by Carol Everett Oliver, RCDD, ESS

CRITICAL

Infrastructure Planning for Today's Health Care Facilities

System designers, consultants and IT managers who have faced the challenges of unique application and pathway challenges in a hospital environment attest that there are many differences compared to planning a premises network for an office facility.

"Our ceilings and pathways are congested and highly protected. Our facility is very old and we have no room for more telecom closets. Our files are intensively graphical and are choking our network bandwidth."

These are the very real challenges heard from health care consultants and information technology (IT) managers in their constant pursuit to stay ahead of technology in the health care environment.

Over the last decade, emphasis in the health care environment has shifted from applying computer technology for administrative purposes to applying technology to the entire clinical process. With the advent of constantly changing technology driving systems to use Internet protocol (IP), the network infrastructure becomes the essential vehicle to transport all data, video and voice functions within the confines of one hospital or out to a multitude of facilities worldwide. From universal electronic health records (EHR) to real-time telemedicine, the network must reliably deliver this information faster and quicker than ever before.

Health care facilities are built for longevity. But, many buildings designed 50 or more years ago are currently inadequate in delivering technology in today's health care environment. To meet increasing demands placed upon them, modern health care institutions must retool and rebuild. Unlike their monolithic predecessors, new health care institutions have diverse master plans, specialized centers devoted to inpatient and ambulatory services, research and education facilities and satellite facilities serving the varied needs of large populations.

To support this paradigm, as well as emerging technologies in the hospital environment, there are expanding government initiatives to promote health care information technology (HIT) and new cabling standards to address the physical infrastructure. But, what are the roadblocks faced by health care IT managers, and what are the solutions provided by consultants and designers of these facilities?

Government Initiatives

Virtually everyone is familiar with the Health Insurance Portability and Accountability Act (HIPAA) privacy form that is signed at every doctor visit. Initiated in 1996, HIPAA was formed by the Department of Health and Human Services (HHS). It was the first government ruling to set national standards addressing electronic records and patient

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Photo courtesy of Memorial Sloan-Kettering

A recently renovated state-of-the-art OR at Memorial Sloan-Kettering in NYC is equipped with multiple workstation outlets for various network applications, including video displays for patient monitoring and telecast.

privacy. This Act also opened doors to encourage the use of data interchange through EHR systems.

In 2005, the Office of the National Coordinator for Health Information Technology (ONCHIT) within HHS was established to promote the development of a nationwide interoperable HIT harmonization process. This includes full digital records for hospitals and providers, fully computerized diagnostics, research and education and total integration of providers, billing and systems.

In 2009, the Health Information Technology for Economic and Clinical Health (HITECH) Act was enacted as part of the American Recovery and Reinvestment Act (ARRA) to use HIT to move the U.S. health care system to broad adoption of standards-based EHR systems on a national basis. The HITECH Act provides incentives for entities to adopt EHR and widens the scope of privacy and security provisions of HIPAA. The goal of ONCHIT and the HITECH Act is to have 100 percent of health care facilities implement EHR systems by 2015.

The use of technology for clinical decision support, combined with

Miles of files at health care facilities are being replaced with electronic health records.

health information exchange, can improve patient care and lower health care costs nationwide by facilitating communication, coordination and collaboration among health care providers. EHR systems can provide many benefits for providers and their patients:

- ***Complete and accurate information***—Providers can obtain all the information they need through their PC to provide the best possible care. Providers will know more about their patients and their health history before they walk into the examination room.
- ***Better access to information***—EHRs facilitate greater access to the information that providers need to diagnose health problems earlier and improve the health outcomes of their patients. EHRs also allow information to be shared more easily among doctors' offices, hospitals and across health systems, leading to better coordination of care.
- ***Encourage patient education***—EHRs will help empower patients to take a more active role in their health and in the health of their families. Patients can receive electronic copies of their medical records and share their health information securely over the Internet.

Two additional regulations have been released to aid in EHR deploy-

ment. One defines the "meaningful use" objective that medical providers must meet to qualify for incentives and bonus payments, and the other identifies the technical capabilities required for certified EHR technology.

To implement EHR within a health care facility, computerized provider order entry (CPOE) systems are being deployed on the network. CPOE is the process of electronic entry of medical practitioner instructions for the treatment of patients. These orders are communicated over a computer network to the medical staff or to the department (i.e., pharmacy, laboratory or radiology) responsible for fulfilling the order. CPOE systems reduce medical errors and improve health care quality and efficiency.

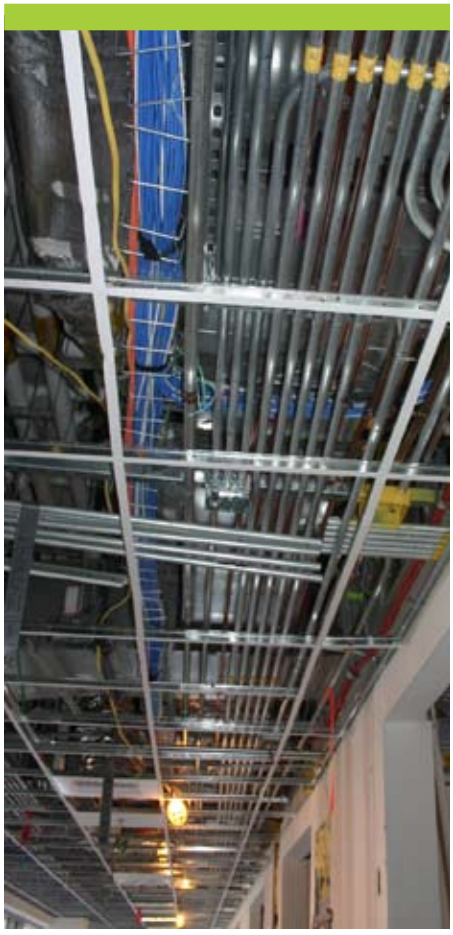
Health Care Network Challenges and Best Practices

"As HIT continues to grow and evolve, many new technologies will apply increasing pressures on the physical building infrastructure of health care facilities," states Gregory Roberts of New York City-based AKF Group LLC, a major design firm. Health care networks will expand exponentially and face the challenges of managing diverse information such as patient records and bandwidth-intensive medical scans and diagnostic information. The amount of data that must be created, transmitted, managed and stored will increase dramatically.

In addition, regulations requiring high levels of data security to protect patient privacy, combined with back-up systems to prevent network failure, add an additional layer of complexity to information management. "Today's health care facilities must offer fully redundant, fault tolerant mechanical systems, conditioned, uninterruptible electrical systems and dependable telecommunications pathways, spaces and cabling systems to support sensitive electronic systems and networks," adds Roberts.

Each hospital environment is unique and creates its own set of challenges and network priorities. Some infrastructure concerns when planning network implementation include:

- ***Protected pathways***—Data cables may need to be separated from other services, such as gases and liquids, that may share the same above-ceiling spaces. In addition, pathways must be firestopped to eliminate the spread of fire, as well as protect clean air.
- ***Bandwidth and data storage***—MRI files and other advanced medical imaging files, such as Picture Archiving and Communications Systems (PACS), are bandwidth intensive. In addition to transmitting these files, networks also need to provide long-term data storage, which can vary from as little as seven years up to a lifetime. This will translate to constant additions of servers and storage area networks (SANs) to these facilities.



Horizontal cable in health care environments often share pathways with conduits containing gases and fluids.

- ***Telecommunications Rooms (TRs)***—As more IP-based devices are being added to the network, telecommunications rooms (TRs) must be sized by number of applications, not necessarily by the number of users or floor size that it serves.
- ***Outlet densities***—The number of outlets and cables per area will also depend on the amount of applications needed to be accessed at that workstation area.

The following two examples provide a real-world look into designing an efficient network for health care and insight on how these two different facilities are addressing challenges.

Johns Hopkins Hospital

An example of a comprehensive design for a new build is the 12-story Johns Hopkins Hospital in Baltimore, Maryland, which is replacing a 50-year-old facility. Scheduled to open in 2012, this 1.2 million-square-foot "megaplex" incorporates total redundant pathways and cable runs (both backbone and horizontal) and several back-up dedicated optical fiber runs. Their 40 gigabit (Gb) network core will serve all IP-based network applications that extend beyond data and voice, including community antenna television (CATV), audiovisual (AV), security, distributed antenna, nurse call, patient monitoring and a real-time location system. Every piece of data is backed up in several on-site and off-site data centers, and files will be archived for 21 years. In addition, there are two back-up UPS systems for each of Johns Hopkins' 48 TRs.

Each area within the new facility had to be uniquely designed according to the specific requirements of the IP applications in that area (e.g., patient room, operating rooms, lobby). For example, eight work area outlets were needed in the patient rooms whereas 38 were installed in operating rooms. For power service and protection, Johns Hopkins owns and operates two power plants to generate main and back-up power for their 50-building campus.

The new 1.2 million-square-foot Johns Hopkins Hospital in Baltimore will replace the adjacent 50-year-old facility.

Within the new hospital, the pathway system includes an intricate ducting system for all fluids and gases, which is separated from the cable tray used for the horizontal communications cable that consists of enhanced category 6 cabling for all for data, voice, video and other ancillary applications such as patient and equipment monitoring.

"Every step we have taken to ensure that this installation ran smoothly and in an organized manner will help in ensuring long-term care of our network and our patients," states Matthew Odell, project manager for the Johns Hopkins Hospital IT Department.

Tift Regional Medical Center

Another example of proactive network planning for a health care environment is the construction of a new data center for the Tift Regional Medical Center, located in "tornado alley" in Tifton, Georgia.

"Previously, there was only one multi-strand optical fiber cable that connected the entire campus to the main network, which was located in a former doctor's office," explains Jonathan Ouzts, RCDD, structured cabling project manager for Tifton-based CooperCraft Communications. After a few spotty power outages and cooling issues, the medical center knew the situation had to be rectified by designing a new highly-reliable data infrastructure. Backed by the board of directors and a tech-savvy IT department, a 15,000-square-foot data center with CPOE systems will open this summer.

Health care networks require reliable data storage. Pictured in the new Tift Regional Medical Center data center are Wade Brewer, director of technology, and Guy McAllister, assistant VP and CIO.

"It takes a vision and a lot of collaboration for a project of this size; but, when you are serving 12 counties with 250,000 people, the network and technology becomes the heartbeat of the hospital," explains Guy McAllister, assistant vice president & CIO for Tift Regional Medical Center. The installation included a total redundant optical fiber ring using 72 singlemode optical fibers to two separate main distribution frames (MDFs). All of the connectivity in the data center uses OM3 50-micron multimode optical fiber terminated in redundant networks.

"With the current five-row layout of server cabinets, which each house

Jonathan Ouzts, RCDD, structured cabling project manager for CooperCraft Communications, checks the cable termination in the new Tift Medical Center 15,000-square-foot data center due to open this summer.

The TIA-1179 standard brings attention to separating cables by application, as shown here in the new Tifton Medical Center.

At the Shapiro Building, Boston Medical Center's new nine-story outpatient facility, Broadway Electrical Company installed self-closing sleeves for the cable pathways that provides fire-stopping and allows the cables to be easily placed inside.

two edge switches, our field-terminated anaerobic terminations totaled 5,088," comments Ouzts. "In addition, there are a total of 1,060 enhanced category 6 cables within the data center, including runs to the administration offices within the building."

"We have 15 10-gig Ethernet ports on each switch for a total of 200 10-gig ports, which is comparable to a large-scale national data center," adds Wade Brewer, NECC, NCTS, NCSS, ACA, director of technology for Tift Regional Medical Center. As a result, Tift Regional Medical Center's data center is rated as Tier 2 due to total redundant cabling, connectivity, power and cooling and achieves N+1 redundancy with future expansion plans to double its size.

Prescribing Cabling Standards

System designers, consultants and IT managers who have faced the challenges of unique application and pathway challenges in a hospital environment attest that there are many differences compared to planning a premises network for an office facility. The main difference in designing a network for a health care facility versus an office is application dependency. This affects all aspects of the cabling infrastructure including pathways, cable types, terminations and the size of the TRs.

Previously, building architects, infrastructure designers and installers relied on two publications to help in the planning of the network cabling for these facilities—the TIA suite of generic industry building standards such as ANSI/TIA-568-C and ANSI/TIA-569, and the CSI MasterFormat®, which is a standard for organizing specifications and other written information for commercial and institutional building projects in the U.S. These standards provide basic guidelines, but do not specifically address the unique requirements of health care facilities.

In 2010, TIA published the ANSI/TIA-1179 *Healthcare Facility Telecommunications Infrastructure Standard* that builds upon existing TIA standards to aid in the planning and installation of a structured cabling system for health care facilities and buildings. While recommending a star topology as found in ANSI/TIA-568-C.0, this standard establishes performance and technical criteria for various cabling and connectivity configurations and takes into account the diversity of the many different health care applications and areas.

TIA-1179 recognizes that there will be more applications and systems supported in equipment rooms (ERs) and TRs and therefore recommends that these areas should be planned to be larger than found in typical office buildings.

"In hospitals, the TR should be dependent on the densities of applications on that floor," remarks Michael Ritchken, senior principal of MTM Technologies, Inc., a national IT consulting and integration firm

located in New York City. "Each area should be a custom design according to the applications within that space." Many older hospitals are struggling to find room for TR expansion, especially since that might mean having to remove beds or other patient areas. In older hospitals, the use of multi-user telecommunications outlet assemblies (MUTOAs) can be considered as an intermediate connection. Another option is the use of centralized optical fiber cabling, bypassing an interconnection.

As for pathways, the TIA-1179 standard brings attention to separating cables by application. In the general requirements section, it also addresses unique environments that will affect the cable type and installation procedures. This includes being aware of high levels of electromagnetic interference (EMI), which are found in radiology labs. There are also regulations that apply to infection control requirements (ICR), which can impact cable installation and placement.

Recently, Boston Medical Center constructed the new Shapiro Center, a nine-story research and outpatient facility that required self-closing sleeves for the cable pathways. "Our biggest challenge was providing a smoke, fire and pathway barrier. During installation, we had to allow for larger riser sleeves that provided firestopping yet allowed the cable to be placed inside and the sleeve to be self-closing," explains Bernie Kamp, project manager with Broadway Electrical Company, the installation firm for the Shapiro Center. "In addition, all of our workstation boxes are acoustically sealed, not only for fire protection, but for sound and air protection as well."

The new TIA-1179 standard also recognizes that work areas vary depending on the classification of health care areas such as patient services, emergency and operating rooms. Therefore, the outlet density will also vary according to the applications needed. The standard provides a general guideline chart for each health care area and categorizes outlet density as "low" (2 to 6 outlets), "medium" (6 to 14 outlets) and "high" (more than 14 outlets).

Photo courtesy of Memorial Sloan-Kettering

The renovated patient rooms at Memorial Sloan Kettering include networked patient monitoring systems.

Backbone and horizontal copper and optical fiber cable types are also specified. For backbone cabling, 50-micron laser-optimized multimode optical fiber, also known as OM3 optical fiber, is recommended. For horizontal cable, the standard recommends augmented category 6 cabling for all new locations. In addition, to identify and segment all the IP-based applications, this standard suggests color-coding of cables and corresponding ports. Although there is no exact color scheme mentioned in the standard, Odell from Johns Hopkins recommended and installed blue cable for data, white for telephone, yellow for physio monitoring, green for TV and orange for nurse call and the real-time location system.

While the TIA-1179 standard provides basic cabling guidelines for health care facilities, it does not delve into any specifics on the network requirements of each unique system or application. Currently a standards committee within BICSI is working on drafting the ANSI/BICSI-004, *Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities*. This standard will address the many different health care communication systems and provide guidance on the coordination between design and construction disciplines. Scheduled for publication in 2012, BICSI-004 will complement the TIA-1179 standard. It will not address cabling types, densities or pathways but will focus on the diverse health care systems.

Information technology systems (ITS) are expanding beyond data and voice applications. As more IP-based devices and unique applications are becoming attached to the network, more education and sharing of expertise are needed. Health care has been identified as one of the fastest growing industries. As health care IT personnel and CIOs face the daunting challenges of managing huge amounts of data being transported, managed and archived on their networks, combined with the constant influx of disparate IP-based applications and having to adhere to unique government regulations and certifications, they are turning to organizations like BICSI to provide education and resource sharing. They know that a healthy network is mission critical when it comes to serving their customers. ■

Keeping a Pulse on Network Changes

The oldest and largest private cancer center, Memorial Sloan-Kettering Cancer Center (MSKCC), has devoted more than a century to patient care and innovative research, making significant contributions to new and better therapies for the treatment of cancer. Today, the Center has more than 11,000 employees, including 804 attending staff spread amongst the seven buildings in Manhattan that make up the main campus, and 11 regional and offsite facilities.

Ongoing construction and renovation defines MSKCC as they strive to provide the most technologically advanced treatment for their patients and keep up with trends in the industry. "There is an interesting trend at MSK to increase the number of outpatients to inpatients," says James Kelly, who has been with the MSKCC's Information Systems Department for 19 years. In keeping up with that trend, MSKCC recently renovated an old operating room floor in their main Memorial building to update the equipment and create 14 state-of-the-art operating rooms (ORs). Each OR is equipped with 10 telecommunications work area outlets, as well as video equipment to record each surgery and display it on flat screen monitors for teaching purposes at the hospital and abroad. Referred to as the Wall of Knowledge, these multiple displays also allow physicians and staff to access and view patient records, as well as check vital statistics.

MSKCC also has been renovating in-patient floors, which include patient rooms and nurses' stations. In addition to data and voice, there are patient monitoring systems, including ventilating systems that are IP-based applications operating through proprietary hardware. However, all the systems are tied to the same network through the use of virtual LANs (VLANs).

The staff at MSKCC utilizes hands-free, wireless communications devices that hang around their necks. It operates as both a paging system and a two-way phone complete with messaging capability, and it is tied to the network. "Because of this technology and the need to prepare for personal digital assistant (PDA) wireless access for doctors to access patient records and transmit files, we have doubled our wireless access points in the ceilings, which also doubles the amount of connectivity in the TRs," notes Kelly.

For every new project or renovation, contractors follow an internal MSKCC IT Standards Document created by Kelly and the Information Systems Department staff that details all products and installation procedures to keep the infrastructure consistent. In the main campus, there are two main distribution frames with diverse optical fiber-connections for total redundancy. MSKCC has upgraded its optical fiber backbone from 12 singlemode and 24 multimode optical fibers to 24 singlemode and 12 multimode optical fibers, primarily because the new switches run over singlemode. Prior to their Voice over IP (VoIP) system, the Center ran four category 6 cables to each outlet. Today, each workstation outlet contains two cables that are specified as a premium higher-than-standards category 6 cable. The size of the TRs on each floor corresponds to the needs of that floor, which are reviewed by the Information Services Department. The cable is color-coded white for phone, blue for data, yellow for patient monitoring and green for nurse call.

MSKCC is also striving toward total EHR over their existing network and is about 75 percent complete. "Even with the addition of IP applications and connections, and with instituting campus-wide electronic health records that has put our network to the test, the infrastructure that we installed six years ago is a testament to our own cabling standards," explains Kelly. "We've had to upgrade switches and servers, but our cabling infrastructure is solid."

James Kelly, senior project manager for the IS Department at Memorial Sloan-Kettering Cancer Center in New York sized the TRs on each floor to correspond to the needs of that floor.

At Memorial Sloan-Kettering Cancer Center, the telecommunications cable is color coded blue for data and white for voice.

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