Berk-Tek® LEVITON® TECHNOLOGIES

WHITE PAPER

Taming The Beast

Can your IT infrastructure stand up to the FEROCIOUS GROWTH of healthcare data requirements?

Table of Contents

Hospitals and other healthcare providers face the daunting challenge of managing information. As patient records, diagnostic information, and even the operating theater increasingly rely on networked electronics, the amount of data that must be created, transmitted, managed, and stored has grown dramatically. In addition, regulations requiring high levels of data security to protect patient privacy add an additional layer of complexity to information management.

Network Drivers in Medical Applications

Digital Connectivity

Medical equipment is becoming more and more digital. A clear example is the X-ray, now both filmless and digital. One benefit of this digitalization is the ability of equipment to be interconnected and IP networked so information can be moved and shared. An X-ray film is discrete; a digital X-ray can be transmitted to any number of other pieces of equipment, from the radiology department computer to locations anywhere in the world. Soon, nearly everything that happens in a hospital will require a network connection.

Electronic Medical Records (EMRs)

While the vast majority of medical recordkeeping is already computerized, the push for universal and uniform records is viewed as an important step to cost control and better patient care. The Health Information Technology for Economic and Clinical Health (HITECH) initiative has a goal of creating a single digital structure for all medical records to ensure compatibility in creating and accessing patient records. As EMRs contain a single repository for a patient's complete medical history, storage requirements grow.

Exploding Storage Requirements

The amount of data grows exponentially, and the need to access the data drives the bandwidth needs of the network. A typical MRI study generates 200 images, requiring about 40 megabytes (MB) uncompressed. A multislice CT study can generate over 2 gigabytes (GB) of data. **Table 1** shows typical storage requirements for different radiological studies, based on 100,000 studies per year.

The medical industry has standardized on managing such records through Picture Archiving and Communications Systems (PACS), again with the aim of facilitating storage, access, and interoperability. RAID 1 (disk mirroring) and other means of keeping multiple copies of records for backup and security reasons also place demands on bandwidth. Therefore, these vast storage requirements necessitate higher data rates in the network. The network must be able to move large files around quickly, while also handling routine transactions like e-mail.

Table 1: Storage Requirements for Radiological Studies

MODALITY	UNCOMPRESSED		LOSSLESS COMPRESSED 2.5 TO 1 RATIO	
	MB PER STUDY (AVG.)	GB PER YEAR	MB PER STUDY (AVG.)	GB PER YEAR
Angiography	15	45	6	18
CR and DR	42	2688	17	1075
CT	52	1040	21	426
MR	39	195	16	78
Nuclear Medicine	1.3	3.9	0.5	1.6
Ultrasound	18	90	7	36
Total Terabytes (TB) per 100,000 studies	**4.1 TB**		**1.6 TB**	

Source: Edward M. Smith, "Storage Management: What Radiologists Need to Know," Applied Radiology, 38(5) 13-15.

Long-Distance Collaboration

Real-time telemedical collaboration requires crisp streaming video, whether locally or across the globe. High resolution requires higher bandwidth and low network latency. This allows for multi-location collaboration among various medical professionals for patient consulting and procedures. It also increases the level of patient care along with educational opportunities.

IP Convergence

The success of Internet Protocol (IP) means that nearly all communication needs can be handled by a single network. Beyond standard data, other systems can run over an IP network, including security, building automation, video and television. If it can be done digitally, it can be transmitted over an IP-based network. While hospitals will normally segregate applications, particularly the medical and nonmedical, the fact remains that the prevalence of IP means there are more bits and bytes being transmitted and increasing the need for greater data speeds.

Confidentiality

The Health Insurance Portability and Accountability Act (HIPAA) of 1996, together with the HITECH requirements for maintaining the privacy and confidentiality of patient information, require physical and application security, backup procedures, and hospital policies.

To meet these challenges, healthcare facilities are making two main network improvements:

- **Higher Bandwidth:** From transmitting MRI images to video consultations, networks must work at higher speeds to deliver services. Networks are looking to support 10 Gb/s speeds in critical areas, with 40Gb/s or 100Gb/s in the core to ensure bandwidth availability.
- **More Connections:** As more and more equipment is network-enabled, more network ports must be provided for users. The port density in any given area depends on the area's function, but network administrators are learning a few extra ports are better than too few. More connected equipment also means more bandwidth is needed.

Faster data rates are needed to support delivery of data in a timely matter, especially for real-time medical data. **Table 2** highlights the theoretical transfer time to transmit 1 GB. The times are best case and are for total transmission, not just the data. The overhead information (directions to IP address, etc) in the Ethernet frame (which can in some cases exceed the length of the data in the frame), network architecture, congestion, and other factors can significantly slow the actual time to transfer data.

Table 2: High-Speed Data Networks are Required to Ensure Fast, Efficient Transfers of Information

ETHERNET SPEED	APPROXIMATE TIME TO TRANSFER 1 GIGABYTE
10 Mb/s	14 (minutes)
100 Mb/s	1.4 (minutes)
1 Gb/s	8.4 (seconds)
10 Gb/s	0.84 (seconds)

Standardizing Cabling for the Healthcare Environment

The network is vital to today's health care facility, and higher data rates are required to handle growing demands on the network. The right structured cabling system must be designed and installed to meet these realities. ANSI/TIA-1179, the Healthcare Facility Telecommunications Cabling Systems standard addresses the special requirements of cabling systems in healthcare facilities.

There are generic standards to address the architecture of the cabling system and recommend best practices for cross connects, cabling distances, and cable and connector performance specifications. ANSI/TIA -568-C is the primary example of a generic standard whose recommendations form best practices for cabling systems.

A typical network in a typical business is largely a cookie-cutter affair. With some exceptions, all work areas have the same network connectivity. Businesses standardize on providing the same connectivity to each office. Schools similarly standardize classrooms. Likewise, chain stores often install the same network in every new store. Variations tend to be small: four data ports instead of two. Generic cabling standards, like ANSI/TIA-568-C, rightly recognize that an extremely wide swath of applications can beneficially adopt similar standards.

Hospitals and other healthcare environments do not fall under this cookie-cutter approach. For example, different areas of the hospital have significantly different connectivity needs. Office areas may require four ports, exam rooms 10 ports, MRI suites 20 ports, and operating rooms 40 or more ports. As a result, the TIA issued ANSI/TIA-1179 to address the specific needs of healthcare facilities.

Work Areas

ANSI/TIA-1179 recognizes hospital and health care facilities have different needs in the number of network connections required and the related density of cables run to a multitude of areas. The standard identifies eleven application-specific types of work areas:

- Ambulatory care
- Caregiver
- Critical care
- Diagnostic and treatment
- Emergency
- Facilities
- Operations
- Patient services
- Service/support
- Surgery/procedures/operating rooms
- Women's health

Each of these work areas has further subareas with varying cable densities, yielding about 75 areas. To paint with a broad stroke: areas dealing directly with patient care and treatment have higher cable densities than areas dealing with administration or facilities.

Table 3 summarizes the cable density recommendations of ANSI/TIA-1179. While an area with 14 outlets is considered a high-density area, that number is conservative. Some new operating rooms have upwards of 50 outlets to support the increasing needs for connectivity.

Table 3: Recommended Cabling Densities for Different Work Areas as Defined in the ANSI/TIA-1179

MAIN WORK AREA	LOW DENSITY (2-6 OUTLETS)	MEDIUM DENSITY (6-12 OUTLETS)	HIGH DENSITY (>14 OUTLETS)
Patient Services	Consultation Family Lounge Waiting Room	Administration Registration Library	Nurse's Station Patient Room
Surgery, Procedures, Operating Rooms	Sterile Zone Sub-Sterile Zone	Anesthesia Offices Patient Prep Patient Hold Patient Recovery	Intensive Care Room Operating Room
Emergency	Ambulance Bay	Evaluation Exam Room	Observation Procedure Rooms
Ambulatory Care	Biopsy Patient Holding X-Ray	Exam Room Mammography Procedure Room	Out-Patient Surgery Room
Women's Health	Lactation Ultrasound	Nursery	Labor/Delivery Room Infant Bay
Diagnostic/Treatment	Fluoroscopy Radiation Processing Radiograph X-Ray	Lab	CT Scanner Linear Accelerator MRI Operating Rooms Procedure Rooms Simulator
Caregiver	Exam Room Galley Soiled Utility	Charting Clean Utility Nourishment Reading Room Workroom	Nurse's Station
Service/Support		Blood Bank Pharmacy	Anesthesia
Facilities	Building Utility Room Communications/Technology Room Electrical Room Elevator Machine Room Janitor Closet Mechanical Room Specialty Storage	Fire Command	Security Office Command
Operations	Cafeteria General Storage General Office Laundry Locker Rooms Lounge On-Call Suite Retail Areas	Administration Central Sterile Conference Room	
Critical Care			ICU Neonatal ICU Recovery

While it is normal practice to gang several ports into a single outlet, ports can be spread around the area as appropriate. For example, ports for biomedical equipment can be located on each side of a patient bed, while ports for television or other ancillary needs can be across the room and at ceiling height. In operating rooms, outlets are even included in booms over the table.

Outlets in the work areas should be clearly and easily identified by function. Since most hospitals will install many separate networks — biomedical, television, phone, security, etc.— fast and easy identification is critical, especially when attaching medical equipment. The outlet jacks themselves are available color coded **(Figure 1)**, as are snap-in icons. Visual identification is essential for end users; TIA recommends additional identification to support network administrators and technicians. For operating rooms, critical care, and other areas, stainless steel faceplates are available to make cleaning and sterilization easier.

Figure 1: *Color-coded outlets allow easy port identification.*

Multiple user telecommunication outlet assemblies (MUTOAs) provide a flexible approach for areas that might experience frequent rearrangements or retrofits. These provide a centralized patching area within specific spaces that are fully accessible. Offering up to 24 ports, MUTOAs should be permanently mounted on the wall or in an architectural column. **Figure 2** shows a MUTOA. (Note that ANSI/TIA-1179 only recommends MUTOAs for retrofits, not for new hospitals).

Figure 2: *MUTOAs offer a flexible approach to providing multiple outlets.*

One possible way to simplify cabling is to run multi-fiber pairs to the work area. The fibers connect to a workgroup switch dedicated to that area. The switch then connects to the individual outlets. (Theoretically, users could connect directly to the switch, but this is a poor practice that should be avoided.) While this approach drastically cuts the number of lines running from the horizontal cross connect, it doesn't satisfy the needs of segmenting network functions, so additional cables will still be needed for building alarms, TV, and the like. Costs also need to be considered when looking at the structured cabling deployment of running all cabling homerun to the telecommunications rooms versus extending the switching fabric to the work areas. Extending the switching to the work area will also require more advanced switch management and operations. This approach is also commonly referred to zone cabling.

Cabling Best Practices for the Future

The varying cable densities underscore the importance of careful planning. In planning, be generous with the number of ports made available, especially in critical areas like patient rooms or operating rooms. The trend, due to rapidly increasing bandwidth demands, is toward more connectivity, not less. Not long ago, Fast Ethernet at 100 Mb/s prevailed. Today, it's Gigabit Ethernet, with most of the market running between 1 and 10 Gigabit. As mentioned, some hospitals are planning to deploy 40G and 100G in the core (data center) for interconnecting servers and storage.

A prudent eye toward the future means installing the best cable available. This is especially important in areas dealing with patient care, from diagnostics to surgery. These areas are the ones where sufficient bandwidth capacity must be available for tomorrow's needs.

Specifically, the following cables are the recommended choices and supported by ANSI/TIA-1179:

- **Category 6A UTP** can support 10G Ethernet at distances to 90 meters in the horizontal or 100 meters when considering the full channel (including patch cords).
- **Laser-Optimized (OM3 or OM4) Multimode Fiber** can be used both for backbone and horizontal cabling needs. For 10G Ethernet, OM3 fiber allows runs of 300 meters, while OM4 supports 550 meters.
- **Single-Mode Fiber** is typically only used where distances preclude the use of multimode fiber, such as between buildings. The cost of transceivers for single-mode fibers is significantly higher than those for multimode fibers.

The choice of Category 6A cable over Category 6 ensures you are ready for heavy data traffic today, while equipped for migration to 10G to support future networking and bandwidth needs. With continued advancement in diagnostic imaging technologies and the growth of electronic patient records, it is safe to say that bandwidth consumption and network speeds will continue to increase over time. To avoid future mitigation, it is wise to install cable based on what your bandwidth requirements will be several years from now, rather than what they are today. Category 6A cabling is the most logical choice for the future as it will ensure 10Gb/s network performance and provide enough bandwidth to fully support emerging technologies. **Table 4** shows the Category 6/6A offerings recommended by Berk-Tek to support various bandwidth requirements.

Table 4: Category 6 and 6A Offerings From Berk-Tek

CABLE	BANDWIDTH (GB/S)	DIAGNOSTIC IMAGING APPLICATIONS
LANmark™-1000 Cat 6	1.0 & 2.5	Nuclear medicine, angiography
LANmark™-2000 Cat 6	5.0	Ultrasound, MR
LANmark™-10G2 Cat 6A	10	CR and DR, CT
LANmark™-XTP Cat 6A	10	CR and DR, CT

For fiber, flexible options also exist in achieving different levels of performance. The preferred choice is 50/125-μm laser-optimized multimode fiber, which is the most cost-effective option with lower-cost electronics compared to singlemode. Laser-optimized fiber is available in two performance levels, OM3 and OM4 **(Table 5)**. The fiber bandwidth translates into the allowable distances the cable can be run.

Table 5: The Main Types of Multimode Fiber for Hospital Networks

FIBER	TYPE	TRANSMISSION DISTANCE (M) @ 850 NM		BANDWIDTH @ 850 NM (MIN.)
		1G ETHERNET	10G ETHERNET	
GIGAlite™	OM3	1000	300	2000
GIGAlite™-10	OM4	1040	550	4700
GIGAlite™-10XB	OM4+	1210	600	4900

Fiber optic cables can be run either as pairs or as multi-fiber array cables. Multi-fiber cables terminated with industry-standard MTP®/MPO (Multi-fiber Push On) array connectors simplify use of fiber in the network. The cables significantly reduce congestion in pathways, provide the highest port densities (12 fibers in a 0.5 x 0.3-inch area), and simplify system design, installation, and management. While fiber ribbon cables are popular for array connections, reduced-diameter cables, such as Berk-Tek's MDP (Micro Data Center Plenum) cable, are setting a new standard in convenience. Cassette modules, like the one in **Figure 3**, provide an easy breakout from the array cable to individual ports.

Figure 3: *Modular fiber cassettes make it easy to transition between array backbone cables and fiber pairs.*

Topologies

Structured cabling systems for hospitals use the same topologies as other applications. The most common is the hierarchical star shown in **Figure 4**. The topology defines three levels of cable distribution:

- **Main Cross Connect** (MC) is the first level of backbone cabling, serving as a termination point for incoming services and a central hub for connecting all parts of the network. The main cross connect is typically located in the equipment room, where the main servers, storage, routers, and switches reside.
- **Intermediate Cross Connect** (IC) separates two levels of backbone cable. In large installations, it is more convenient to have an intermediate cross connect feeding several horizontal cross connects. As shown in **Figure 4**, the standard does not require an IC. The IC is typically located in a telecommunications room.
- **Horizontal Cross Connect** (HC) marks the transition between the backbone cable and the horizontal cable to users. It is located in a telecommunications room or a telecommunications enclosure.

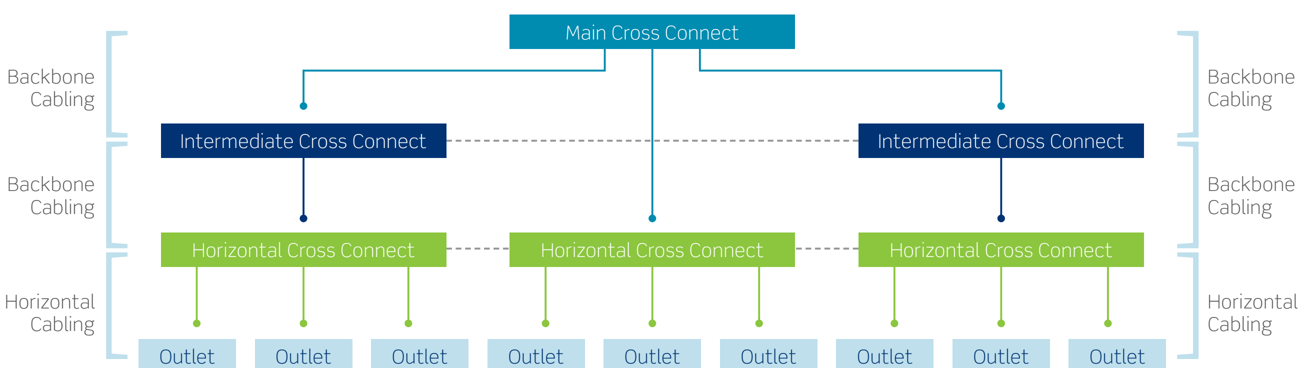

Figure 4: *Hierarchical star topology for cabling systems as recommended by ANSI/TIA-1179.*

Each level of cross connect can include active network equipment or it can simply be a transition point from one cable level to another. For reasons of flexibility and redundancy, ICs can also connect to one another directly to provide a secondary backup path.

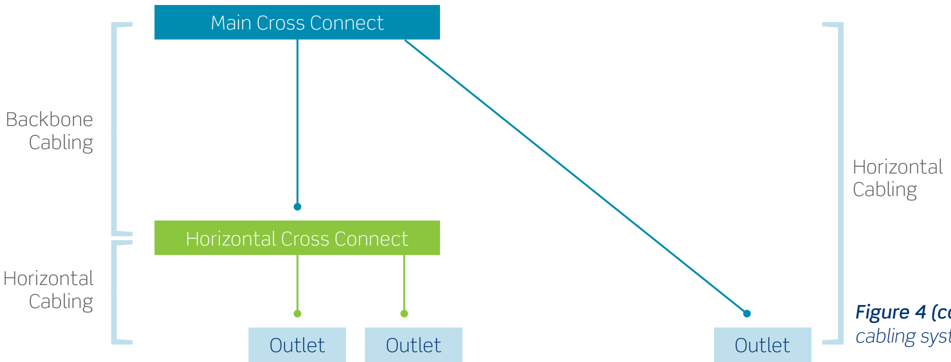

Figure 4 (continued): *Hierarchical star topology for cabling systems as recommended by ANSI/TIA-1179.*

In most hospitals, several networks will "overlay" this topology, each with its own cross connect, to keep medical and nonmedical networks separate. Different networks can also be physically separated by dividing equipment rooms into different areas. Hospital and network administrators may wish to apply a higher level of physical security to the medical network. This would prevent outside services providers, such a telephone or cable TV, from having access to the other network equipment and cabling.

Telecommunications Rooms

Equipment rooms and telecommunication rooms in hospitals are typically larger than those used in business. Be generous in sizing a room, allowing for 100% growth. Racks, patch panels, and fiber-management hardware should offer great convenience in managing the cables. This includes such issues as supporting cable vertically in the rack, limiting bend radii, eliminating any stress on the point of connection, and making it easy to make moves, adds, or changes (MACs).

The cabling density in hospital and other health care applications and high-density servers mean that racks need to accommodate both more equipment and more interconnections. High-density cross connects allow for cable management while conserving space. In designing for high-density configurations, look for racks and cabinets with generous cable-routing capabilities on both the front and the back. Deep management channels not only accommodate a larger number of cables, they also make them easier to manage—such as tracing an individual cable or adding new cables.

Choosing the right rack and cable pathway components can save money in the long run. Make sure racks and trays can handle future weight requirements. A fully loaded enterprise-level switch can weigh 700 pounds. While a two-post rack might be fine for patch panels, a four-post rack is the better choice for equipment

Pathways

Consideration of the special needs of the hospital must be made when routing cable from the entrance facility to the user outlet. Because of the critical nature of the many applications, redundancy is often built into the systems, with more than one pathway delivering cables to work areas. Similarly, segregating cables by application and network function is advisable. Spaces for running cable in hospitals can be at a premium since cables must share space with gas delivery, pneumatic tubes, and other needs that distinguish medical facilities from other buildings.

Infection control requirements are an additional concern in routing cable. Sophisticated air filtering and area segregation cannot be compromised by the cabling system. The need to avoid atmospheric contamination may require special cables with filled or blocked construction and low-gassing materials. Infection control policies may limit access to the cabling system for MACs in sensitive areas. These policies may, for example, forbid deployment of patch cords from one area of the hospital to another for safety reasons. Other policies may place strict rules limiting access to the pathways (plenum spaces for example) for reasons of health and safety. Thus, even lifting a ceiling tile may require careful scheduling.

High-voltage wiring and highly sensitive gases and fluids will be encased in closed conduits in their pathways. Therefore, open cable trays offer a clean and convenient way to route low-voltage communications cable through pathways. They prevent accumulation of debris during and after installation, and the open structure makes it easy to ensure correct separation of cables by visual inspection.

Electromagnetic Interference

Electrical noise must also be figured into the cable and pathway design. Some equipment used in hospitals, such as MRI machines, can generate high magnetic fields that translate into electromagnetic interference (EMI). Whatever the source, EMI must be dealt with to preserve signal integrity on cables. At the least, EMI can cause excessive retransmission of data which can slow the network to a crawl and significantly reduce its overall effectiveness.

EMI can be reduced in several ways:

- **Shielded Cable:** Shielded cables are an excellent way to reduce the effects of EMI and have gained acceptance in the healthcare field and other environments.
- **Optical Fibers:** Fiber is inherently immune to EMI, allowing it to be run close to noise sources.
- **Rerouting:** Radiated EMI reduces with distance, so routing cables away from noise sources is advisable.
- **Shielded Conduits:** Pathways themselves can be shielded to isolate the cables.
- **Shielded Rooms/Equipment:** The noise-inducing equipment itself can be shielded, either at the equipment or room level. Similarly, areas with very sensitive monitoring needs may be shielded from their surroundings. Some rooms, such as those involved in epilepsy monitoring, are RF shielded and all cables into the room pass through an EMI filter.

Look to the Channel, Not the Parts

In the end, it is not the performance of individual components that is important, but the end-to-end performance of the components working together — the channel. Theoretically, you should be able to mix and match components from different vendors — cable from vendor A, connectors from B, patch panels from C — and have no problems. This will work much of the time, but buying a system has three distinct advantages: it ensures performance headroom, it includes a healthy warranty, such as the limited lifetime warranty offered by Berk-Tek Leviton Technologies, and it gives you peace of mind by having a single source ready to support the cabling system.

Look for systems that have performance claims verified by an independent testing agency. The system should provide adequate headroom above the standard. Headroom equals peace of mind. Over time and many MACs, inadvertent tight bends, or rough handling of patch cords, the cable system's performance can degrade somewhat. Headroom is the extra margin that ensures your network operates at peak performance for years to come.

A system-level approach does not mean a single vendor who offers everything. It means that all the components are designed and tested to optimize performance. The Berk-Tek Leviton Technologies system, for example, is an alliance between Berk-Tek, a Nexans Company, for cable and Leviton for connectors and cable management hardware. A close partnership between companies allows each to lend its expertise in achieving system performance and providing systems with guaranteed headroom.

Conclusion

The network infrastructure in a healthcare facility is unique in both its requirements and its significance. In a healthcare facility, an underperforming network has more than just customer service or financial implications — it could inhibit critical patient care.

More than ever, healthcare infrastructures are burdened by exploding data storage, stringent security regulations, and ever-increasing bandwidth requirements. These challenges will only grow as technology continues to advance. Your cabling infrastructure, from racks and cabinets to cable and connectors, must not only meet today's needs, but those evolving on the horizon.

BerkTekLevitonTechnologies.com

Build your high-performance networks with Berk-Tek and Leviton, two of the most innovative, reliable, and service-oriented names in the industry. Berk-Tek cable and Leviton connectivity combine to create the industry's premier copper, fiber and AV, end-to-end solutions.

Berk-Tek has spent the last 50 years maximizing the capabilities of cabling systems. This focus has enabled the development of innovative cabling that addresses the particular needs of enterprise, campus and data center networks, including high-speed transport, high-density installations and rapid deployment.

The products offered by Berk-Tek lead the industry in performance, reliability and robustness. Independent verification to product specifications, not just industry standards, offers customers an added level of certainty of the quality being delivered.

For the past quarter century, Leviton Network Solutions has engineered and manufactured copper and fiber optic connectivity products for enterprise, data center, government, education, health care and residential markets around the globe.

Leviton manufactures nearly all of its branded products in company-owned, ISO 9001-2008 certified facilities located in the United States. All Leviton products are engineered to exacting standards, offer industry-leading performance and are backed by the industry's best service and support. That's what makes Leviton the smart choice for a better network.

Berk-Tek Corporate Headquarters
132 White Oak Road
New Holland, PA 17557 USA
800.237.5835
berktek.com

Leviton Network Solutions
2222-222nd Street S.E.
Bothell, WA 98021 USA
800.722.2082
leviton.com/ns

G15 5616

Released July 2015

Customer-focused, technology-driven, quality-assured
for unparalleled return on infrastructure investment

For questions about this paper or to get more information, please contact:
Susan Larson (Susan.Larson@nexans.com or **Melissa Janecka** (MJanecka@leviton.com).