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HOW SMART PLANNING AND CABLING CAN SHAPE A SUCCESSFUL HEALTHCARE FACILITY

New product designs are the prescription to a healthy telecommunications room.

By Mitch Cohen, RCDD

There is no denying that a robust ICT foundation is crucial in healthcare facilities. Not only does it enable the business to run, it plays a key role in saving patients' lives. And with the current boom in the internet of medical things (IoMT), a market that is expected to reach $158 billion by 2022 according to intelligence firm Deloitte,[1] the growing significance of modern technology in critical health care is indisputable.

When it comes to planning ICT infrastructure in new or existing healthcare facilities, architects, consultants, installers and Registered Communications Distribution Designers (RCDDs) should not take lightly the importance of a properly designed, planned and deployed ICT system. These professionals face many complexities associated with delivering a resilient facility that must ensure high quality patient care, regulatory compliance, and facility and patient safety while meeting budget and leaving room for future growth.

SMART INFRASTRUCTURE = SMART HEALTHCARE FACILITIES

Unlike a typical commercial building, healthcare facilities must support several dozen subsystems to operate efficiently, such as wireless biometrical telemetry, audiovisual presentation systems, patient monitoring, nurse call and integrated operating room systems. These subsystems demand careful ICT infrastructure design and planning to create a telecommunications room (TR) that can deliver high-bandwidth and resilient low-latency connectivity throughout the entire facility. As an added challenge, the hospital TR must also support the current explosion of data transfers that can top 320 GB per patient (e.g., MRI scans, ultra-HD/4K imaging, video diagnostic applications).

An examination of a few of these complexities sheds light on what to consider to best address them in order to meet code, accelerate project delivery, comply with regulations and reduce costs.

ROOM SIZING: BEST PRACTICES AND FUTURE PLANNING

Healthcare standards from the Telecommunications Industry Association (TIA), the American National Standards Institute (ANSI) and BICSI have been recently updated to address infrastructure requirements in modern health care. ANSI/BICSI 004-2018, *Information Communication Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities* and ANSI/TIA-1179-A "Healthcare Facility Telecommunications Infrastructure" standard (published in August 2017) provide design guidelines on healthcare system topologies and the planning and installation of structured cabling systems for healthcare facilities.

As many in the industry know, both the planning and installation of structured cabling systems are recommended during either construction or remodeling and not after occupancy. This is particularly true in healthcare facilities that must consider factors, such as infection control and continuous acute care even during power outages and natural disasters.

The updated guidelines now include topologies to address evolving technologies, such as wireless, digital signage, imaging and network security, thereby providing updated and detailed layout options for TR spaces in healthcare facilities. For example, in ANSI/TIA-1179-A, the minimum size of the healthcare TR was increased to 170 square feet (approximately 16 square meters) from a minimum of 130 square feet (approximately 12 square meters). Note that the recommended size for TRs is smaller for commercial buildings per ANSI/TIA-569-C that says "there shall be a minimum of one TR per floor and additional telecommunications rooms (one for each area up to 1000 m (10,000 ft) should be

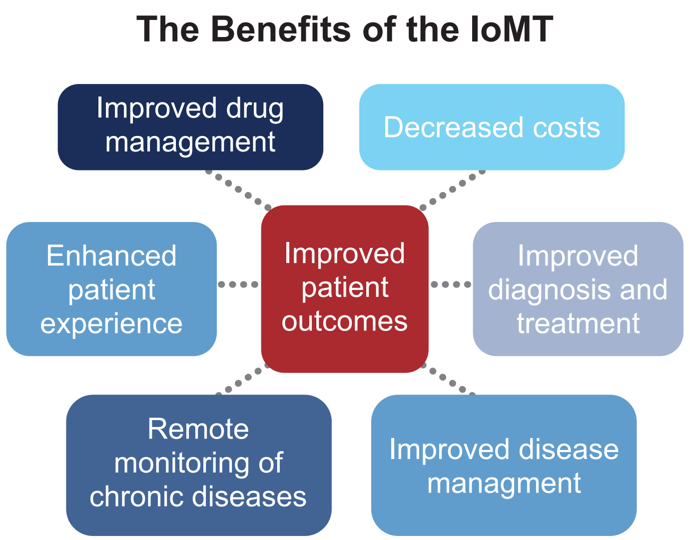

FIGURE 1: Modern healthcare facilities must support several subsystems that have a great impact on the design of the telecommunications room. (Graphic source: Deloitte).

provided when the floor area to be served exceeds 1000 m (10,000 ft); or the horizontal distribution distance to the work area exceeds 90 m (295 ft).” Both the commercial building and healthcare facility TR designs shall comply with TIA-569-D. The additional size for a healthcare facility TR accommodates the additional systems and provides room for growth (see Figures 2, 3 and 4).

Use the following guidelines when designing and planning TRs in healthcare facilities:

- At least one TR must be included on each floor.
- The TR must serve a maximum area of 20,000 sq. ft. (approx. 1,858 sq. m).
- The TR dimensions must meet the requirements of the authority having jurisdiction (AHJ); if an AHJ is not present, then the minimum floor dimensions should be 12 ft. x 14 ft. (approx. 3.65 m x 4.27 m).
- The TR must be planned to support a 50 percent growth factor of systems and services.
- Consider limitations where certain medical and building systems cannot be located in the TR. In this case, the room must be dedicated for the use of ICT and related systems and not shared space with storage, maintenance, janitorial and other applications.
- Working space in front and back of racks and cabinets should be at least 3 feet (1 meter).

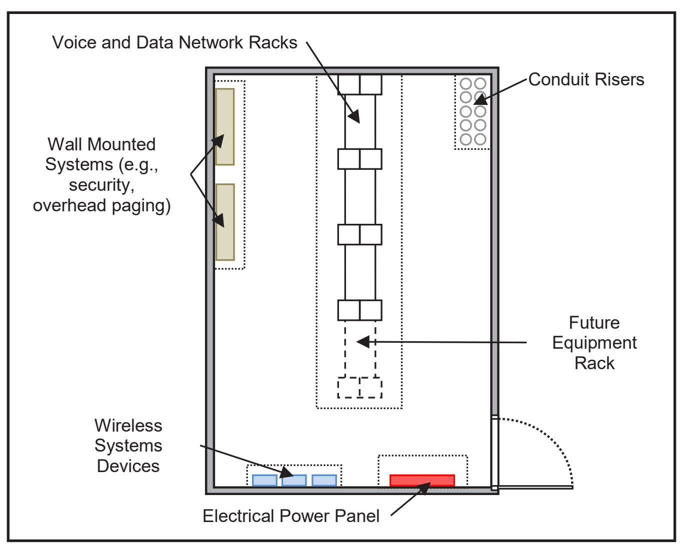

FIGURE 2: In a typical TR layout, the minimum floor space is 10 ft. x 10 ft. (approx. 3.04 m x 3.04 m) for every 10,000 sq. ft. (approx. 929.03 sq. m) of area. (Source: ANSI/BICSI 004-2018).

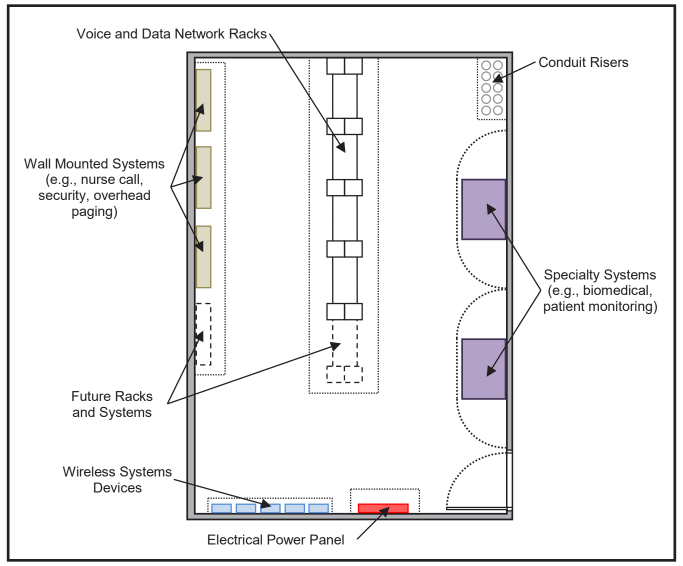

FIGURE 3: Healthcare TRs must include sufficient space for specialty systems, such as nurse calls, biomedical devices, and patient monitoring. The minimum floor recommendation is 12 ft. x 14 ft. (approx. 3.65 m x 4.27 m) for every 20,000 sq. ft. (approx. 1,858 sq. m). (Source: ANSI/BICSI 004-2018).

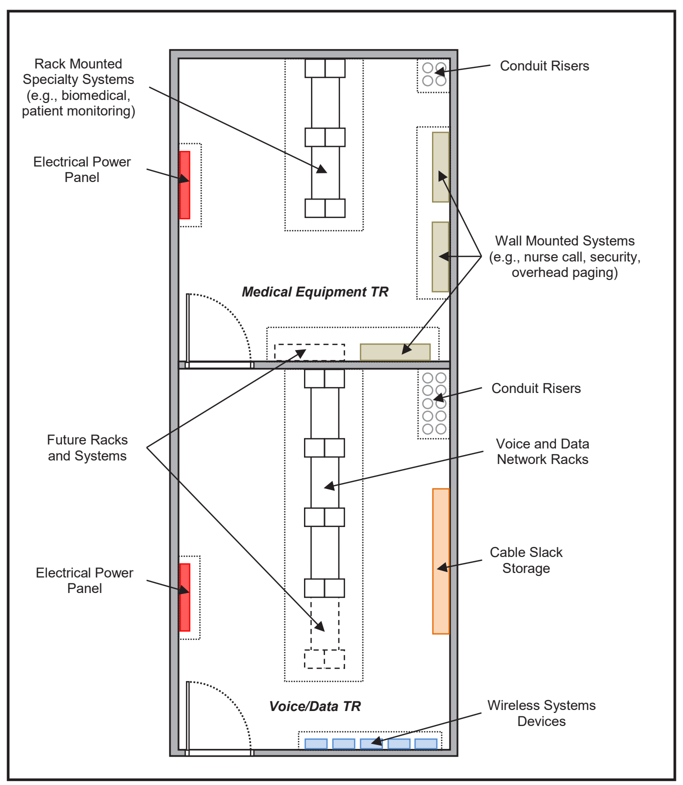

FIGURE 4: As an added challenge, certain hospitals will not allow medical or building systems to be included inside the TR. In this instance, a slip room design is required. (Source: ANSI/BICSI 004-2018).

ANSI/BICSI 004-2018, *Information Communication Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities* and ANSI/TIA-1179-A “Healthcare Facility Telecommunications Infrastructure” standard provide design guidelines on healthcare system topologies and the planning and installation of structured cabling systems for healthcare facilities.

RELIABLE CONNECTIVITY BEGINS WITH CABLE MANAGEMENT AND PATHWAY

If the TR is the central nervous system of the network, then cables are the arteries that keep the system connected and running. Cabling in healthcare facilities is more complex because there are more subsystems to support. The cross-connect is more involved than regular office facilities. With more mission-critical data being carried through fiber optic cable, appropriate cable management is a must.

Because TRs must be planned with at least 50 percent open space for future growth and updates, it is important to look for infrastructure products that optimize the signal quality and network speed of information exchange with maximum flexibility and easy moves, adds and changes (MACs).

Cable Management

Although the fundamentals of cable management have not changed, the structural support components have improved significantly so as to better support sensitive optical fiber cable. This is where advanced cable management solutions (Figure 5) can help streamline the management of cables and cords to:

- Fulfill high-density cabling requirements while maintaining proper bend radius and slack management for maximum network performance.
- Organize cables so that they can be easily traced from start to finish when performing MACs, saving valuable time and money.

Cable management solutions are evolving from simple troughs that hold cable bundles in place to mechanical systems that can now adjust to optimize cable support. Best practice dictates supporting cable to prevent sharp bends, twists and stretching. When making a vertical or horizontal transition, it is best to use a smooth 90-degree bend radius that is four times the diameter of copper conductors and a minimum of 1 inch for optical fiber conductors.

In traditional cable managers, bundles are stacked and secured against the backplane of the manager, thereby making it difficult to troubleshoot or change cables. By comparison, a central track system allows cable bundles to be properly spaced and fully supported precisely where needed. This approach is well-suited for Type 4 PoE applications where higher wattages require properly spaced and smaller cable bundles to avoid excessive heat accumulation. The latest cable management solutions also offer practical accessories with tool-less installation and adjustment capabilities to perform multiple tasks effectively.

FIGURE 5: Newer cable management solutions now provide flexible cable support and interior space optimization needed in high-density healthcare applications.

Support: Cable Pathway and Wire Mesh Trays

Flexibility, particularly in installations with multiple cable drops, is also important when planning the cable pathway (Figure 6). In the case of runways, new designs offer movable cross members that allow for maximum flexibility. Radius drops can be placed exactly where they are needed to path cable into or out of the vertical manager. Additionally, easy-to-use tool-less pathway dividers allow the user to maintain required space between cable bundles within the pathway as dictated by industry standards.

Another popular cable support solution is the wire mesh cable tray, which can be supported from the wall, ceiling, floor or from the tops of open racks. When looking for wire mesh cable trays, look for designs featuring smooth edges to protect cable and installers from getting hurt, as well as zinc plating to allow electrical continuity through splice connections.

Considerations for selecting a robust cable pathway solution include:

1. Route

Will the cable pathway require irregular transitions or simple turns? Look for tool-less and adjustable designs that allow for ultimate flexibility in the pathway.

2. Support

The pathway should be able to support cables from the ceiling, wall, racks or floor with adequate space support away from sources of electromagnetic interference (EMI).

3. Weight

Based on the size of runway and tray and distance between supports, what is the maximum weight supported? The support must be designed using a 50 percent fill of cabling to allow for future growth.

4. Bonding and Safety

Consider designs with integrated bonding studs to make installation easier. Is the bond appropriate for the circuits carried per local electrical code? Make sure the pathway is securely supported and bonded.

5. Accessibility

Is the pathway isolated from nontechnical staff but still accessible for new cable runs?

6. Accessories

Each egress/ingress point should provide sufficient protection for cables. This includes ensuring cables are properly divided/organized within the runway or tray for easy tracing.

7. Heat

NFPA-70 and TIA TSB-184-A also address heat buildup and limit cable fill based on the types of circuits. PoE circuits above 60 Watts (high-amperage power circuits) fall into this category.

8. Corrosion Resistance

Is the pathway located where it will be exposed to weather, chemicals or other environmental conditions that require an additional layer of corrosion protection? Consider a cost-effective corrosion-resistant finish with resistance class IEC 61537 Class C8 that delivers corrosion resistance almost equivalent to stainless steel.

FIGURE 6: Flexibility, particularly in installations with multiple cable drops, is also important when planning the cable pathway.

OPTIMIZE TR SYSTEMS WITH INTEGRATED POWER MANAGEMENT

To optimize critical server equipment in hospital TRs, monitor power and environmental conditions at the rack level (Figure 7). Collecting data at this level provides the granularity to visualize exactly where equipment is being overutilized or underutilized. Often, there is stranded capacity and underutilized equipment that can be retired or consolidated. Simply stated, a rack-level remote monitoring solution turns measured data into visual, intuitive, actionable information. Invest in intelligent power distribution units with integrated environmental monitoring and access control to:

- Achieve more granular, complete visibility, helping to take concrete steps to reduce power consumption.
- Remotely reboot hung equipment and monitor at the device level.
- Monitor for water, smoke, gases, access, temperature, humidity, pressure and other factors to minimize hardware failures.
- Meet regulatory compliance of data security per the Health Insurance Portability and Accountability Act of 1996 (HIPAA).

FIGURE 7: Integrated power management with access control at the rack helps to monitor power and environmental conditions, reduces power consumption, and minimizes hardware failures to optimize critical server equipment in hospitals and healthcare facilities.

EMERGENCY PREPAREDNESS, BUILDING CODES AND CRITICAL EQUIPMENT

One of the most important goals for those designing and building healthcare facilities is meeting the International Building Code's (IBC) Risk Category IV criteria, which states that hospitals, including their nonstructural components, are critical and must be designed to stay operational even during natural disasters and other emergencies.

According to the 2018 Hospital Construction Survey, which is conducted annually by the American Society for Healthcare Engineering's (ASHE's) *Health Facilities Management* (HFM) magazine, "89% of hospital facility professionals consider resiliency, ability to withstand natural disasters and power outages, some of the most critical components in the design of new healthcare facilities."

Critical Facilities Requirements

Natural disasters are unpredictable and uncontrollable, so preparedness and enacting preventative measures within the healthcare facility are key.

In the past few years, there have been many hurricanes and other natural disasters that have swept the U.S. In many cases, smaller hospitals were required to transfer patients to larger more robust buildings or to other nearby hospitals.

To ensure operation during flooding and hurricanes, TIA-569-D 6.3.8 requires that TRs must be located above water level, unless preventative measures against water infiltration are employed. The TR must be free of water or drain pipes not directly required in support of the equipment within the room. A floor drain with a backflow preventer must be provided within the room if risk of water ingress exists.

There are unique architectural and engineering challenges when building in seismically active areas. Seismic events are not limited to the state of California; earthquakes take place every day throughout the world.

According to the Incorporated Research Institutions for Seismology (IRIS), a consortium of universities dedicated to researching seismological data, magnitude 2 and smaller earthquakes can occur hundreds of times a day worldwide, while major earthquakes with magnitudes greater than 7 happen more than once a month.

> *The TR must be planned to support a 50 percent growth factor of systems and services.*

This past summer, two major earthquakes (6.4 and 7.1 magnitude) hit California within 24 hours. Severe earthquakes with a magnitude of 8 and higher occur about once a year.

It is much easier to prepare for the next earthquake than to predict when it will happen.

Seismic areas require specific building codes and installation guidelines to ensure, primarily, the safety of people but also the protection of expensive equipment. This is especially important in healthcare TRs, which cannot afford to be offline or backed up at a secondary location.

Furthermore, structures designed according to the International Building Code (IBC) are expected to have a very low to no likelihood of collapsing during a seismic event. The IBC also incorporates the ASCE 7, *Minimum Design Loads for Buildings and Other Structures*, as developed by the American Society of Civil Engineers (ASCE), which provides guidelines and specific calculations to prevent nonstructural components from sliding or overturning in the event of an earthquake.

The state of California has its own set of codes, the California Building Code (CBC), which substantially incorporates IBC's criteria and requirements but includes a few adjustments to accommodate the state's laws. For instance, the CBC requires that a licensed structural engineer design the components, supports, and attachments for nonstructural building components, such as equipment racks. This means an engineer defines the exact installation hardware, placement and materials that attach the rack to the floor and, if necessary, how it will be braced overhead. The design must also include a calculation to determine the seismic load of the rack. With this design, any rack can be used in a seismic area.

However, the penalty may be a greatly reduced equipment load if a designer does not select a rack specifically designed for seismic applications. Racks that are specifically designed for seismic applications are more expensive than nonseismic racks, but they generally have higher load ratings and can be filled with equipment. With nonseismic racks, multiple racks are needed to hold the same amount of equipment.

Racks specifically designed for seismic applications have heavily braced frames to resist side-to-side, front-back and up-down motion. Reputable manufacturers load test these racks on a shaker test table that simulates a seismic event to demonstrate rack performance in order to verify their load claim.

Mission-Critical TRs

Mission-critical facilities, such as hospitals and fire and police stations, are required to continue operation even after an earthquake. In California, the Office of Statewide Health Planning and Development (OSHPD) has permitting authority for hospitals and healthcare facilities. CBC requires all critical facilities to meet the most stringent seismic design requirements in code, regardless of site location. To speed permitting, the OSHPD preapproval of manufacturer's certification (OPM) allows manufacturers to precertify an OSHPD-compliant anchorage design. OPM can be used by contractors to eliminate the expense of retaining an engineer to design rack anchorage. Most importantly, OPM defines an anchorage that meets the maximum requirement in code. Therefore, an OPM anchorage should be sufficient in any seismic zone.

If a seismic rack is needed for a healthcare facility or tenant, consider using OSHPD's OPM to shortlist a few racks of interest. Then, compare the details to find the highest seismic load. For permitting approvals outside of California, a local engineer typically makes the recommendation.

Mounting Considerations

Installers and contractors must also address the way nonstructural components are anchored and braced

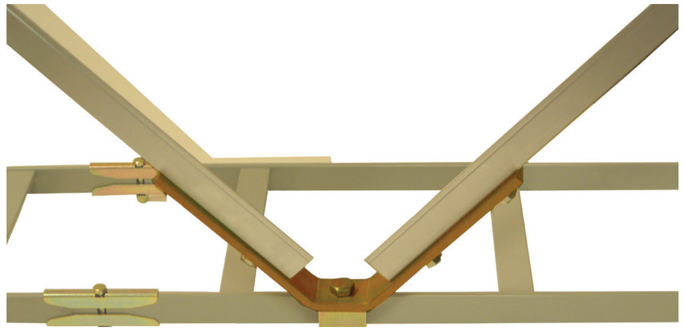

FIGURE 8: Seismic zones require proper anchoring and bracing of all nonstructural components. An OSHPD OPM preapproved product reduces the OSHPD approval cycle when planning installations in seismically active regions. Reputable manufacturers also hold OSHPD preapproval of anchorage (OPA) numbers for their products.

in a seismic zone or in a Risk Category IV building. Bracing and anchorage must be strong enough to resist a seismic activity (Figure 8). Fasteners and anchors with high-shear and high-tensile strength rating should be used to secure components. When mounting on a concrete floor, it is extremely important to choose seismically-rated floor anchors that can support the load of the rack and equipment. A minimum of four floor anchors (one at each corner) are typically required for a two-post or four-post equipment rack or cabinet installation.

CONCLUSION: THE PRESCRIPTION FOR A HEALTHY TR

Designing and planning TRs in healthcare facilities require special considerations. Beyond the aforementioned factors, consider the following prescription for a successful ICT infrastructure for years to come:

- Equipment and TR sizes need to be larger to accommodate additional systems.
- Simplify the project by specifying and selecting the infrastructure from one or fewer vendors. This will allow the products and systems to be compatible and minimizes dealing with different lead times.
- Plan cable management and pathway spaces with at least 50 percent open space for future growth and changes.
- Select products with advanced features, such as tool-less installation during future upgrades, adjustability (ultimate flexibility) and integrated bonding studs (enabling quicker bonding connections).
- Adopt cable management and pathway that are both copper and optical fiber friendly, while allowing for maximum use of interior space. This means the cable manager can support higher density cabling without impacting airflow. Remember to look for a design that promotes intuitive MACs.
- Monitor power, environmental conditions and security in equipment and TRs to help prevent power outages and to protect data.
- In seismic zones, California OSHPD OPM provides excellent planning and installation guidance. Consider seismic-rated (shaker tested) racks to maximize load per footprint.
- Take advantage of a manufacturer's online tools, such as cable fill tables that provide recommended and maximum cable fill values for the specific cable management and pathway products included in the project.

By addressing these considerations, the prognosis on any future TR looks strong.

AUTHOR BIOGRAPHY: Mitch Cohen, RCDD, has been in the ICT industry since 1984, working seasonally for the first optical fiber only distributor, Fibertron. During his tenure, Cohen has worked for both distributors and manufacturers, including his longest stint of 18 years with Corning Optical Communications. He holds a bachelor's degree from UC Santa Barbara and a master's degree from Cal State Fullerton. Mitch joined Chatsworth Products (CPI) in July 2018 as a regional sales manager in Southern California, helping engineers, contractors, distributors and end users implement the latest technologies while protecting their technology investments. He can be reached at mcohen@chatsworth.com.

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