pay for just the ones they need. As more capacity is needed, they can purchase additional ports. But even though the

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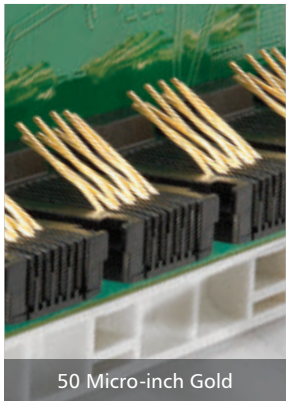
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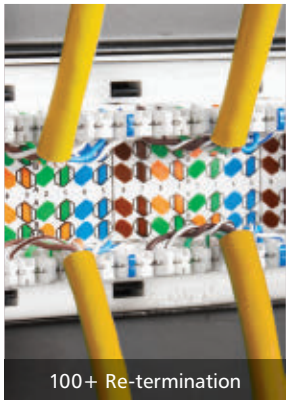
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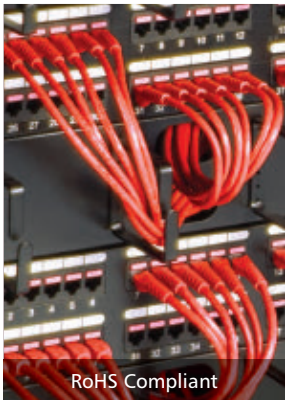
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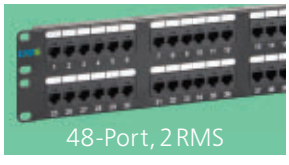
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transceiver is plugged into the switch, it is part of Layer 1 in the OSI Model. Not only is it part of Layer 1, but most of the transceiver is part of the physical media dependent (PMD) portion of Layer 1. This means that the transceiver and the cable types have to match. The Physical Media Dependent illustration visualizes what is explained here. However, because the transceiver is physically plugged into the switch, it has always been considered the networking group's responsibility.

Until recently, this imperfect procedure was more of an annoyance than a problem. With multiple fiber types, multiple operating wavelengths, and multiple connectivity options, the number of solutions seemed limitless. But since the data rates in the enterprise are relatively low, and the pace of change was manageable, a decision could be made to satisfy the demands of the business in a reasonable amount of time.

But the problem has become pronounced in the data center. The data center has two specific attributes that have led to unintended additional challenges.

The data rates are higher. Because the data center is the aggregation point of a significant number of transactions, higher data rates are needed to ensure that there is not a bottleneck. These higher data rates have forced a significant number of connections out of the realm of copper and into optical fiber.

The pace of change is exponentially higher than in the enterprise LAN. This does not allow the time to alter physical cabling layouts in between changes in data rate. Many data centers have seen their switch-to-switch connections migrate from 1G to 10G to 40G in the span of five years. A proliferation of transceiver types has been developed to address many specific applications.

A real-life example of the situations follows, to demonstrate the challenges faced in today's data centers. (The names have been changed to protect the innocent.)

Company A has a data center. Marsha is the facilities manager and is responsible for the data cabling. She has designed a cabling plan that has migrated from 1G into 10G. Anticipating the 40G requirements defined by IEEE 802.3ba (40GBase-SR4), she used a cassette-based platform to allow for the transition from LC connectivity of 10G to the MPO connectivity of 40G. The design incorporated several links that crossed from one data hall to another and therefore had additional patches.

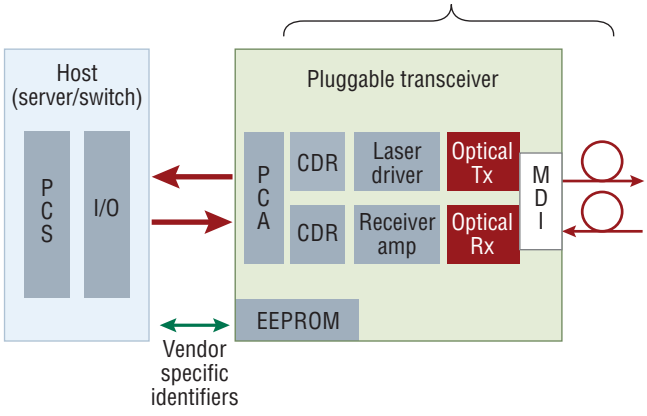
Greg is the network manager. As the migration to 40G switches was about to commence, his hardware vendor recommended that they change to a new unique transceiver solution that used LC connectivity. This appeared to be a great idea because it would mean that Marsha would not have to change any of her connectivity. However, he did not consult with Marsha, because the hardware decisions are his to make.

When the 40G switches arrived, Marsha was surprised by the connectivity choice because it limited her power budget. This created problems for the longer runs. She was forced to start making unplanned changes to the cable plant to accommodate the new technology. Marsha was not happy with Greg.

The point of the story is not that Greg did something wrong. He did what he was expected to do, what he has always done. The point is that his decisions are no longer independent of Marsha's. Structured cabling was built on the premise that the IT department and the facilities department could act independently. This example is one of many that shows why this is no longer the case.

And as with the old Wang coax, the IT equipment manufacturers are using their influence to create product "tie-ins." Instead of the cable, however, it now pertains to the optical transceiver. Even though this is an independent device, many manufacturers attempt to force the end-user to use their branded version.

And depending on the recommended version, this can lead to conflicts with the cable plant (or other pieces of equipment).



Even though a transceiver is plugged into a switch, it is part of the OSI Model's Layer 1, the Physical Layer. Additionally, most of the transceiver is part of the Physical Media Dependent (PMD) portion of Layer 1, as illustrated here. As such, the transceiver and cable types must match.

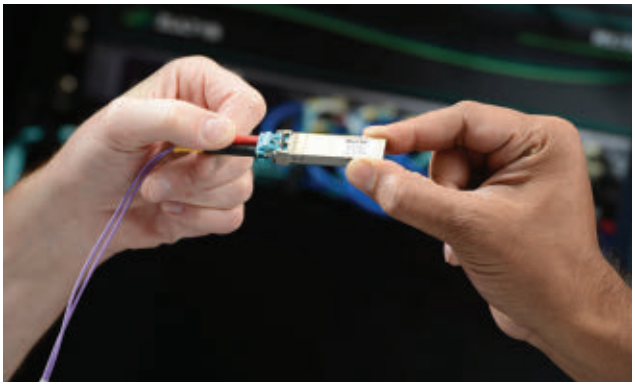
What should Marsha and Greg do?

If we think about the original objective of the OSI Model, it was to allow various components of a networking system to be specified as a module. In practice, for twisted-pair copper-based systems,

the structured cabling/network equipment worked well. The physical application of the cable was fixed and the channel bandwidth simply had to match the data rate.

But for fiber-based systems, it is not as clean. This is true in all parts of the network, but as stated earlier, it is most apparent in the data center.

So let's ask the question: What does the network manager (Greg in the example of our story) need? Greg needs to have a 40G connection from Rack A to Rack B. From a Layer 2/3 perspective, that is all that matters.



If responsibility for a single component—the transceiver—shifts from IT to facilities, it will allow facilities to manage the entire link, from transceiver to transceiver. The facilities manager's experience with fiber and connectivity options puts that individual in an ideal position to determine which transceiver options are most appropriate.

He still has the responsibility and complete control to define his needs and select equipment vendors for things like switches, routers, servers, etc. Instead of defining the ***form*** of the data rate, he simply specifies the speed.

With that direction, the facilities manager (Marsha) can determine the most cost-effective solution. Marsha can take the following into consideration.

- Maintaining the existing cable plant
- Cost of replacing with new cable plant
- Impact of transceiver options on either existing or new cable plant
- Road map of future technology changes

By shifting the single component (pluggable transceiver) from Greg to Marsha, the organization can make its decision much more efficiently. Greg does not have to worry about the variety of fiber and transceiver options, nor the impacts that they have on each other. And Marsha can manage the entire optical link, from transceiver to transceiver, which is all within Layer 1. Her experience with fiber and connectivity options puts her in a better position to determine which transceiver options are the most appropriate.

The new way

In this model, the service delivery that facilities management (Marsha) provides matches the original expectation of Layer 1 of the OSI Model. The complexities of optical fiber types and their interaction with various PMDs can be managed by a single group. Because the performance of these two products relate to each other, a single dollar value can be assigned to various combinations to determine the best option. And this decision will seamlessly integrate into the Layer 2/3 equipment specified and purchased by IT.

Along with more direct economic decisions, this can also lead to improved supply chain logistics. These include the following.

- Common sourcing provides better supply chain economies.
- Analysis of bills of materials will highlight mismatches (in type or quantity) before orders are placed rather than at the time of install.
- Project tracking and receiving become easier to manage.

As anyone reading this knows, the pace of change in our industry is staggering. It is imperative that everyone involved continues to adapt and change, not only to current requirements, but also in anticipation of the additional changes that will inevitably come in the not-so-distant future.

But it's not only the products and technologies that need to adapt. The processes and business practices we follow also need to change, in order to make the most informed, most efficient decisions for the successful operation of our network infrastructure, and in turn, of our overall organization.

Looking back, the onset of structured cabling did this by separating the cabling purchasing from the IT hardware purchasing. Looking at present-day and into the future, rapidly increasing data rates—especially in the data center—are requiring another shift in the way we conduct business. By redefining the link to include not only cabling and connectivity, but also the transceiver, we put Layer 1 performance in the hands of the people most familiar with it. ◆

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BY PATRICK McLAUGHLIN

In a document that encourages the proper use of labels in multiple cabling environments, Brady describes the value of an effective wire, cable and component marking system. The 32-page document, titled "Get Real Value from the Right Cable Labels," can be downloaded from Brady's website. The guide describes considerations to make when selecting cable labels and also "explains the variety of benefits of labeling, label durability and feature considerations, and the elements of a complete labeling system," the company says. "It also provides visual examples of labels for wires, cables, components and facility identification," Brady adds.

The guide includes six chapters: 1) The benefits of labeling; 2) Label durability; 3) Label considerations; 4) Identification options; 5) A complete labeling system; and a conclusion. Among the notable statistics in the guide is, "Only 25 percent of a tech's service time is spent fixing the problem; the rest is spent searching for it."

When Brady made the guide available right around the first of this year, the company's regional product manager for product identification, Chris Gauthier, commented, "When it comes to installing, managing and updating hundreds to thousands of wires on a daily basis, the right labels can make a big difference.

Brady's BMP21-PLUS was recently re-engineered to improve durability and ergonomic performance, the company says. Improvements include a center balance and ridges that assist gripping and handling.

Not only do durable and professional-looking labels help to create an aesthetically flawless installation that you can be proud of, but they lead to increased efficiency, profitability and customer satisfaction. That's because they provide the consistency you need to find just what you're looking for and quickly complete the task at hand."

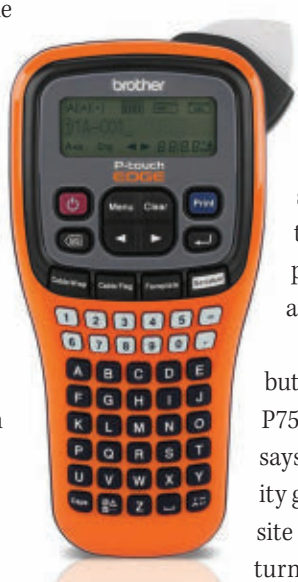
The guide's second chapter, addressing label durability, underscores the fact that some labels exist in less-than-friendly environments. "When considering a labeling system that aligns with your needs, keep in mind the various conditions that your wires, labels and components face on a daily basis," the guide says. "Label materials and adhesives are made differently to stand up to a variety of challenges." A durable label, it continues, typically includes a topcoat, substrate, adhesive and liner.

While some labels will have to survive in tough environments for the long term, the tools that produce those labels also must stand up to challenging environments—temporarily but repeatedly—when producing labels on-site. Brady's BMP21-PLUS handheld label printer "combines a tough exterior with smart printing capabilities," the company explains. The labeler's shape was recently re-engineered to improve durability and ergonomic performance. Improvements included a center balance and ridges that assist gripping and handling, Brady notes. The BMP21-PLUS passed shock and vibration testing per

MIL-STD-810G Method 5.16 S4.6.5, the company adds.

A range of innovations

Other providers of labels and label makers have also innovated and updated their portfolios to achieve more-efficient label production, including in harsh environments. Brother Mobile Solutions' P-Touch Edge PT-E550W wireless industrial handheld labeling tool is the company's first industrial handheld product to feature WiFi connectivity to Windows, iOS, Mac and Android devices.



Brother Mobile Solutions' P-Touch Edge labeler product line includes the PT-E550W, which features WiFi connectivity for user efficiency.

Brother explains that users of the PT-E550W can download and store custom label files and databases from select tablets, smartphones or PCs to print full project labels or individual labels wirelessly and on-demand at the jobsite. It prints labels up to 24mm wide, including heat-shrink tubing, and includes a dual-blade auto-cutter to make label strips easy to peel. Brother says the tool was specifically engineered as an alternative to sheet label systems, and is appropriate for large infrastructure installations.

Duane Yamashita, senior product manager for Brother's Edge industrial brand, commented about the label maker, "Building on the functionality of the PT-E500 model, our PT-E550W adds increased convenience and functionality at the job site. With built-in templates, files and databases instantly available via wireless connectivity, work crews can help save time, improve accuracy, and minimize keystrokes in generating clear, long-lasting labels for wires, cables, faceplates, patch cords and other components of an installation."

The tool's wireless connectivity "provides greater flexibility to handle changes on-site in real-time," Brother notes. "Should changes be required, users can make the as-built changes directly to the database in the PT-E550W, or to the same database file used for preprinting the sheets in the office, and send the file to a computer, smartphone or tablet for printing at the site."

More recently, Brother debuted the P-Touch Edge PT-P750WVP, which the company says "fills a common productivity gap by enabling quick, on-site labeling from an app that turns a mobile phone or tablet into a powerful label design and print solution."

Yamashita said, "The goal is to help system designers and their contractor/installer partners bridge the gap between the development location where the project is designed and the jobsite where actual installation is performed." He added that the tool "was designed to align with common datacom, labeling configurations. This allows for 'as-built' documentation and professional labeling of all components—including wires, cables, patch panels, termination points, faceplates, racks, cabinets and more. Using built-in templates, installation crews can print industry standard labels right from their smart devices."

Brother's datacom industry specialist Craig Robinson added, "Following best practices in cabling system installation requires a high degree of precision—and the ability to make on-site, real-time labels or modifications to labels is key to project efficiency. This solution brings true mobile functionality to the jobsite at a price point that puts it within reach of every contractor."

Efficiency on the jobsite

In late 2015 Dymo launched the XTL series of industrial labelers. The Dymo XTL 300 and Dymo XTL 500 label makers are "fully outfitted with an array of time-saving features, all designed to make complex labeling jobs simple," the company said. Both offer lifelike on-screen print preview that "showcases exactly how labels will look when applied to cables, pipes, patch panels and more," the company added. "Additionally, hundreds of preloaded label templates further simplify the often-complex industrial labeling process by saving time and helping to eliminate mistakes."

The Dymo XTL 300 is built specifically for professionals in the datacom and electrical fields. The rechargeable tool has impact-resistant bumpers and a wipe-clean keypad that prints labels from one-quarter inch up to one inch, in a full range of UL-rated materials and colors, Dymo said. It features PC connectivity and Dymo ID software for importing Excel and other database files for entire label batches. The XTL 500 prints labels from one-quarter inch to two inches, including safety signage and heat-shrink tubes in a range of UL-rated materials and colors.

A recent new-product introduction from HellermannTyton addresses another in-the-field issue associated with label creation—tight spaces and portability. The TT130SMC has a small footprint that the company says "allows for highly efficient printing in applications in which space is tight or when portability is important. The smaller

size and optional hard-shell carrying case make it easy to transport to job sites, especially useful for data center and solar-installation labeling," HellermannTyton said.

The carrying case has room for two printers, cables and label stock. It also can hold a wireless router, though one is not included with the kit. "One- and two-printer kits are also available that include everything you need for efficient and convenient industrial printing," the company added.

The TT130SMC accommodates label roll stock up to 2 inches wide. The printer includes an Ethernet port that allows the user to connect to an existing network or to a wireless router for wireless, portable printing. The company stated, "For ultimate efficiency and optimized workflow, users can network several TT130SMC printers and use HellermannTyton's TagPrint Pro label-creating software or a free TagPrint Xpress mobile application to create a multiple-printer network."

HellermannTyton says its TT130SMC combines a small footprint with toughness; those attributes enable label production in tight spaces and in unforgiving environments.

In the conclusion of its labeling guide, Brady comments, "Well-labeled wires, cables and components give you immediate insight into how an installation works and how it's connected. That way you can perform repairs, installation updates and upgrades in a safer, more-secure way, with a reduced risk of human error. By finding the right label type and material, the right way to acquire labels and a software system when it's needed to manage your network, your job becomes more efficient."

Providers of labels and label-making equipment continue to innovate and improve their offerings for the benefit of installers, technicians, and users who work with labels. ◆

Patrick McLaughlin *is our chief editor.*

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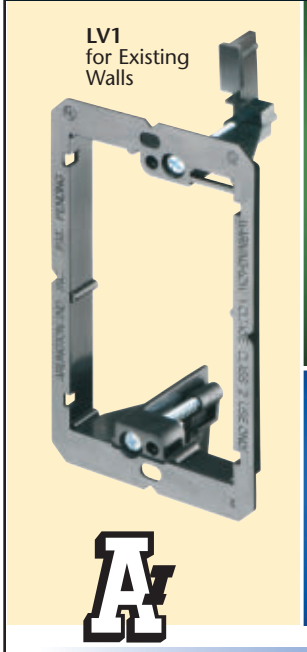

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Zone cabling and coverage area planning

Recommendations for today's highly automated buildings

BY VALERIE MAGUIRE, Siemon

Zone cabling is ideal for supporting convergence of data and voice networks, wireless (WiFi) device uplink connections, and a wide range of sensors, control panels, and detectors for lighting, security, and other building communications. A zone cabling design consists of horizontal cables run from the floor distributor in the telecommunications room (TR) to an intermediate connection point that is typically housed in a zone enclosure located in the ceiling space, on the wall, or below an access floor. The name of this intermediate connection point depends on the types of endpoint device connections it serves, and on the applicable regional structured cabling standard (see Table 1). For convenience, this article refers to the intermediate connection location as the service concentration point (SCP). The outlet supporting a building device connection is referred to as the service outlet (SO).

Connections at the SCP are typically facilitated by connecting hardware supporting 2 to 96 outlets. Cables are then connected from outlets in the SCP to building devices, SOs, or telecommunications outlets (TOs).

Zone cabling benefits

Zone cabling is a highly flexible infrastructure that is ideally suited for the convergence of voice, data, wireless, and building device applications over one managed network. Furthermore, outlets serving voice/data, wireless, and building device connections can be conveniently combined within one SCP.

Zone cabling solutions support rapid reorganization of work areas and equipment and simplify deployment of new devices and applications. With this type of infrastructure, moves, adds, and changes (MACs) are less costly, faster to implement, and less disruptive because changes are limited to the cabling segment between the SO/TO and SCP instead of the entire length of horizontal cabling. In addition, zone cabling designs allow the option of deploying factory-preterminated and tested trunking cables to support quick implementation, performance exceeding field terminations, and reduced field testing times.

The rendering on the next page shows a zone cabling deployment, depicting a ceiling-mounted zone enclosure connected to SOs that provide connection to fixed WiFi, IP surveillance, and electronic display devices. The same SCP may connect to TOs in work areas and common spaces for phones, computers, and docking stations. Siemon offers a wide range of zone enclosures supporting up to 96 outlets for ceiling, underfloor, and wall-mounted SCP applications. Products that may be used to provide SO and TO connections include 3- and 6-port boxes and 1-, 2-, 4-, and 6-port outlet boxes.

TABLE 1: Outlet and connecting location naming conventions

	ISO/IEC 11801-2 (pending) or ISO/IEC 11801-6 (pending)	ANSI/TIA-568-0.D or ANSI/TIA-862-B
Intermediate connection location in a zone cabling topology supporting a building device	Service concentration point (SCP)	Horizontal consolidation point (HCP)
Intermediate connection location in a zone cabling topology supporting a voice/data service	Consolidation point (CP)	Consolidation point (CP)
Outlet connecting to a building device	Service outlet (SO) [optional if an SCP is present]	Equipment outlet (EO) [optional if an HCP is present]
Outlet connecting to a voice/data device	Telecommunications outlet (TO) [required even if a CP is present]	Telecommunications outlet (TO) [required even if a CP is present]

The major benefit of zone cabling is its ability to provide an easily accessible intermediate connection point. Being able to locate zone enclosures in an access floor, ceiling, on the wall, or within modular furniture enables convenient access to these connections. The deployment of strategically placed zone enclosures throughout a building space creates a flexible, futureproof infrastructure for data, voice, building devices, and wireless access points (WAPs).

What is a coverage area?

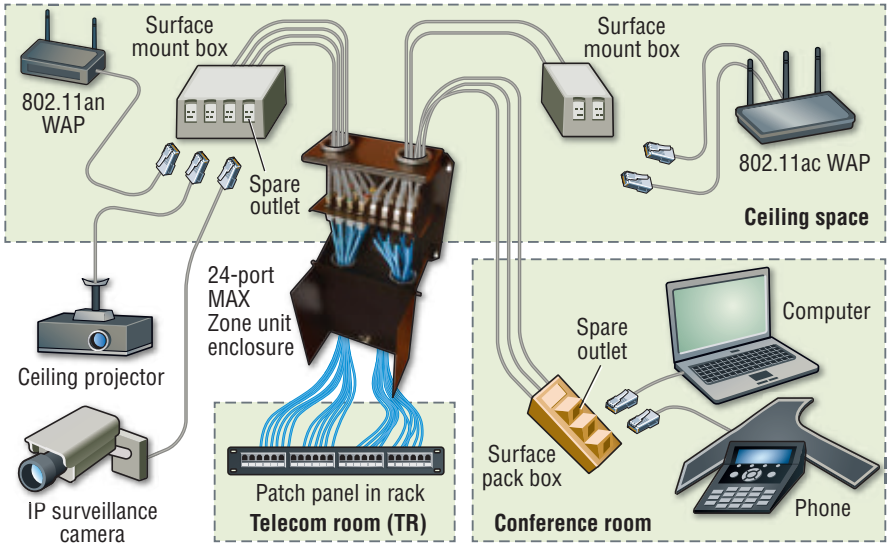
According to ISO/IEC and TIA standards, the area served by a device is called its coverage area. For the purpose of this article, the term "coverage area" is extended to describe a space that may serve multiple devices and their respective coverage areas. We recommend that device coverage areas be planned to have a radii no greater than 13m to ensure support of fifth-generation (IEEE 802.11ac) and future WiFi. While other devices may have wider coverage areas, the area served by a WAP is generally the smallest of all building device applications. This practical guidance ensures generic support of all current and future building device and WiFi applications with a single zone and coverage area design.

The illustration to the right shows an example of a ceiling-mounted zone enclosure functioning as the SCP. It is centrally positioned within four coverage areas, providing connections to four, 2-port SOs serving IEEE 802.11ac WAPs, each having a coverage area radius of 13m. Note that the 26-meter diameter of each WAP coverage area is larger than the square grid coverage area pattern to ensure no gaps where the coverage areas intersect.

We recommend that the number of connections in the zone enclosure should not exceed 96. This recommendation harmonizes with IEEE 802.3 Type 2 and Type 3 Power over Ethernet (PoE) maximum bundle size limitations and is aligned with guidance provided in ANSI/TIA-862-B Structured Cabling Infrastructure Standard for Intelligent Building Systems, both of which optimize zone enclosure access by eliminating over-congestion in the SCP. The size of the zone area should be decreased if more than 96 outlets are required at the SCP to support initial and projected device connections over a ten-year period.

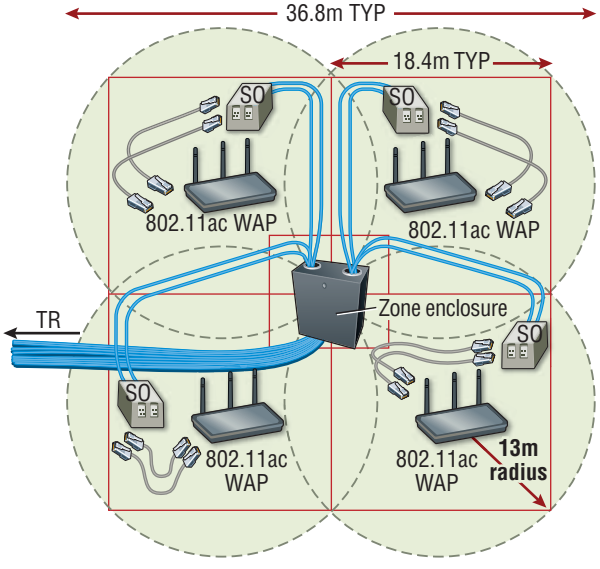
Dividing the coverage areas between multiple SCPs provides optimum accessibility, which translates to lower cost for MACs. For example, the pending international standard ISO/IEC 11801-6 Information Technology – Generic Cabling for Customer Premises – Part 6: Distributed Building Services, states that the SCP should be limited to serving a maximum of 36 service areas, each of which can have one or more connections. Since "should" is not a normative requirement, it is left to the

Sample zone cabling deployment configuration

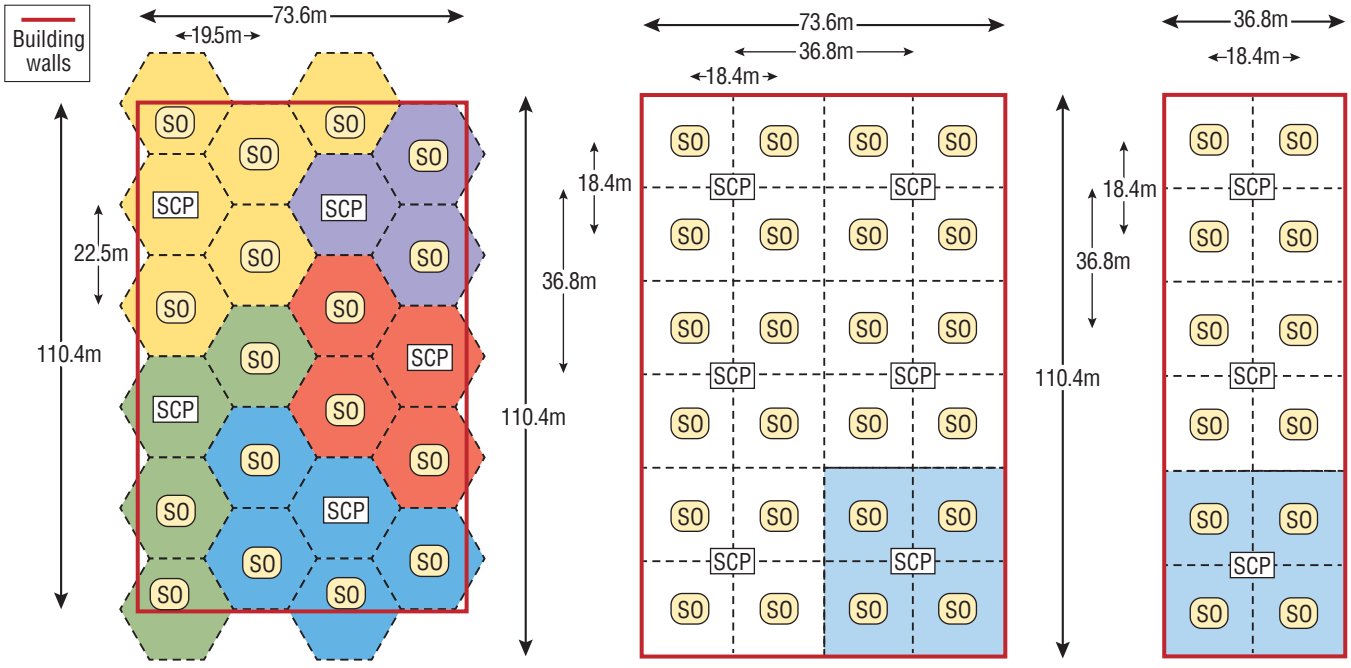


The sample zone cabling deployment configuration depicts a ceiling-mounted zone enclosure connected to service outlets that provide connections to fixed WiFi, IP surveillance, and electronic display devices.

SCP serving four WAPs with 13m coverage radii



Here, a ceiling mounted zone enclosure functions as the service concentration point (SCP). It is centrally positioned within four coverage areas.



A hexagon deployment pattern, sometimes referred to as a "honeycomb" pattern, may be most suitable for large, open spaces such as open office, industrial, retail, and warehouse environments. A grid deployment pattern may be most suitable for large building spaces supporting classrooms, enclosed office spaces, patient rooms, or similar spaces. A leg deployment pattern suits long, narrow structures or wings whereby zone enclosures are positioned in a line above, along, or below building hallways.

discretion of the infrastructure designer to determine the maximum number of connections in the zone enclosure.

Location of coverage areas served by zone enclosures

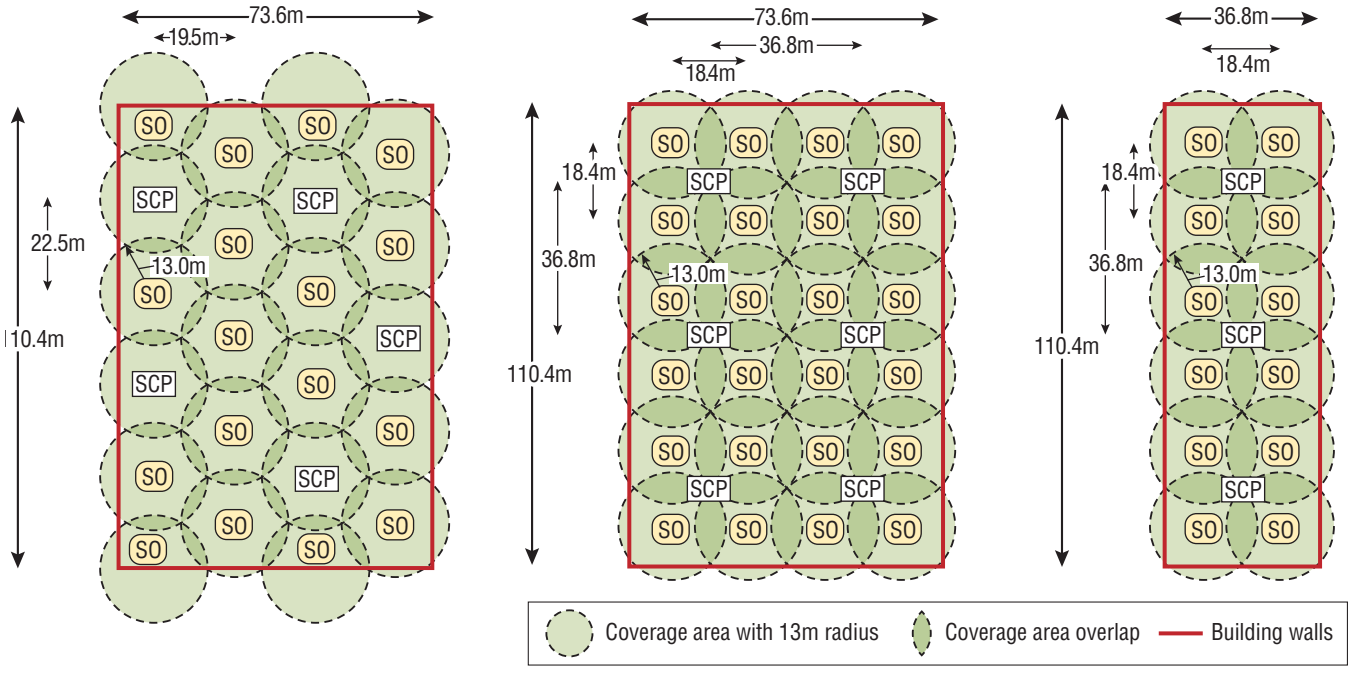
Unless the TR has limited accessibility, an SCP does not provide significant added benefits if it is located within 17m of the TR. Coverage areas that are in close proximity to the TR can be connected directly to the floor distributor without passing through an SCP. We therefore recommend that zone enclosures be positioned at least 30m from the TR.

Different patterns may be used to lay out arrangements of hexagon- or square-shaped coverage areas, with the intent that zone enclosures should be located within their associated grouping of coverage areas. The figure above shows examples of coverage areas arrange in hexagon, grid, and leg deployment patterns. For simplicity, these examples depict only one SO in the center of each coverage area. In real-world deployments, coverage areas typically contain multiple telecommunications outlets and service outlets connecting to a wide variety of devices. The area comprising multiple coverage areas served by one zone enclosure is called the zone area. Representative zone areas for SCPs are highlighted in various colors in the figure. Note that the figure does not show the location of the TR, which can affect the arrangement of coverage and zone areas.

A hexagon deployment pattern (sometimes referred to as a "honeycomb" pattern) typically serves four to five, 425m^2 hexagon-shaped coverage areas and may be most suitable for large, open spaces such as open office, industrial, retail, and warehouse environments. If the coverage area radius is 13m, then an SCP should ideally serve a zone area of approximately 2000m^2 (excluding unused portions of coverage areas around the perimeter). This pattern may be best suited for supporting up to 96 outlets at the SCP.

A grid deployment pattern typically serves four, 350m^2 square-shaped coverage areas and may be most suitable for large building spaces supporting classrooms, enclosed office spaces, patient rooms, etc. In this configuration, each SCP will serve a zone area of approximately 1400m^2 with zone enclosures positioned above, along, or below building hallways to facilitate easy access to the SCP. This pattern may be best suited for supporting 36-96 connections at the SCP and for designs where the zone enclosure is located below access flooring.

A leg deployment pattern may be most suitable for long and narrow structures or wings whereby zone enclosures are positioned in a line above, along or below building hallways. Each zone enclosure typically supports, four, 350m^2 coverage areas similar to the grid deployment pattern. Typically, a leg

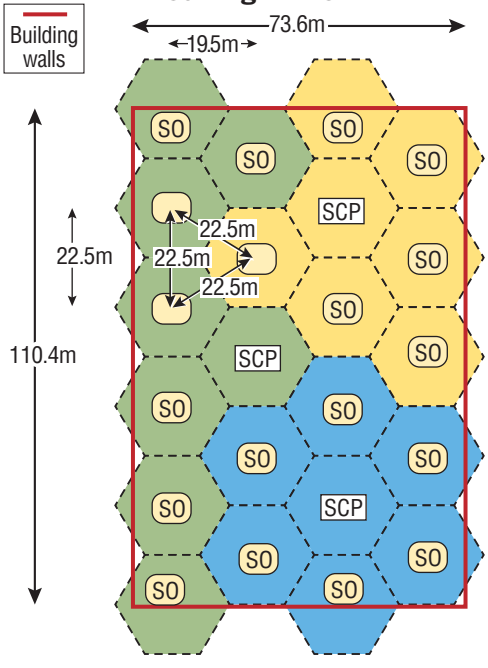


These illustrations show coverage area overlap associated with hexagon, grid, and leg deployment patterns. The hexagon pattern's primary advantage is that it supports the least degree of overlap. In the real world, a combination of patterns may be most economical and most functional.

coverage area pattern featuring 24 to 96 outlets housed in a zone enclosure positioned along a wing or hallway is sufficient to provide desired coverage.

No single coverage area pattern is best for all zone cabling designs. As shown in the figure above, the main advantage of a hexagon deployment pattern is that it supports the least degree of overlap between coverage areas, potentially resulting in fewer zone enclosures and fewer coverage areas in the overall cabling design. Because the size of the zone area served by a hexagon coverage area deployment pattern is larger than that of a grid coverage area pattern, it may be necessary to divide the area into more zones or use a combination of zone area patterns to meet the recommendation of no more than 96 outlets per SCP. In real-world infrastructures, a combination of patterns may provide the most economical and functional design.

SCP and hexagon coverage areas serving WAPs



This example shows one SCP and seven or eight hexagon coverage areas dedicated to serving wireless access point uplink connections only.

A site survey report can be extremely helpful in determining the best coverage area layout. The following are true in general.

- The 1400m^2 zone area served by a grid or leg deployment pattern of four, 350m^2 square-shaped coverage areas is most accommodating of one zone enclosure being capable of housing all required SCP connections in a highly automated building.
- The 2000m^2 zone area served by a hexagon deployment pattern of four to five 425m^2 hexagon-shaped coverage areas is most accommodating of one zone enclosure being capable of housing all required SCP connections in a conventional or moderately automated building.
- The 3000m^2 zone area (excluding unused portions of coverage areas around the perimeter) served by a hexagon deployment pattern of seven or eight 425m^2 hexagon-shaped coverage areas accommodates one zone enclosure supporting WAP uplink connections with very limited support of other building devices.

Standard ISO/IEC 11801-6 (pending), ANSI/TIA-862-B, and TIA TSB-162-A Telecommunications Cabling Guidelines for Wireless Access Points, all provide useful information on hexagon and grid coverage area deployment patterns.

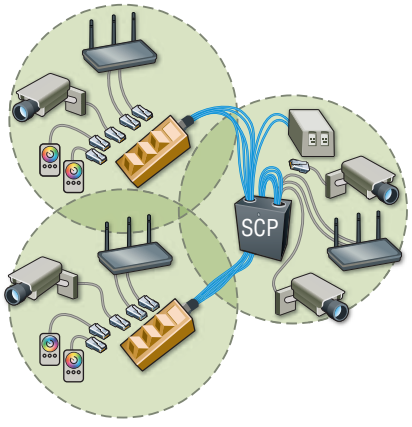
Service outlet use within coverage areas

Each coverage area may have multiple SOs, TOs, and direct connections from SCPs to building devices. The figure to the right depicts two coverage areas serving WAP, IP-camera, and IP-lighting connections via SOs and one coverage area containing a zone enclosure serving security camera and WAP connections via SOs and direct connections. SOs in ceiling spaces are typically housed in outlet boxes and available in 2- to 6-port configurations. In some jurisdictions, these outlet boxes may need to be plenum-rated.

ISO/IEC and TIA intelligent building specifications do not require an SO to be present in a zone cabling infrastructure if an SCP is present. However, because building devices can be located as far away as 30m from the SCP, SOs eliminate the need to install long lengths of cable when devices are added. Removing abandoned cable when devices are taken out of service can be just as labor-intensive. We recommend that an SO be used if a building device or WAP is more than 5m from an SCP.

Due to the higher resistance and up to 50 percent higher insertion loss of cable having stranded conductors and much greater sensitivity of higher-AWG stranded cables to elevated temperatures, we recommend that solid-conductor cables be used exclusively in spaces that do not have environmental control (e.g. ceilings and warehouses). In temperature-controlled spaces, we recommend that building device connections to an SO or SCP should not exceed 5m if stranded conductor cords are used.

Building device connections



Pictured here is an example of building device connections in multiple coverage areas.

Solid conductor cable assemblies are much less temperature-sensitive and less prone to resistive heating for remote powering applications and support lower parasitic power loss, higher transmission performance, and longer reach in these spaces at ambient temperatures ranging from 20 to 60 degrees Celsius.

Zone area device density

While arrangements of hexagon-shaped and square-shaped coverage areas are recommended to optimally accommodate most converged cabling networks, coverage areas may range in size to support device coverage area radii from 3m to 30m.

The Internet of Things (IoT) allows objects to be remotely sensed and controlled across a common network resulting in improved efficiency and comfort. Building automation systems enable IoT by providing a structured framework to monitor and control utilities, ambient air, lighting, security and safety. These relationships influence cabling infrastructure decisions such as the number of outlets needed in the zone enclosure at each SCP. Availability of spare ports in the zone enclosure offers the ability to rapidly add new services and reconfigure devices. An assessment of the desired level of building automation and anticipated deployment of building devices as new technologies come available can be used to determine the number of spare ports to be provided in an initial zone cabling design. Because of the rapid advancement in IoT technologies and building solutions that rely on sensors and

TABLE 2: Typical building device density

Use of floor space	Coverage area per building device (m^2)	Number of connections in the SCP required per 2000m^2 (hexagon pattern)[a]		Number of connections in the SCP required per 1400m^2 (grid pattern)[a]	
		Minimum	Recommended	Minimum	Recommended
Classroom, data center, hospital, hotel, office, retail, or indoor parking[c]	25	80	96	56	72
Manufacturing	50	40	48	28	36

a) Each SCP is assumed to support four to five 425m^2 hexagon-shaped coverage areas for a total maximum usable space of 2000m^2.
b) Each SCP is assumed to support four 350m^2 square-shaped coverage areas for a total of 1400m^2.
c) ANSI/TIA-862-B provides an estimate coverage area per building device of 50m^2 for indoor parking application.

Service outlet usage for building device and WAP connections

The SO provides a point of connection, administration, and testing for a telephone, computer, building device, WAP, camera, or any other networkable device. The SO is different from the TO, which is the assembly consisting of one or more connectors mounted on a faceplate, housing, or supporting bracket used exclusively in the work area in a commercial building application.

While it is well-known that standards require a minimum of two permanent links/TOs be brought to each work area, practices related to SO usage when supporting building device and WAP connections can be confusing. The following guidance has been excerpted from the ISO/IEC 11801-6 (pending), ANSI/TIA-862-B, and TIA TSB-162-A.

Building device (including camera, security, fire alarm, access control, energy management, HVAC, lighting/power control, audio/video paging, digital signage, service/equipment alarm, and other non-voice/data communications) connections:

- The SCP supports flexibility in a zone cabling topology for fast and easy reconfiguration of building device coverage areas and may be configured as an interconnect (i.e. one patch panel or connecting block) or a crossonnect (i.e. two patch panels or connecting blocks);
- When the SCP is configured in a crossconnect, an SO shall not be installed to ensure that the cabling system serving the building device contains no more than four connection points;
- When the SCP is configured as an interconnect, the use of an SO is optional (i.e. direct connections from the SCP to the building device is allowed);
- If an SCP is not present, then an SO must be used;
- Only one permanent link connection is required to each building device.

WAP connections:

- A minimum of two permanent link connections to each IEEE 802.11ac WAP is recommended to support link aggregation.

We recommend a zone cabling topology consisting of a horizontal distributor, SCP, and an SO to support building device and WAP connections. The SO connection is optional if the building device is located within 5m of the SCP. This design supports ease of coverage area reconfiguration, administration, and cable management, as well as the ability to overlap coverage areas and allocate spare SCP ports to support future building device and telecommunications equipment connections.

automation to increase energy efficiency, occupant safety, and comfort, we recommend a minimum initial spare port capacity of 25 percent above initial deployment needs.

ISO/IEC 11801-6 (pending) and ANSI/TIA-862-B provide information on typical building device density for various floor spaces as shown in columns 1 and 2 of Table 2. These recommendations may then be applied to determine the minimum number of device connections required for 2000m^2 hexagon pattern and 1400m^2 grid pattern coverage area arrangements as shown in columns 3 and 5. For example, an SCP having a minimum 56 outlets can support a floor space of 1400m^2 based on 25m^2 coverage area per building device. The recommended number of connections to accommodate present and future services based on an allowance of 25 percent spare port capacity is shown in columns 4 and 6.

Outlet density at the SCP can vary throughout a zone cabling design depending on the specific applications that are supported. For example, zone areas containing surveillance equipment, displays, vending machines, and point-of-sale (POS) kiosks in public spaces (e.g. arenas, stadiums, conference center, airport, train station) may benefit from higher outlet density at the SCP.

Mechanical and plant rooms typically have a significantly higher building device density than other spaces. Unlike other independent building devices, the location of air handlers, chillers, boilers, pumps, fans, and compressors can significantly impact the placement of zone enclosures. If the mechanical and plant rooms are within 30m of the TR, we recommend that these connections be home run to each SO without an SCP. Otherwise, deploy one zone enclosure per mechanical and plant room, and have the zone area served by the SCP to these spaces be reduced to no larger than 580m^2 (22m x 22m) to ensure that no more than 96 outlets are served by each zone enclosure.

These standards-based device density guidelines can be refined to develop more focused recommendations for the number of connections supported by various coverage area deployment patterns in different building applications. For example, Siemon considered the exact coverage area requirements of specific devices (e.g. IEEE 802.11ac WAPs) and included provisions for spare TOs to accommodate

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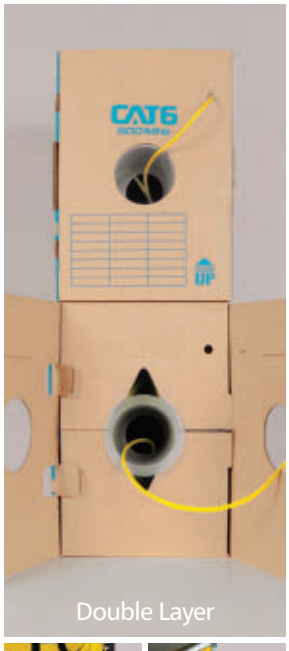

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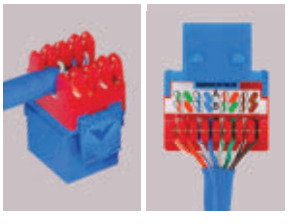

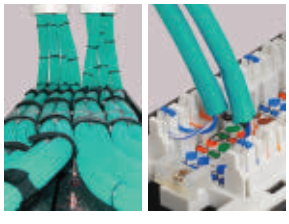

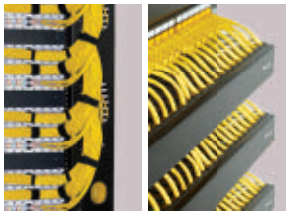

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future growth to develop the following guidelines for highly automated and conventional buildings. Emerging technologies, such as remote powering of smart lighting, have unique requirements that may require significantly increased coverage area density and are not factored in to the recommendations below.

Recommendations for highly automated buildings

If the total number of building devices and WAP connections to be supported is unknown in a highly automated building, we recommend the following two deployment configuration approaches.

1. The SCP supports 96 connections and serves a grid deployment pattern of four square-shaped coverage areas totaling 1400m^2, or
2. SOs/TOs supporting 3 or 6 connections are logically positioned throughout the floor or ceiling space to satisfy coverage requirements (SCPs optional).

In the first deployment configuration, 96 shielded Class EA/Category 6A or higher-performing ports should be provided at the CSP. The breakdown of building device, WiFi, and telecommunications services supported by this approach is shown in Table 3. This recommendation enables scalability and flexibility to accommodate new building services.

In the second deployment approach, outlets contained in outlet boxes are positioned or "flooded" throughout the floor space in accordance with predetermined building application needs. Typically, this deployment uses an access floor solution and may eliminate the need for zone enclosures. SOs/TOs are positioned approximately 2m apart in a grid pattern in the specific spaces where building device and data connections are required. Port availability at each SO/TO ranges from 3 to 6 ports depending on the number of building device and data

TABLE 3: Recommended number of connections in a highly automated building

Application	Coverage area per device (m²)	Number of connections per 1400m² zone area (96 ports total)
802.11ac WiFi[a]	350	12 (8+4 spare)
Centralized control (e.g. HVAC, temperature sensors, lighting controls)	75	18
Advanced security (e.g. cameras, alarm, sensors, access control)	40	36
Advanced video and digital signage	75	18
Telecommunications outlets	100	12[b]

a) Providing two links to each WAP enables scalability and flexibility to connect to multiple 1000Base-T ports on a single WAP, while also supporting future next-wave wireless devices with 10-Gbit/sec backhaul capability
b) If connections to TOs located in work areas are to be exclusively supported from SCPs, then Siemon recommends planning for 2 outlets every 25m^2 or 96 outlets every 1400m^2. This may necessitate one additional zone enclosure per 1400m^2 in a highly automated building. TOs located within 30m of the TR should be served directly from the horizontal distributor in the TR.

Summary of zone cabling recommendations

The bullets below summarize Siemon's recommended best practices for zone cabling and coverage area design.

Media recommendations:

- Class EA/Category 6A or higher-performing shielded cabling should be in all zone cabling deployments.
- Horizontal cable should be temperature rated to 75 degrees Celsius and connecting hardware should be independently certified to ensure reliable support of remote powering applications.
- Solid conductor cables should be used exclusively in spaces that do not have environmental control (e.g. ceilings and warehouses) for optimum thermal performance.

Technology and design recommendations:

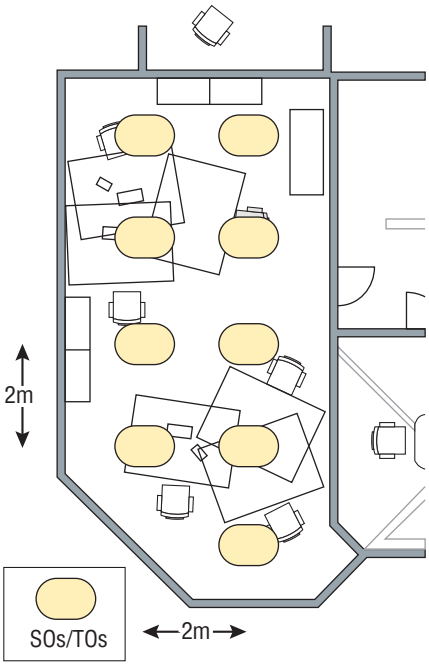
- Device coverage areas should be planned to have a radii no greater than 13m to ensure support of fifth-generation (IEEE 802.11ac) and future WiFi.
- The number of connections in a zone enclosure should not exceed 96.
- TOs located within 30m of the TR should be served directly from the horizontal distributor in the TR (no SCP required).
- A minimum initial spare port capacity of 25 percent above initial deployment needs should be provided at each SCP.
- An SO should be used if a building device WAP is more than 5m from an SCP.
- Building device connections to an SO or SCP should not exceed 5m if stranded conductor cords are used.

TABLE 4: Recommended number of connections in a conventional building

Application	Coverage area per device (m^2)	Number of connections per 1400m^2 zone area (24 ports total)	Number of connections per 2000m^2 zone area (48 ports total)
802.11ac WiFi[a]	350	10 (8+2 spare)	20 (14+6 spare)
Basic security requirements (e.g. cameras and access door)	340	4	8 (6+2 spare)
Basic video and digital signage	340	4	8 (6+2 spare)
Telecommunications outlets	225	6[b]	12[b] (9+3 spare)

a) Providing two links to each WAP enables scalability and flexibility to connect to multiple 1000-Mbit/sec ports on a single WAP, while also supporting future next-wave wireless devices with 10G backhaul capability.
b) If connections to TOs located in work areas are to be exclusively supported from SCPs, then Siemon recommends planning for 2 outlets every 25m^2 or 96 outlets every 1400m^2. This may necessitate one additional zone enclosure per 1400m^2 in a highly automated building. TOs located within 30m of the TR should be served directly from the horizontal distributor in the TR.

Flooded underfloor SCP design



In a so-called "flooded" underfloor SCP design, typically an access-floor solution is in place and the need for zone enclosures may be eliminated.

connections required. These configurations are sometimes referred to as grid outlet positions (GOPs). The benefits of this approach are as follows.

1. Device connections are provided exactly where needed, making it a recommended approach for enterprise, office, and other walled spaces served by network connections located on the wall, below the floor, or above the ceiling; and
2. Support of both building device (SOs) and work area connections (TOs) may be integrated into one design.

This solution can be optimized based on advanced knowledge of how the floor space will be used/configured and may benefit from the assistance of comprehensive technical services to determine the appropriate SO/TO density and number of spare ports.

Recommendations for conventional buildings

If the total number of building device and WAP connections to be supported is unknown in a conventional building design, we recommend the following three deployment configuration approaches.

1. The SCP supports 24 connections and serves a grid-based pattern of four square-shaped coverage areas totaling 1400m^2, or
2. The SCP supports 48 connections and serves a hexagon-based pattern of four to five hexagon-shaped coverage areas totaling 2000m^2, or
3. SOs/TOs supporting 1 to 4 connections are logically positioned throughout the wall, floor, or ceiling space to satisfy coverage requirements (SCPs optional).

The breakdown of building device, WiFi, and telecommunications services supported per 1400m^2 and 2000m^2 zone areas is shown in Table 4.

There are many reasons why zone cabling solutions are the ideal network system for automated buildings—from their ability to simplify and reduce the costs associated with MAC work, to the opportunity to leverage intelligent building solutions for green credits, to the option to use factory preterminated and tested trunking solutions for rapid deployment of TR-to-SCP connections and SCP-to-SO connections. The zone and coverage area approaches described in this article may be used as guidelines for infrastructure planning. Since every site is different, there may be additional design factors that need to be considered to ensure adequate coverage of building devices and telecommunications equipment.

To that end, intelligent building experts with specialized experience in the design and deployment of integrated building devices and applications to streamline project engineering can assist in the automated building network design and integration process. This network design expertise provided can result in significantly lowered building-construction costs, reduced maintenance costs, and a safer and more comfortable working environment for building occupants. ◆

Valerie Maguire *is global sales engineer at The Siemon Company (www.siemon.com). She received her BSEE degree from the University of Connecticut and actively participates in groups responsible for the development of telecommunications standards. Among other responsibilities, she is the TIA TR-42 appointed liaison to IEEE 802.3.*

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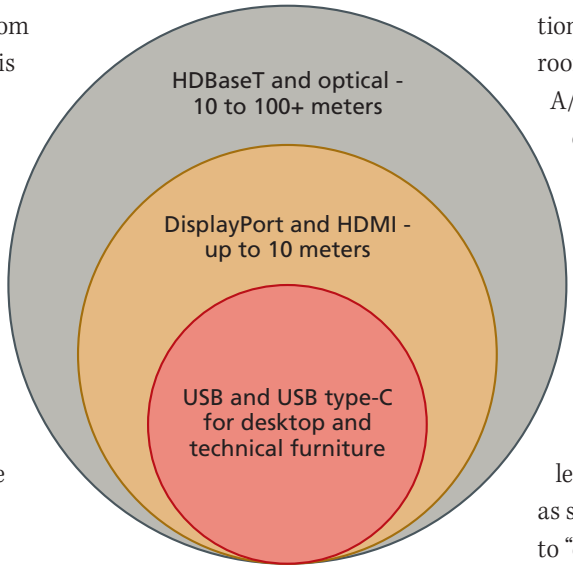
A/V structured connectivity: Wheels within wheels

Deploying the right connectivity for A/V applications is not difficult, but does require knowledge and new thinking.

BY JOSEPH C. CORNWALL, CTS-D, CTS-I, Legrand

I often use the following thought experiment to illustrate the importance of technology in modern premises. Imagine a "forgotten" building. Let's further imagine that this structure, perhaps in a seldom-travelled corner of your town, has architectural significance, an interesting location, useful size and inherent beauty. It's just waiting for an occupant to sweep the dust from the floor and clear the leaves from the gutters. Further, imagine that this structure can be yours at such a low cost that words can't begin to describe the bargain. But there's a catch. Imagine that inside the building it's not possible to have or use any technology in any meaningful way. No television. No radio. No Internet. No telephone or cell service. No streaming. No satellite. Nothing. Could you do business there? Could you live there? Would you want to?

Of course such limitations are strictly imaginary, but our thought experiment does contrast the role of technology in today's culture. We are more than three generations into the "TV Age" and nearly two generations into the "Internet Age." For businesses to attract and retain top talent or tempt sophisticated modern clients, we need to have a well-thought-out technology plan. And that means we need to have a well-thought-out technology infrastructure.



A future-ready A/V infrastructure will include the connectivity technology types outlined in this "wheels-within-wheels" diagram.

Dedicated infrastructure required

The last two decades have redefined A/V technology in particular. Today we might think of technology in terms of internet connectivity and of software as a service (SaaS). Anything we want, and much of what we own, resides in the "cloud." This view has become so ubiquitous that some might even say the only low-voltage infrastructure necessary can be provided by the local area network (LAN). Everything we need to do we can do on the network.

Upon closer inspection we find that this belief isn't fully baked. While we may evolve to that point at some future time, for both today and the coming decade we will still need to have dedicated A/V infrastructure for most applications. From huddle spaces to conference rooms, classrooms and boardrooms, A/V technology is really best thought of as the last 100 meters of connectivity between the network drop and the imagination. A/V technology is an element of how we communicate. It's the last bit of wire that makes so much of our work work. It's not a detail that should be left to chance.

This might be a short story if selecting A/V structured wiring were as simple as making a check mark next to "electronics" on a list of options. All around us are computers that use VGA connectors, Blu-Ray players that use HDMI connections and smartphones that use, well, some of them appear to

use no connection at all. What connectivity do we really need to maximize the utility of a space? Is there a way to support laptops issued five years ago and tablets that might not be purchased for another five years? There is if we think of A/V connectivity as a wheels-within-wheels and select the wheels we need to make our spaces go.

The innermost wheel

Let's start at the very beginning of the technology chain, the device in our hand, on our lap or on our desk. Smartphones and tablets, like the one you might be using to read this article, connect to other devices in two ways—through a wireless access point (WAP) or through that small connector we use to charge the battery. That connector is a universal serial bus (USB) port. USB appeared on the scene in 1998 and has only grown in importance since. While we often think of USB as the charging port for our personal digital services, the truth is that little plug can do a whole lot more. Through the USB connection we can connect to a keyboard and mouse, to the LAN via Ethernet, to speakers and a monitor, or to another computer. USB is so important that we now find USB charging ports in duplex AC outlets, embedded into technical furniture such as podiums and workstations, and in the center console of our automobiles.

There is a new USB connection waiting in the wings that will change your relationship with personal technology in profound ways. Called USB Type-C, this littler connector can deliver up to 100 watts of power, high-definition video to drive multiple monitors, and even allow the screens on our desks to be upgraded to interactive touch-sensitive devices. USB Type-C is just now making its way into the market, but in a year or two you'll see it everywhere. Fortunately, when USB Type-C arrives in force it will come with a plethora of adapters to allow easy interface with the structured wiring decisions we have to make today.

Ultimately we find that USB is a desktop and collaboration space device-charging imperative but it's not a connection that regularly reaches the flat panel or projector, with one glaring exception. That exception is interactivity. Every interactive touch panel will demand a USB interface. While USB for data and power is a connection we can keep in the small circle that touches the desktop and immediate surroundings, simply including multiple USB charging ports paired with AC convenience outlets in our workspace design might not be enough to support our needs. We have to ask if interactive touch panels are now or will be a part of our technology expectations. If we anticipate interactive solutions being an element of the space at some point, we have to include it in our plans.

DisplayPort and HDMI

Following our chain to the next link, we find DisplayPort and HDMI direct digital connections. These are the connections we commonly associate with digital video. HDMI is the most ubiquitous A/V connection in the industry, and any structured solution we consider must include at least one HDMI port. HDMI connectivity needs to be on the wallplate leading from the conference table to the display, and the connection needs to support the resolutions we anticipate supporting over the life of the installation—not the resolution or performance of the devices we have now. If we demand certified Hi-Speed HDMI(e) performance that supports up to UltraHD 4K video resolution, we will have a system that will remain adaptable to emerging technologies for several years.

DisplayPort is the connection that is replacing the now-obsolete VGA connector. Right now, when we look around we might see a lot of VGA ports still in use on laptop computers and productivity workstations. It's important to remember that we can't judge tomorrow by what we experienced yesterday. VGA is a technology that we need to accommodate in our plans, but we don't want to enshrine a legacy solution by chaining ourselves to the past. Any well-designed A/V infrastructure today will feature digital DisplayPort connectivity. New computers, tablets, convertible devices and USB Type-C enabled products will all come with advanced DisplayPort connectivity, and VGA is fully adaptable to a DisplayPort environment. A DisplayPort connection also needs to be on that wallplate from the conference table to the display.

These three connections—USB, HDMI and DisplayPort—are at the core of our A/V concerns. Research will reveal that each of these has fairly tight length restrictions that must be observed if we're going to get the best performance from our structured A/V connectivity design. Generally speaking, we can get to about 10 meters with any of these in either a plenum or in-wall space, but beyond that we need to look for special solutions. Fortunately for us, there are two very effective solutions readily available for connectivity beyond 35 feet—HDBase-T and optical media conversion.

Longer-distance options

HDBase-T was adopted as a standard for whole-home and commercial distribution of uncompressed high-definition multimedia content by the IEEE in 2015. The cornerstone of HDBase-T technology is 5Play, a feature set that includes uncompressed UltraHD 4K digital video, embedded digital audio, 100Base-T Ethernet, USB 2.0, up to 100W of power, and various control signals through a single

category cable for connectivity up to 100 meters. HDBase-T solutions are available in a small box transmitter-receiver form factor or in a wallplate version that can be mixed and matched as needed for a particular application. Some flat panels and projectors even come with a built-in HDBase-T RJ45 receiver port for enhanced installation convenience.

It's important to recognize that HDBase-T doesn't connect to the LAN and, therefore, doesn't affect network security or capacity. HDBase-T uses a similar physical topology to the LAN, but it is a dedicated point-to-point digital A/V solution. And because digital video content can be far more demanding than even advanced network connectivity, it's vital that we demand either a shielded F/UTP Category 6 or a discontinuous shield U/UTP Category 6 for our system. All category cables used for HDBase-T solutions should be HDBaseT.org certified for the application.

When A/V connectivity distances might exceed the 100-meter limitation of HDBase-T, or if we need a solution that supports 32-bit color space and is scalable to the maximum levels of A/V performance deliverable today, then the best solution is optical media conversion. There are two ways to do this. We can use traditional OM3 or OM4 multimode 50/125 optical fibers and a pair of transmit/receive modems, or we can use a unified solution that includes electrical-to-optical and optical-to-electrical conversion built into the fiber interconnect. Typified by products like RapidRun Optical, these unified solutions are particularly easy to install and can accommodate runs up to 330 meters in length.

Getting structured connectivity right for A/V applications isn't difficult, but it does demand familiarity with emerging technology and some out-of-the-box thinking. If the project is very large or very complicated, retaining an experienced A/V integration professional can be an important step.

Whether we go it on our own, or retain top professional talent to ensure dependable A/V performance, one thing is certain: The need for a future-ready, scalable, high-performance structured A/V solution is undeniable. The spaces in which we live and work must enhance our technology and add to our productivity if they are to deliver their real value. ◆

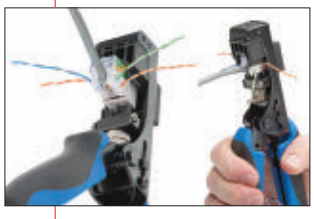
Joseph Cornwall *is Legrand's (www.legrand.us) technology evangelist. He holds the Certified Technology Specialist-Design (CTS-D) and Certified Technology Specialist-Installation (CTS-I) designations, which are offered by InfoComm to indicate expertise in A/V system design and installation, respectively.*

PRODUCT FOCUS

PUNCHDOWN TOOLS

One-squeeze punchdown, plus new blades

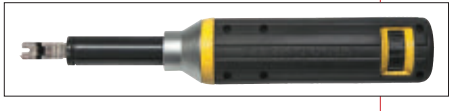
The Xpress Jack punchdown tool from Platinum Tools is "designed to make keystone jack terminations easier than ever," said the company. Designed for one-stroke keystone jack terminations, the Xpress Jack is designed for use on 110-type 4-pair keystone jacks. The tool's comfort grip TPR handles reduce hand stress on large jobs where prolonged use is required. Die sets for Platinum Tools and Leviton keystone jacks and other similar designs are available. The Xpress Jack cuts and trims all 8 conductors in one simple and smooth motion, Platinum Tools explained.



Also available from Platinum Tools are NEVERDull blades. "These high-performance blades stay sharp and last twice as long as traditional ones," claimed Platinum Tools. The blades work with all industry-standard 110 and 66-style crossconnect blocks and keystone jacks, and are compatible with all industry-standard bayonet mount (twist and lock) punchdown tools.

Platinum Tools, *www.platinumtools.com*

Cushion-grip impact tool



Klein Tools' Cushion-Grip Impact Punchdown Tool allows you to install and maintain jacks, panels and blocks with securely punched-in terminations. This tool incorporates a cushion-grip handle with Hi/Lo impact settings and an inherently long shaft for reaching into narrow/crowded blocks. The tool's Dura-Blade metal injection molded (MIM) 110/66 blade has been optimized for durability to deliver reliable, long-lasting cutting performance. The punchdown tool can also accept other standard twist-lock blades. "The Cushion-Grip Impact Punchdown Tool delivers precise wire insertion and trimming each time for pristine voice and data wire installation," said the company. It is offered as a standalone tool, or in a kit with a wire pick/spudger and a multi-pocket pouch with belt clip.

Klein Tools, *www.kleintools.com*

EDITOR'S PICKS

News, products and trends for the communications systems industry

- NOKIA DEBUTS POL
- PLENUM-RATED SURFACE-MOUNT BOXES
- WIRELESS DATA CENTER MONITORING

COMPILED BY
Matt Vincent
CIM@PENNWELL.COM

SOUND MASKING

Cambridge tailors healthcare environmental sound masking for patient privacy

The new Qt Patient Privacy System from Cambridge Sound Management (Waltham, MA) uses the company's direct-field sound masking technology to protect patient and staff speech privacy in medical office waiting areas, exam rooms, and pharmacies. The system is installed by Cambridge Sound Management's extensive network of certified sound masking specialists.

The all-in-one privacy solution consists of a control module, two lighted privacy status signs, and a series of barely visible direct-field sound masking emitters that can be installed in any ceiling type. The control module is easily installed behind a reception desk or in a back office. The system's lighted privacy signs inform patients and staff that their conversations are protected.

According to Cambridge Sound: "The Qt Patient Privacy System helps protect patient privacy by making conversations in healthcare environments less intelligible to unintended listeners. Often overlooked in healthcare design is the lack of speech privacy in reception areas where private conversations can be easily overheard. Furthermore, many patient exam rooms often don't provide adequate speech privacy due to a lack of sound blocking building material. With an increased focus on patient quality of care and achieving HIPAA privacy regulations, the Qt Patient Privacy System is an affordable solution to solve an important problem."

"Our healthcare customers and designers have been asking for a simplified speech protection system that could be easily deployed in open reception areas to protect sensitive conversations between patients and staff," explains Christopher Calisi, CEO of Cambridge Sound Management. "Helping medical staff and facility managers meet HIPAA privacy rules – while simultaneously improving the overall patient experience – was the core driver behind this exciting product." ♦

INSTALLATION TOOLS

Side-cutting pliers also strip, crimp

Klein Tools has combined several major functions of side-cutting pliers into a single tool geared to electricians. Klein's Journeyman High-Leverage Side-Cutting Pliers with Wire Stripper/Crimper is a multi-tool that cuts and strips 10- to 12-AWG solid and 12- to 14-AWG stranded wire; it also crimps non-insulated connectors, lugs and terminals.

David Klein, associate director of product management at Klein Tools, said, "We know electricians often use their Kleins to strip wire. So we incorporated striping holes into the cutting jaw to make the task more efficient. That added function saves time on the jobsite and means fewer tools needed in the tool bag."

Other features of the 9-inch multi-functional side-cutting pliers include a high-leverage design for increased cutting and gripping power; cross-hatched knurled jaws for sure gripping; induction-hardened cutting knives; crimping die positioned behind hinge for significant leverage; hot-riveted joint, ensuring smooth action without handle wobble; dual-material handles for a comfortable grip. ♦

PASSIVE OPTICAL LAN

Nokia introduces POL system

In its recent analysis of the passive optical LAN (POL) marketplace, market-intelligence firm BSRIA stated that uptake of the technology would be bolstered by the entrance of a big-name player. It looks like the market now has that big-name entrant.

Nokia announced on April 5 that it offers a passive optical LAN system. "Based on proven and established Gigabit Passive Optical Network [GPON] fiber technology that is already serving millions of people worldwide, the solution requires, on average, 50 percent less space to deploy and power to run than traditional Ethernet-based LANs," the company said when making the announcement. "Delivering virtually unlimited data capacity, it is also capable of supporting all video, voice and data requirements over a single fiber-optic cable." It added that it is targeting customers including operators, enterprises, governments, healthcare and hospitality providers, as well as higher-education institutions, "all of which are seeking a more-cost-effective way to deploy their local area networks."

Nokia pointed to its recent success deploying passive optical LAN systems for the Japanese hospitality industry, where it teamed with systems integrator KDDI "to manage the growing communication demands" in that country. "To better serve customers around the world, Nokia is collaborating on the launch with global systems integrators, resellers and distributors including IBM and KDDI."

Key components of the Nokia passive optical LAN system are the following GPON elements.

- 7360 ISAM FX high-capacity fiber platform
- 7368 ISAM ONT fiber termination points
- 5571 POL command center (PCC) intuitive management system

"New solutions for enterprise LAN are needed due to growing capacity needs, management complexity, network maintenance and high upgrade costs," said Federico Guillen, president of Nokia's fixed networks business group. "Passive optical LAN provides a viable, simple and cost-effective alternative, and will accommodate the evolving connectivity needs of organizations today and in the future."

Erik Keith, principal analyst for broadband networks and multiplay services at Current Analysis, stated, "We've seen interest in POL increase dramatically over the past few years as enterprises around the world have come to realize the substantial service delivery and operational efficiency advantages that POL architectures provide over Ethernet-based LANs. We expect to see accelerated momentum in the POL space as Nokia and other major vendors enter the market and provide compelling, future-proof alternatives to the existing Ethernet LAN model."

As part of its POL system launch, Nokia published a document titled "Build a LAN that exceeds expectations." Within that article the company explained, "Our passive optical LAN solutions … allow businesses, governments, hospitals, hotels, real estate developers, and universities to reduce costs by deploying one simple network; add capacity to boost business performance; improve mobile connectivity for all users." ♦

MERGERS AND ACQUISITIONS

Madison Electric acquires telecom conduit body manufacturer Smart Pathways LLC

Madison Electric Products recently announced it has acquired Smart Pathways LLC, which manufactures and distributes the Smart LB brand of telecom conduit bodies. Madison said Smart Pathways LLC is the second company it has acquired through its crowd-sourced product development platform, the Sparks Innovation Center.

"Conduit bodies have long been part of the installers' toolbox, but Smart Pathways offers a more-advanced solution that solves numerous problems they face on a daily basis," Madison Electric Products said when making the announcement. "Designed by Ken Bing, managing member of Willow Rest LLC, who drew from his experience as a contractor in both the electrical and data communication areas, the Smart LB conduit body has a built-in elbow that helps prevent cables from getting caught or damaged when they're pulled around corners. Unlike traditional LBs that have a sharp 90-degree corner, this helps save time and labor during installation."

Brad Wiandt, president of Madison Electric Products, commented, "We recognize the long-term potential and opportunity in the data communication industry. Smart LB conduit bodies complement the existing products we promote in that segment, positioning Madison to establish a much greater presence in this new and growing market."

The existing Smart Pathways product portfolio includes six different SKUs, all of which Madison plans to continue manufacturing after the acquisition is complete. Madison said it will continue to work closely with Bing to determine the best way to take the concept further into the market in the future.

"Madison is the ideal partner to take Smart LB to the next level," said Bing. "I look forward to working with their team to really maximize the potential and reach of our product line."

Wiandt added, "Smart Pathways is exactly the type of partner we look to work with at Madison. Their vision to revolutionize installation practices underscores our ongoing commitment to innovation and pushing the electrical and data communication industries forward. Further, this acquisition reinforces the success and potential of our Sparks Innovation Center." ♦

OPTICAL FIBER

Sumitomo Electric unveils coupled multi-core optical fiber suitable for ultra-long-haul transmission

Sumitomo Electric Industries, Ltd. has developed a new type of coupled multi-core optical fiber suitable for ultra-long-haul transmission, which the company says has set new records for low attenuation and low spatial mode dispersion in optical fibers for space division multiplexing.

The company maintains that data network traffic in long-haul transmission systems is growing due to the widespread use of smartphones, data centers, and other applications; and that transmission capacity has been improved with the use of low-loss singlemode fibers. At the same time, to realize such drastic improvements in capacity, space-division multiplexing (SDM) has been intensively studied, and multi-core fiber (MCF) is expected as a next-generation optical fiber that can realize ultra-high-capacity transmission systems.

For its part, Sumitomo Electric has now developed a coupled-core MCF (CC-MCF) including 4 pure-silica cores in the standard 125-μm cladding. The developed fiber has achieved attenuation of 0.158 dB/km at the wavelength of 1550 nm and spatial mode dispersion (SMD) of 6.1 ps/√km in the wavelength from 1520 to 1580 nm, both of which are the lowest ever reported in optical fibers for space division multiplexing, contends the company.

The new product's ultra-low attenuation — approaching that of the commercial ultra-low-loss singlemode fiber (SMF) — enables signal transmission with lower noises than previously reported SDM fibers, and is expected to realize the spatial channel count increase without per-channel capacity degradation. Sumitomo maintains that the SMD of 6.1 ps/√km is one fifth the lowest SMD of previously reported SDM fibers, and thus can reduce the calculation complexity of multiple-input-multiple-output (MIMO) digital signal processing (DSP) for crosstalk compensation.

Further, the company says the developed CC-MCF with the standard 125-μm-diameter cladding can be cabled with existing cable designs for standard optical fibers, and is expected to have high mechanical reliability equivalent to that of standard optical fiber. ♦

DISTRIBUTOR SERVICES

Graybar extends customer service hours

Graybar recently announced that it is offering extended customer service hours nationwide, via the distributor's newly centralized National Customer Service Team in St. Louis.

According to a Graybar press release, "the National Customer Service Team can help customers place orders, check order status, obtain proof of delivery, pricing and product availability before and after the traditional business hours of Graybar's more than 260 branches nationwide."

Support though the National Customer Service Team is available Monday through Friday from 6:00 a.m. – 10:00 p.m. CDT and Saturday and Sunday from 8:00 a.m. to 5:00 p.m., by calling 1-800-GRAYBAR (1-800-472-9227). Customers can continue to call their local branches for service during regular business hours.

"Graybar's primary goal is to make it easier for our customers to do business and complete their projects," comments Scott Clifford, Graybar's senior vice president, supply chain management. "Extending the breadth and depth of our customer service program nationwide demonstrates our ongoing commitment to working to our customers' advantage." ♦

SECURITY

Home security hub integrates sensor, wearable devices for personal safety, fall detection

Nortek Security & Control LLC, a specialist in security, smart home and wellness technology, has introduced the Numera Home Safety Hub, a next-generation PERS [Personal Emergency Response Systems]. The hybrid hub combines information from sensing devices such as CO and smoke detectors, and glass-break, motion and window/door sensors with alerts from wireless personal emergency sensors in a single PERS console for seniors or others needing support while living alone.

"The Numera Home Safety Hub communicates with the array of 2GIG sensors and creates a self-designated safety ecosystem that delivers user and environmental data to their care team," said a Nortek press release for the product.

The release added: "The Numera Home Safety Hub's integration with connected wireless security sensors represents an evolution of personal safety technology in the home. With complementary lightweight wearables and an upgradeable ecosystem, the [hub] ensures a safer and more protected home for seniors and families. [The system] features upgradeable firmware, a range up to 1,000 feet, customizable 'night-time,' 'do-not disturb' and personalized activity windows, along with full compatibility with personal safety and 2GIG home sensors. The hub is easily installed and set up, reducing field time, complexity and cost."

Also according to Nortek, "via the system's Personal Help Button, assistance is just a discreet button push away, and with remote alerts of a potential fire or fall in the home, help is summoned even when the user cannot react. Creating interoperability between the smart home and personal safety devices provides caregivers with notifications of events that require their involvement, including a smoke alarm, detection of a potential fall or prolonged inactivity during a certain period of time. It also enables activity control when used with door and motion sensors, where caregivers could receive an alert if the door is opened and motion detected at a time that would be cause for concern such as late at night or during unsafe weather conditions."

"Creating the ability for communication between our personal safety device and home and security sensors gives caregivers more complete ways to ensure the well-being of their loved ones," says Tim Smokoff, group vice president health and wellness, Nortek Security & Control. "With this new hub and access to more information about their environment, users and their care teams can rest easier and feel more comfortable about their loved ones dealing with chronic illness or aging-in-place." ♦

ZONE CABLING

Panduit's plenum-rated surface mount boxes gain UL 2043 certification

Panduit Corporation recently announced that a family of its surface mount boxes has received UL 2043 certification, allowing the boxes to be used to route connectivity in air-handling spaces.

"Equipment such as wireless access points, security cameras, safety systems, intelligent lighting, and audio/video components are frequently installed in the ceiling and require a plenum-rated connectivity solution," the company said. "The Panduit Mini-Com surface mount boxes join other Panduit plenum-rated components—RJ45 jacks, cords, and horizontal cabling, as well as hook-and-loop cable ties and J hooks—to deliver a complete connectivity solution for plenum applications."

Three Panduit surface mount boxes carry the plenum certification: a one-port box and two different two-port boxes. All three accept Panduit Mini-Com brand modules. UL 2043, Panduit explained, is awarded to products that have passed testing to prove the products help to limit the spread of flames and smoke in the event of a fire. The solution is also compliant with the latest Power over Ethernet standards, the company noted.

Dennis Renaud, vice president of Panduit's enterprise business, commented, "Panduit recognizes that applications like wireless and security are growing rapidly, driving the need for a connectivity solution that is certified to be used in the ceiling. This latest certification means that Panduit can provide customers with a complete plenum solution that meets the latest standards and helps protect building occupants, while also delivering the high-quality performance our customers expect from Panduit." ♦

WIRELESS LAN

Aerohive makes Synnex exclusive distributor of WiFi portfolio to U.S., Canada

Aerohive Networks and Synnex Corporation recently jointly announced that they have entered an agreement through which Synnex has become the exclusive U.S. and Canadian distributor of Aerohive's cloud networking and enterprise WiFi portfolio. The agreement includes the complete Aerohive portfolio of access points, routers, switches, and network management tools.

"By collaborating with Aerohive Networks, Synnex is able to help its resellers address the multitude of connected devices that are currently active on the network," the companies' announcement said. It cited Gartner's projection that by 2020 more than 25 billion "things" will be Internet-connected—driving home that point that the design, deployment and support of wireless networks is growing increasingly complex. "In response to the exponential proliferation of devices, Aerohive Networks delivers a simple, secure and scalable cloud networking platform designed to enhance the user and management experience, turning the challenges of today's highly mobile work into opportunities."

The agreement with Aerohive is part of Synnex's ConvergeSolv Secure Networking group, "which offers a comprehensive portfolio of products and services that allow resellers to deliver a true IT convergence model by building their customers' networks, adding applications to each network and securing each network seamlessly," the companies explained. "Synnex offers Aerohive resellers tools to help them work faster, smarter and more accurately. While Synnex offers a wide array of tools for resellers, some of its most-utilized tools are its financing programs, education experts, SMB specialists and free predictive wireless surveys. The agreement benefits a range of technology verticals, with strong implications for K-12 education. With E-Rate funding at record levels and device proliferation now above 50 percent, Aerohive Networks enables Synnex resellers to offer a wider range of wireless solutions to meet the needs of their K-12 customers."

Synnex's vice president for integrated communications, Reyna Thompson, commented, "Our agreement with Aerohive Networks delivers a highly efficient option for resellers to offer to their end-customers to help keep their businesses connected in dynamic environments. Through a connected platform equipped with the best in cloud networking, WiFi, and applications and insights, Aerohive Networks' solutions allow businesses to increase productivity and efficiency to result in better customer experiences and ultimately, to fuel business growth."

Michael O'Brien, vice president for global channels with Aerohive, added, "Aerohive has been a channel-driven company since it was founded in 2006 and channel partnerships have been critical to our growth over the years. We are excited to collaborate with Synnex in this critical segment of the IT market. By working together with Synnex, we believe we will deliver even better support to resellers to help them grow with Aerohive." ♦

TOP-OF-RACK CONNECTIVITY

RCx initiates multi-source agreement for new in-rack connection standard

The RCx Multi-Source Agreement (MSA) has announced the formation of a four-member industry working group, aimed at defining and promoting adoption of a new intra-rack connection standard. The industry group will be led by RCx founding members Amphenol Corporation, Broadcom Corporation, Dell Inc., and Hewlett Packard Enterprise.

The proposed RCx connector and cable system is designed specifically for rack-based interconnect providing simple, low cost, low power options for 25/50/100-Gbit/sec connectivity. RCx is a passive, copper-only, modular and high-density cabling scheme for server adapters and network switches. There are three RCx configurations – RCx1, RCx2 and RCx4, providing 25-Gbit/sec (25Gx1), 50-Gbit/sec (25Gx2) and 100-Gbit/sec (25Gx4) connectivity, respectively.

According to the new consortium, the streamlined RCx MSA design eliminates the need for costly active electrical components like EEPROMs, optics, retimers, and management ICs; simplifies the electrical design of switches and adapters; and significantly reduces the cost of the overall system solution. ♦

Upsite Technologies debuts wireless monitoring solution

Upsite Technologies unveiled its wireless EnergyLok Environmental Monitoring System (EMS) 300 at AFCOM's Data Center World Global Conference in Las Vegas, Nevada (March 14-18).

According to Upsite, the EnergyLok EMS 300 is a scalable wireless monitoring solution designed to track a variety of environmental conditions to help identify opportunities for improving the effectiveness and efficiency of cooling and airflow management. The latest addition to Upsite's data center airflow management product line, it gives facility managers and data center operators an advanced tool to optimize cooling efficiency and prevent downtime in their mission critical spaces, adds the company.

The EMS 300 offers up to one-hundred and fifty wireless sensor inputs, allowing for the deployment of multiple temperature and humidity sensor configurations along with four wired digital inputs, which can be used to track open/closed doors, motion and airflow sensors, fire alarms, gas and liquid leaks, and summary alarms from critical equipment, including uninterruptible power supplies and generators. To help ease of integration into existing management systems, the EMS 300 also includes two wired relay outputs.

The introduction of the EnergyLok EMS 300 marks the first major product introduction for Upsite since launching its award-winning AisleLok Modular Containment solution.

"In addition to providing critically important real-time information on environmental conditions in the data center, the EnergyLok EMS 300 is also an essential tool for owners and operators who need to optimize their cooling systems," comments Peter Crook, president and CEO of Upsite Technologies. "I am delighted that Upsite is debuting its newest monitoring solution and sharing our field-based research at one of the data center industry's most influential events."

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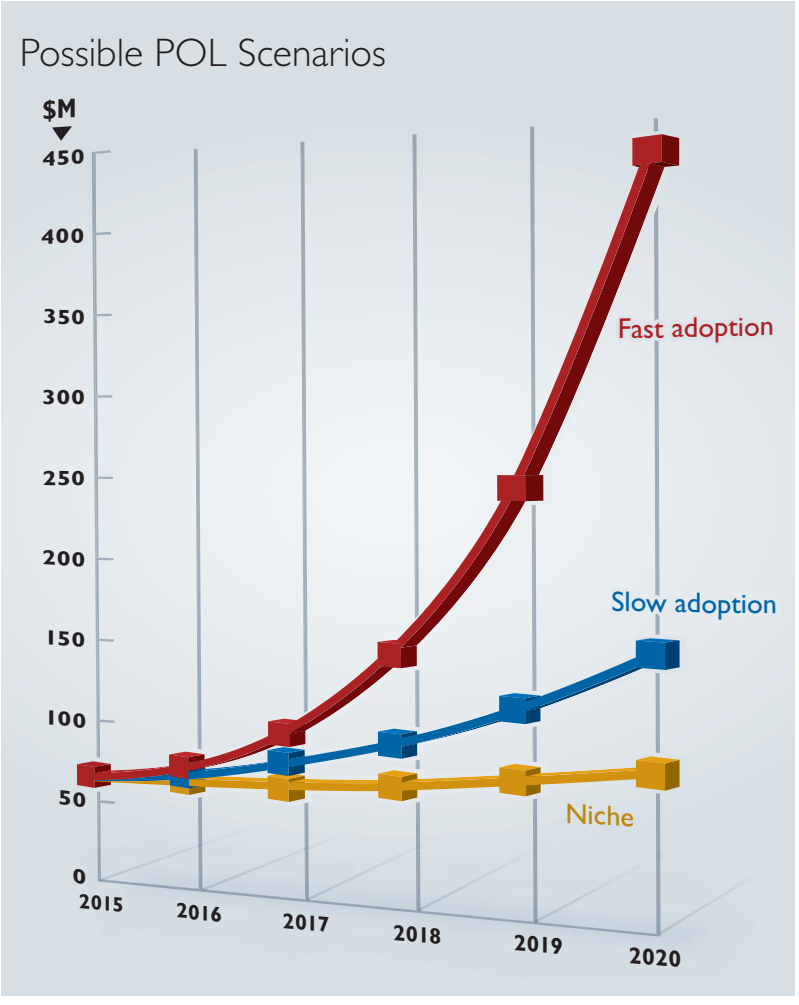
INFRASTRUCTURE INSIGHTS

Will POL market soar with Nokia, Huawei on board?

As we reported in our March issue, BSRIA recently analyzed the passive optical LAN (POL) marketplace ("Researcher says passive optical LAN market poised to take off"). Among the conclusions it reached was that the market "will only really take off when a big player or several medium sized players enter the market with a clear go-to-market strategy …" In early April, Nokia announced its entry in the POL market. Nokia may very well be the big player that BSRIA said will be needed to enjoy a hockey-stick growth curve.

In a private presentation that took place in early February, BSRIA presented information on the POL market to several cabling-industry vendors. As part of that presentation, BSRIA unveiled the graph that appears on this page. The graph depicts POL market growth curves under three scenarios: the technology remains niche; it experiences slow adoption; or it enjoys fast adoption. As the chart indicates, the POL market is pegged at approximately $75 million this year regardless of which path it ultimately takes. But if everything lines up right for the POL market and it experiences fast adoption, the total market could pass $100 million next year and eclipse $150 million in 2018.

Under any scenario, the growth path charted by BSRIA has the POL market exceeding $100 million by 2020. However, depending on which path the market takes, by that year—2020—it could be anywhere from approximately $110 million to approximately $425 million.



When announcing its entry into the passive optical LAN market, Nokia quoted Erik Keith, principal analyst for broadband networks and multi-play services at Current Analysis. Keith said, "We've seen interest in POL increase dramatically over the past few years as enterprises around the world have come to realize the substantial service delivery and operational efficiency advantages that POL architectures provide over Ethernet-based LANs. We expect to see accelerated momentum in the POL space as Nokia and other major vendors enter the market and provide compelling, future-proof alternatives to the existing Ethernet LAN model."

The fact that a Nokia brand-name passive optical LAN system has reached the market results from the long-in-the-works merger of Nokia and Alcatel-Lucent. The network equipment in the system is Alcatel-Lucent hardware. The two organizations began operating as a joint company in January.

If Nokia's entry alone doesn't put POL on the fast-adoption track indicated in the graph above, perhaps Huawei's entry into the market will do the trick. It launched the AgilePOL solution at CeBIT in March and had joined the Association for Passive Optical LAN in February. At the time it joined the APOLAN, Huawei demonstrated several POL solutions.

With the entry of these high-profile network vendors, and perhaps others in the future, the next handful of years will be telling for the passive optical LAN market.

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