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PLUS

+ Migration to High-Speed Ethernet
+ DAS in Your World
+ Planning Health Care Infrastructure
+ Fiber Considerations for 100 Gig

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Planning Health Care Infrastructure

A TOP 10 CHECKLIST

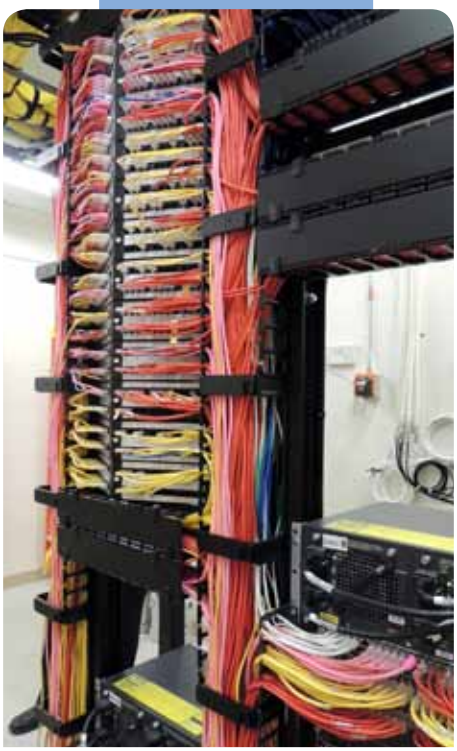
Picture this. You are a patient in a newly built, ultra high-tech hospital. You are hooked up to a heart monitor. All of a sudden you see a flat line, but you are still alive. You press the nurse call button, but there is no response. The IV stops dripping. The bedside computer with your medical records goes blank. This is not a scene from a science fiction film. In reality, the hospital network just crashed.

by Carol Everett Oliver, RCDD, ESS

Hospital networks are critical because lives are at stake. You do not want to be a patient stuck in a hospital bed when the network goes down. Even more important, you do not want to be the IT manager that was responsible for designing, installing and managing that network. As the IT manager or infrastructure consultant in health care, it is important that you have designed and implemented a fully fault-tolerant hospital network. The foundation of this core network needs to be run over a highly reliable cabling infrastructure.

Due to Internet protocol (IP) convergence with many applications and systems being connected by an Ethernet network, today's hospital network includes more than just data and voice applications. It is now "one cable" for all applications, including patient tracking, physiological monitoring, dispensary tracking and refills, digital signage, paging, wireless and nurse call systems, just to name a few. Today, industry standards are emerging to aid IT managers in the design of a converged health care network and infrastructure. The TIA-1179 *Healthcare Facility Telecommunications Infrastructure Standard* supports a wide range of health care facilities and provides guidelines and cabling best practices, including topology, pathways and spaces, cable types and work areas. The IT manager and structured cabling consultant finally have a concrete document to bring to the meeting table with the engineers and architects when planning a new health care facility or conducting renovations in an existing building.

Soon to be published is the BICSI-004 standard, *Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities*. This document addresses specific health care subsystems, such as nurse and code call, medical imaging, telemetry, patient TV, alarm management and other unique health care applications. This standard will provide an overview, system architecture, telecommunications room (TR) requirements and different communications interfaces. It expands beyond typical structured cabling to address these individual system requirements.



Because of the diverse applications in a health care facility, it is recommended that the cable be color coded and terminated to its dedicated active equipment.

Matt Odell, RCDD, rechecks cabling in the new operating room at Johns Hopkins Hospital in Baltimore, Maryland.

Together, these two standards become vital, not only to IT managers, but architects, engineers, consultants and contractors, especially as the health care industry shifts towards total electronic medical records (EMR) by the year 2015. To understand the unique challenges in a health care building and the cabling infrastructure needed to meet those challenges, this article presents the top 10 concerns, myths and ultimate checklist for the IT manager or cabling consultant.

1. DESIGN WITH TECHNOLOGY IN MIND

No one can be expected to accurately predict all the technology needs and applications for the future, but as a first step, a good IT manager assesses the requirements of the facility and the users to define the statement of work. Interviewing users will provide a comprehensive understanding of network applications to be implemented in the facility. Some of today's applications have large bandwidth requirements, such as the picture archiving and communication system (PACS) software used for magnetic resonance imaging (MRI) and other types of diagnostic imaging applications. It is important to identify the data requirements for handling these applications, as well as EMR systems that also include bandwidth-hungry applications. This will help avoid possible network

A special radiology unit at Johns Hopkins Hospital features copper-lined walls to act as an RF shield and optical fiber cable for resistance to electrical interference.

The right cable should be matched to the environment. For example, the operating room booms require a flexible network cable.

bottlenecks that could occur by prioritizing network traffic needs. To support these diverse applications, think about the requirements needed for running separate virtual local area networks (VLANs) and determine if both logical and physical separation should be included.

2. KNOW YOUR BUDGET

Funding of health care projects may come from various sources—the public sector, health organizations (profit or nonprofit), health insurance companies, religious orders or charitable donations from companies or individuals. The budget for the IT infrastructure will be dictated by the total project budget. Prioritizing the network needs should be done during the design process. Crafting an IT budget is an art and is based on detailed research on the needs of today, as well as trying to predict future needs and applications.

"During the design phase for the new Johns Hopkins Hospital, we researched cabling and connectivity types and knew that there were technologies on the horizon, such as OM3 50-micron multimode optical fiber," observes Matt Odell, RCDD, former project manager for Johns Hopkins Hospital and current director of health care technologies at Clark Construction Group. "To plan for this, we made sure that we would have the money for the cabling and the electronics, and waited almost until the end of our installation to purchase the switches. We certainly did not want to be out of date before we even moved into the building."

3. SELECT THE CABLING INFRASTRUCTURE TO HANDLE THE TECHNOLOGY

As mentioned previously, IP convergence means that disparate applications all reside on the same network. It is therefore important to understand the bandwidth and transmission speeds required to run these systems and then select the appropriate cabling. For example, if an MRI file is 60 gigabytes (GB) and is running over a 1 gigabit per second (Gb/s) system such as 1000Base-T over category 6 copper cabling, it would take almost three minutes to access that file. However, if a 10 Gb/s system using 10GBase-T over category 6A cabling is installed, the time would be reduced to less than 20 seconds.

Thinking of future network requirements would certainly warrant looking for the best and fastest cabling system available today, but could be inhibited by other factors such as the space, longevity of the facility, ease of installation and, of course, budget. TIA-1179 recommends category 6A for all new installations. However, sometimes that is not feasible due to pathway and work area constraints.

Look at all the options. If category 6A cannot be implemented in a new environment, look at an enhanced category 6 cable offered by reputable manufacturers that performs above current TIA-568-C electrical specifications and provides additional headroom for future applications.

4. MATCH THE CABLING TO THE ENVIRONMENT

Sometimes it is not feasible to select just one cable type as the only solution for all applications. The environment in which the cable will be run and terminated may dictate the cable type. At the new Johns Hopkins Hospital, the network department was faced with coming up with some creative cabling for many unique areas. For example, in the radiology room, equipment that emits electri-

cal interference would greatly impact the performance of the copper cable. A special radiology unit was installed with copper-lined walls as a radiofrequency (RF) shield around the room to protect sensitive monitoring equipment. In this case, a 12-strand optical fiber cable was installed through a special electromagnetic interference (EMI) filter terminated to a dedicated switch. The elevator cable consisted of four strands of optical fiber installed in the traveler cable, which allows connection to security cameras, electronic bulletin boards, wireless access points (WAPs), and even robot tracking within that space. In the operating room, optical fiber cable was selected to be used for both data and transporting audiovisual (AV) signals out to other medical facilities through a wide area network (WAN) for teaching purposes.

Category 6A shielded copper cable is another option. At a gene research facility in Florida, the network manager selected Category 6A foil twisted-pair (FTP) for the horizontal cable supporting all data and video applications. This shielded cable was selected mainly because of the bandwidth needed for genomics and imaging research, but also for ultimate data protection against signal interference. Providing 10 Gb/s to the lab bench is on their horizon as they are already generating half a terabit (Tb) of imaging per day. Also, because this facility is rated a Biosafety Level 3 (BSL3), they wanted to be guaranteed that the cable that they installed today would last 20 years as recabling would be very costly due to the stringent safety requirements when working in a BSL3 environment.

5. DETAILED SPECIFICATIONS AND DRAWINGS

During the schematic design phase, all general installation methods and materials for the systems should be identified and documented for the construction documentation, which will be used for bidding and installation purposes. It is important to coordinate with the architects and all other disciplines to ensure that everyone is on the same page so that there are no surprises at the job site.

There is no such thing as overdesigning when it comes to the needs of a health care environment. Hospitals are built to last 50 years or more, and these drawings become the architectural records needed for future renovations and upgrades. As changes propagate, the network documentation should be

Cable pathways in a health care environment share space with other systems, such as HVAC, gasses and electrical services.

continually updated to show the exact configuration of the network topology.

6. HIRE ONLY PROFESSIONALS

It is important to hire consultants such as BICSI Registered Communications Distribution Designers (RCDDs) and mechanical, electrical and plumbing (MEP) professionals who are familiar with installing in the health care environment. These people have the experience to help with the design and budget. Bring in these professionals at the very beginning and make sure to work with them throughout all the phases—from design, specification, budget and bidding, to installation and commissioning. You might also want to hire a different firm for the commissioning (see checklist item #10).

Make sure the professionals that you hire are aware of all the stringent codes in a health care environment, especially the Biosafety Levels (1-4) for Infection Control Requirements (ICR), as defined by the Center for Disease Control and Prevention. These Biosafety Levels classify low-to-high risk isolation of dangerous airborne pathogens, also known as aspergillus, that could be fatal to patients within the facility that have lower immune systems, such as cancer patients going through chemotherapy. Most hospitals today have aspergillus training for onsite consultants and contractors.

To obtain the manufacturer's warranty for the cable installation, you will need to hire a cable contracting firm whose installers have been certified by that cable or connectivity manufacturer and who take all proper steps to assure that the installation meets their warranty policy. Work with the cabling system manufacturer to select a qualified installation company.

7. MAKE SURE YOU HAVE ADEQUATE REAL ESTATE

During the design stages, it is imperative to make sure that your equipment rooms and TRs will be large enough to handle the cable, termination equipment, electronics and power for today's applications and also allow for 100 percent future growth. The TIA-1179 standard lists a minimum size of 12 square meters (m^2 [130 square feet (ft^2)]) for TRs. The upcoming BICSI-004 standard actually provides schematics for two types of TRs to accommodate and separate all systems and to protect the core data network.

"You can never have too much space allotted for your TRs," notes Odell. "On the clinical floors of the new Johns Hopkins Hospital, the core IDFs, or TRs, were sized at 12 ft x 15 ft, which could hold four racks. Because everything is shifting to IP, all these cables need to be terminated to corresponding network gear."

8. IDENTIFY THE OTHER SYSTEMS IN THE PATHWAYS

In addition to the low-voltage cabling running through the pathways, there will be other shared systems such as heating ventilation and air conditioning (HVAC), liquids, gasses, electrical and lighting. In many hospitals, there is often a pneumatic tube system to deliver blood samples. Allow for enough separation between these services and your network cabling. Most of the other systems will run through conduit, allowing low-voltage cabling to run separately in cable tray or through J-hooks. Color coding of separate applications is also recommended to provide easy identification for future moves, adds, or changes (MACs).

9. REALIZE THE PROS AND CONS OF WIRELESS

The days of prohibited cell phone usage in hospitals are over. Today's medical professionals now use smart devices like cell phones and tablets that require wireless systems, including WAPs or a distributed antenna system (DAS). However, every time a WAP is added, the bandwidth for that network is divided.

Most wireless systems require a hard-wired cable to each WAP. At a hospital in Cincinnati, Ohio, the network department was tasked with recabling their entire backbone from multimode optical fiber to single-mode optical fiber due to the bandwidth requirement of the DAS they were implementing.

10. FOLLOW A COMPREHENSIVE COMMISSIONING PLAN

In construction, everyone is familiar with the saying, "measure twice, cut once." This is applicable when checking and rechecking all the systems and network before moving anyone

With IP convergence, many applications are running over one cable. Pictured here is an IP-based security camera running over Category 6 cable at Johns Hopkins Hospital.

into a facility. Commissioning is often one of the most neglected aspects of the infrastructure installation. A system that is properly tested and commissioned will ensure that the network and subsystems achieve the project requirements as designed by the architects and engineers.

Most commissioning procedures are documented in the organization's internal standard, which is a living document that is constantly updated to keep up with new technologies. At Johns Hopkins Hospital, their *New Clinical Building Commissioning Guideline* maps out all installation procedures for mechanical, electrical, plumbing and low-voltage systems.

"The commissioning process actually takes place at the start of construction and continues after all the cabling has been installed," says Odell. "Since there were other services, such as lighting, that were installed after the low-voltage cabling, we had to recheck all the cable pathways and connectivity to make sure that everything remained to code and follows the best practices outlined in the most recent version of the BICSI *Telecommunications Distribution Methods Manual* to a T."

Odell adds, "Johns Hopkins has an expert internal IT team but also supplemented with outside RCDDs. They went through a very rigorous inspection process that lasted more than a year after the last cable was pulled to inspect, re-inspect, test and retest and then record all the copper and optical fiber cabling test results on CDs."

GET IT DONE RIGHT

The last words an IT manager wants to hear are "the network is down." Planning and implementing an efficient network is essential to any business. But in a health care facility, it becomes the most critical undertaking. Building a reliable health care network is important to the total operation of every department and affects every person in the hospital—from doctors to clinicians to patients. This article merely scratches the surface of what is involved for IT managers in planning a health care network, but it does provide a good base for planning the infrastructure. There are many other facets involved in network planning, such as allotting power and cooling. "We did our power and cooling budgets after we put in the active equipment because you have to make sure that you have ample services, and with each new version of switches comes additional power requirements," notes Odell.

Each health care location is unique and has its own requirements based on the services they are providing. These services can vary from a small outpatient doctor's office to a full-scale hospital. One thing is certain—IP convergence is prevalent in the health care environment and IT managers are challenged to design a network that will handle all the diverse applications today while acting as fortune tellers in trying to predict the requirements for the future. END