VERTIV WHITEPAPER

Infrastructure Configuration Guide for Healthcare Network Closets

Trends Impacting Healthcare Network Closets

Trends Impacting Healthcare Network Closets

Few industries face as much continuous disruption, or stand to benefit as much from digitalization, as healthcare. The ability of healthcare organizations to capitalize on digitalization depends, to a large degree, on whether network closets can adapt to changing requirements. Those changing requirements include rapid growth in the volume of data being managed, mergers and acquisitions, and expansion and new construction.

Data Growth

Healthcare organizations have seen an explosion in health data and technology. According to statistics compiled by Dell/EMC, healthcare data grew 878% between 2016 and 2018.[1]

Network closets represent the "circulatory system" of the healthcare network, keeping data flowing. Legacy closets were not designed to manage the volume of data in today's increasingly digital healthcare delivery network. Many hospital systems need to upgrade their closet systems and the infrastructure that supports them.

IT managers are generally confident making decisions about the servers, switches and routers they need, but often don't have expertise in power and cooling infrastructure.

Mergers and Acquisitions

Hospital merger and acquisition activity in 2019 remained strong. There were 92 transactions announced in 2019 compared to 90 the previous year, according to consulting firm Kaufman Hall.[2]

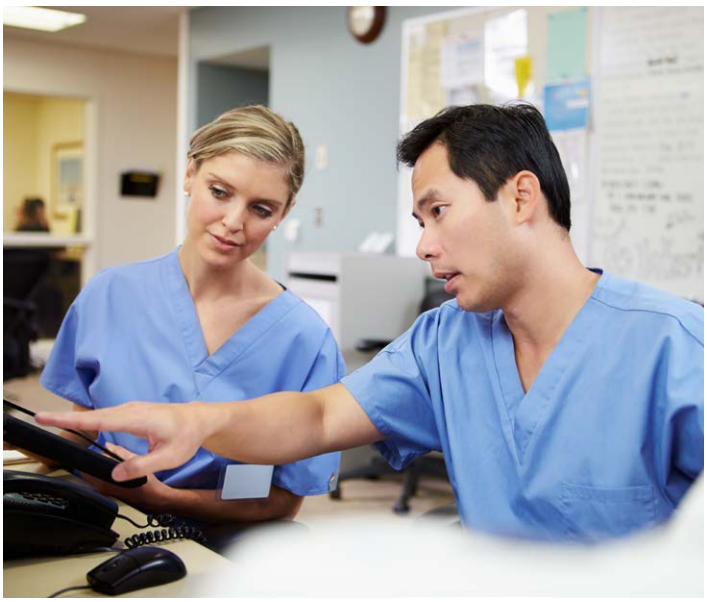
These events can significantly expand the number of closets IT managers are responsible for and often result in a mix of closet configurations with varying levels of protection. In many cases, it's a challenge for IT managers to even know what they have let alone develop effective strategies for managing the expanded network.

Mergers and acquisitions may force IT management to upgrade older closets to bring them to the level of newer closets as well as implement monitoring and management systems that provide centralized visibility into closets across the network.

New Construction and Expansion

The already robust market for construction in healthcare was projected to grow 4.4% in 2019 with $400 billion worth of projects in development.[3]

Network closets for these projects must not only be designed to meet the current requirements of today's digitalized delivery network but also built in anticipation of future changes. While often not the highest priority in a large construction project, well designed network closets can play an important role in enabling the hospital to execute its digitalization strategies.



1. https://hitinfrastructure.com/news/organizations-see-878-health-data-growth-rate-since-2016
2. https://www.kaufmanhall.com/2019-healthcare-mergers-acquisitions-in-review
3. https://blog.plangrid.com/2019/03/the-state-of-healthcare-construction-in-2019-infographic/

Designing and Managing Network Closet Infrastructure

These trends, among others, are forcing many healthcare organizations to upgrade the infrastructure within existing closets and consider more robust technologies for new closet designs.

Healthcare network closet infrastructure must not only be designed for the specific equipment and applications being supported but for other factors as well, such as local power quality, the size of the space, regulatory requirements, and available maintenance resources.

Organizations should also consider the typical technology refresh cycle compared to the infrastructure refresh cycle. In many cases, infrastructure is expected to support multiple technology refreshes.

The following systems and services should be considered when updating or designing network closet infrastructure:

- Power Continuity
- Power Distribution
- Rack/Enclosure
- Cooling
- Monitoring and Remote Management
- Service and Support

Ensuring Power Continuity

The uninterruptible power supply (UPS) system provides power continuity to ensure network connectivity and critical applications such as patient monitoring and electronic health records are always available.

It does this by providing a source of backup power that enables the equipment in the closet to continue functioning when utility power is interrupted, and conditioning the power coming from the utility to eliminate the spikes and sags that can damage or disrupt equipment operation.

Determining UPS Capacity

Capacity of the UPS system is determined by the load of the equipment being supported, the UPS output power factor and future expansion plans.

UPS capacities are typically specified in terms of voltage, but most manufacturers also show capacity in terms of watts. For example, 3000 VA / 2700 W. In addition to power capacity, you may need to consider the number of outlets available on the UPS if you don't plan to have a power distribution unit within the closet.

The UPS power factor describes the maximum active power the UPS can tolerate by design and can range from as low as .8 to as high as 1. With a power factor of .8, a 3000 VA / 2700 W UPS could support 2400 V / 2160 W. With a power factor of 1, or unity, the same capacity UPS would support 3000 VA / 2700 W.

In most applications, the best practice is to specify some "headroom" in the UPS system to prevent overload. A good rule of thumb is to multiply the total wattage of the IT equipment being supported by 1.2 (assuming a unity power factor) to determine required capacity.

The exception would be if additional technology systems will be added in the near future. If so, estimate the consumption of those systems and create a plan for accommodating the additional capacity, either by designing extra capacity into the UPS or planning for additional UPS units.

Single-phase, rackmount UPS systems suitable for network closets are available in sizes from 500 VA to 10,000 VA from a variety of manufacturers, including Vertiv, APC, and Eaton.

Ensuring Power Quality

The ability of the UPS to deliver clean, consistent power to the equipment it supports is determined by the "topology" or internal design of the system. Two main topologies are used in UPS systems for healthcare closets: line interactive and online double conversion.

If incoming power is relatively clean and stable, a line interactive UPS may provide adequate protection. When power quality is poor, a double conversion UPS may be required as it protects against more types of power disturbances than a line interactive UPS and does not rely on the battery system for power conditioning.

Double conversion UPS systems tend to be more expensive than line interactive systems so be sure you are comparing like models when evaluating UPS pricing from different manufacturers.

Rackmount line interactive UPS systems are generally available from leading manufacturers in capacities from 500 VA to 5000 VA and online double conversion UPS systems in capacities from 500 VA to 10,000 VA.

Once you determine the required topology and capacity, you can narrow vendor selection to those that offer the right size UPS in the desired topology.

Ensuring Sufficient Battery Runtimes

The UPS system will include a battery to provide continuous power to IT equipment in the event of a utility disruption.

With many closets not supported by a backup generator, the battery system determines how long equipment and applications can continue to function in the event of an outage. Typical runtimes for a 3000 VA UPS systems range between 2 and 6 minutes at full load, depending on the manufacturer. Runtimes will be longer at partial loads and can be extended to over two hours using additional battery packs. Many UPS manufacturers provide a runtime calculator to help you determine the right battery configuration.

Batteries are often considered the "weak link" in the critical power system in that their performance naturally degrades with time and usage. Monitoring battery performance is highly recommended to ensure batteries provide the required capacity and runtime when needed.

It's also a good idea to prepare a strategy for battery replacement. Single-phase UPS batteries are typically "hot swappable," meaning they can be replaced without powering down the unit. This is necessary when supporting critical workloads such as security system monitoring, nurse workstations, and intensive care units which operate 24/7x365.

However, battery replacement is probably not a task clinical or administrative staff would be expected to accomplish. For healthcare delivery networks with closets in remote locations, it can be time consuming and disruptive for IT staff to have to travel to satellite facilities to replace batteries. The more closets you have, the more frequently you'll be replacing batteries. Some manufacturers provide service programs to address this challenge.

One way to reduce the number of battery replacements required is to consider lithium ion batteries. These batteries require less maintenance and provide lifecycles two or more times longer than the traditional lead-acid batteries used in UPS systems. They are being deployed across the product lines of major UPS vendors.

Enabling Connectivity

In the increasingly digitalized and connected healthcare delivery network, it's a good idea to ensure the UPS system can be connected to a network or a building management system (BMS). UPS systems from most major manufacturers can be purchased or retrofitted with communication cards that enable connectivity through various platforms.

Key Questions for Power Continuity

- How much capacity is required to support the IT systems in closets? Calculate the load of your IT equipment and select a UPS size that can comfortably handle the load, based on the capacity and power factor of the UPS.
- Is local utility power stable and clean? If local utility power is good quality, a line interactive UPS may prove sufficient. If local utility power is inconsistent, a double conversion UPS may be the right choice.
- How critical are the applications running on the equipment in closets? If applications aren't critical to patient care or business operations, a line interactive UPS will provide adequate protection in most cases. If applications are critical, choose a double conversion UPS.
- Are closets connected to a backup generator? If closets are supported by a backup generator, shorter battery runtimes will be sufficient to bridge closet equipment to generator power.
- How much battery runtime is needed? If batteries need to support equipment for outages exceeding 6 minutes, consider adding external batteries. Whether or not the UPS relies on the battery for power conditioning (line interactive) can also impact runtime.
- Are lithium ion batteries a viable alternative for this application? Lithium ion batteries can reduce the frequency with which UPS batteries need to be replaced, offsetting their higher initial costs, and should be considered where they are available.
- Is remote monitoring and management of the UPS and batteries required? The additional cost of adding a communications card is small relative to the total investment and enables significant savings in how closets are managed. Most UPS systems can be purchased with communications cards.

Distributing and Monitoring Power within the Closet

Healthcare closet applications supporting multiple pieces of IT equipment typically require a dedicated power distribution strip or unit. Rack power distribution units (rPDUs) can be mounted vertically or horizontally within the equipment rack and can provide functionality that goes beyond simply distributing power from the UPS to connected equipment.

Basic rPDUs are available in a variety of electrical and receptacle configurations, including number of outlets. Newer rPDUs may feature a universal input to enable support for a range of AC power configurations. Universal rPDUs enable standardization with a single rPDU model across the entire delivery network.

Investing a little more in an intelligent rPDU with remote monitoring capabilities enables a comprehensive view of power usage at the rack or via remote access. In addition to enabling remote management, the intelligent rPDU displays power consumption locally to reduce the risk of accidental overload.

Some rPDUs also support monitoring of environmental conditions within the rack. A variety of sensors can be connected to the rPDU to enable monitoring of temperature, humidity, airflow, door position, and water detection.

Switched rPDUs add to these monitoring capabilities by providing the ability to remotely turn off or reboot power at each outlet, which can be extremely convenient when there is need to manage equipment remotely. It also provides an added layer of security by enabling the ability to lock unused outlets.

While sometimes seen as little more than power strips, the rPDU can actually be an important tool in enhancing visibility into, and management of, network closets.

Key Questions for Power Distribution

- How many devices will be in the rack and what are their power requirements? As with the UPS, it can be smart to select an rPDU with more outlets than required for the initial deployment to simplify expansion.
- What types of receptacles are required? Leading manufacturers provide a variety of configuration options that will support the IT systems used in healthcare closets. Using an rPDU with universal configuration options enable standardization across the delivery network and provides the ability to easily adapt to changes and additions.
- Is the ability to monitor power to equipment through the rPDU required? Power monitoring can be a high-value addition for large distributed networks.
- Is the ability to remotely switch outlets on and off required? If equipment in closets has to be occasionally rebooted, or security protocols require unused outlets to be locked to prevent unauthorized personnel from plugging devices into the rPDU that could create an overload, a switched rPDU is worth the investment.
- Is the ability to monitor environmental conditions through the rPDU required? For closets that don't have dedicated cooling units that can manage and report on environmental conditions, environmental monitoring through the rPDU provides peace of mind that IT system performance isn't being degraded by excessive heat or humidity.

Organizing and Protecting Closet Systems

While the choice of an equipment rack for the closet is a relatively simple one—does the rack have enough space to support all IT equipment plus the UPS and any gateways or ancillary systems—there are a couple of factors that should be considered.

An open rack configuration, meaning a rack without a door, will enable more airflow to the equipment, which can be important in tight spaces without dedicated cooling. If equipment is located in an actual closet with a lockable door, this may be the best approach.

If equipment is not physically secure, it's best to configure the rack with a lockable door to prevent malicious or unintentional tampering with IT systems. In this case, consider the impact of the door on airflow. Various solutions for improving airflow or providing dedicated cooling are discussed in the following section.

Cable management features within the rack can simplify equipment adds and changes, keeping IT management from dealing with tangled bunches of network and equipment cables.

42U is the standard size for an IT equipment rack, but not all closets will require a full rack of equipment. Wall-mount and freestanding racks and enclosures are available in smaller sizes. If equipment is located in a particularly harsh environment, which isn't typically the case in healthcare, a fully enclosed system with integrated cooling could be required.

Key Questions for Racks/Enclosures

- How much physical space (measured in rack units or U) is required by the equipment to be supported by the rack? Equipment racks and enclosures are available in a variety of sizes. Most applications will be best served by a 42U rack, but if you are only supporting communications equipment and a UPS, a smaller rack or enclosure will provide ample space.
- Will additional equipment be deployed in the rack in the future? As with other infrastructure decisions, it's typically best to plan for expansion at the time of deployment to minimize future disruption.
- How will cables be managed? Choose a rack with cable management features to enable efficient equipment changes, maintenance and troubleshooting.
- Is the rack located in an environment that is physically secure? If the room or closet is physically secure, the rack probably doesn't have to be. If the rack is in an environment where unauthorized associates may have access, a lockable door should be considered.
- Will the rack house or be supported by dedicated cooling systems? The approach to cooling can impact rack selection in terms of both airflow and rack space. If the plan is to use fans to enhance airflow in the rack, an open rack is required. If the plan is to deploy dedicated rackmount cooling, factor in the size of the cooling unit into rack requirements.

Ensuring Airflow and Preventing Excessive Heat

The equipment in closets may receive some cooling from the building air conditioning system but increasingly that is proving insufficient to maintain safe operating conditions. Servers, in particular, generate a lot of heat and in an enclosed small space there is nowhere for that heat to go. Operating in conditions outside of manufacturer recommended guidelines can shorten equipment life and lead to premature failure.

Cooling is where network closet design gets interesting. While there is a lot of commonality in the features and size ranges for UPS systems, rPDUs and racks across various manufacturers, that is not the case when it comes to closet cooling. Not all vendors focus on cooling and a variety of different approaches can be found across those manufacturers that provide solutions.

The first thing to consider is airflow within the space. In some cases, the challenge won't be so much the temperature in the room but the tight confines of the space limiting airflow through the rack. This is a relatively simple problem to address. You can enhance airflow by adding small fans at the front of the rack to supplement the fans within servers and help move air through the rack.

However, switches have different airflow requirements than other IT equipment. They "breathe" side to side rather front to back. Passive airflow management systems are available that provide a dedicated path for cool air to flow to the intake of the switch, using the on-board fans of the switch to pull cool air from the front of the cabinet.

If dedicated cooling is required, a number of options are available, including space-efficient ceiling-mount and rackmount cooling systems. Portable cooling systems are also available, space permitting.

Key Questions for Cooling

- What is the total power load of the environment? As more equipment is packed into network closets, the need for dedicated cooling increases. If the closet is supporting more than 1.5 kW of equipment in a closed space, the need for dedicated cooling should be strongly considered.
- Does the environment have access to building air? Even when building air conditioning systems can effectively reach the equipment in closets, they may not provide the cooling capacity or airflow required to keep equipment in safe operating conditions.
- Is there open floor space within the environment? In most cases, floor space is at a premium in network closets, making ceiling-mount or rackmount cooling systems the preferred option.

Monitoring and Managing Network Closets

One of the key challenges healthcare IT organizations face as delivery networks expand and the criticality of closets increases, is effectively managing distributed resources. This can deliver significant cost-savings through productivity and efficiency gains resulting from minimizing nuisance service calls, middle of the night disturbances and travel times to satellite facilities. A variety of tools and systems are available today that enable remote monitoring and control of network closets.

Remote monitoring used to be a fairly complex undertaking, but today has been simplified. Smart, connected equipment, simple sensors and web-based monitoring solutions are easy-to-install and provide a single interface to multiple closets. Systems such as this provide alerts and notifications when problems occur, protect IT equipment with controlled, automated shutdown and organize data to support enhanced decision making.

Connected UPS, power distribution and rack systems also enable power and environmental monitoring of the closets to be integrated into existing BMS or data center infrastructure management (DCIM) systems.

Another important tool for network closet management is IT management through KVM switches or advanced console servers. KVM over IP switches provide streamlined, local and remote management of IT equipment, allowing users to control server and serial targets from a single console. Advanced console servers, which integrate remote access of IT systems and infrastructure into a single solution, can further consolidate and simplify closet management.

Key Questions for Monitoring and Remote Management

- Is there visibility into network closet assets? As IT resources become more distributed with expanded delivery networks, it becomes less practical to monitor closets manually. In many cases, the problem extends to not having knowledge of where assets are located or their condition. Monitoring not only provides visibility but enhances asset management.
- Can extended outages in closets be tolerated? The ability to monitor and receive alerts can streamline troubleshooting and significantly reduce the time to respond to events that can lead to downtime.
- How many closets need to be remotely monitored and what are the key parameters that need to be monitored? Select a monitoring platform that can scale to meet your needs. Some solutions are as simple as installing sensors that connect to the rPDU while others provide a more comprehensive monitoring platform.
- Is remote access to IT systems required? KVM over IP switches and advanced console servers enable remote access to equipment across your distributed network.

Servicing and Maintaining Network Closets

It's easy to get caught up in day-to-day operations and neglect regular maintenance procedures that can prevent unexpected downtime and extend equipment life. Today's infrastructure systems are built for quality, but they do require regular maintenance.

This includes cleaning of the environment to protect equipment from dust, debris and combustible materials such as paper, cloth, cardboard or corrosive fumes. Also, check to make sure the UPS is not placed near windows or areas that contain high amounts of moisture, and that the ventilation openings at the front, side or rear of the unit remain unobstructed. Also, check the temperature within the environment, if remote environmental monitoring is not being used.

Operating the UPS within recommended temperature and humidity levels will maximize life expectancy and optimize performance. UPS batteries are particularly sensitive to temperature. For every 8.3°C (15°F) above the ambient operating temperature of 25°C (77°F), battery life will be reduced by 50%. The health of the UPS battery should be visually inspected periodically for cleanliness, leaking and excessive swelling. In addition, the automatic battery self-test will indicate if the battery needs replacement.

Most manufacturers recommend UPS operational testing every 6 months. This includes simple tests to check for audible or silenced alarms or fault indicators, and operating mode to see if the unit is operating in normal, bypass or battery mode.

In closets that include dedicated cooling, monthly maintenance checks are recommended. Verify that air flow is not restricted, air filters are clean, the area is free from foreign materials, and the condensate-drain is properly connected and free from clogs.

Infrastructure vendors recognize the challenges of maintaining high availability in distributed environments and have developed special service packages specifically for these applications. Services not covered under a long-term warranty can be secured through a service contract to reduce the burden on internal teams.

Some infrastructure providers also provide installation support services. These can be particularly valuable when multiple new closets are being added or if a technology refresh project impacts closets across the network.

When selecting a service provider evaluate their capabilities in proximity to your location. Not all vendors have fully developed service organizations that can provide local, time-sensitive support in all areas.

Key Questions for Servicing and Maintaining

- Who will perform regular infrastructure inspection and maintenance, particularly for closets in satellite facilities? Expanding distributed networks can strain IT resources and cause important maintenance services to be neglected. If dedicated resourcess aren't available, consider a service contract that includes on-site maintenance.
- Are the resources and expertise available to replace UPS batteries when required? Healthcare IT operations are increasingly being asked to do more with less. If IT staff are spending their time replacing UPS batteries, what essential tasks aren't getting done?
- Is access to critical operating data that can be used to improve operations important? Moving from preventive to predictive maintenance can reduce overall maintenance costs but requires the ability to consolidate and analyze operating data across multiple locations.
- Can installation of new technology at multiple closets be managed effectively? If one closet is being updated, this may not be an issue, but if multiple closets need to be updated quickly it could prove to be. Check with the infrastructure vendor to see whether they offer installation support.

Simplifying Purchasing and Deployment

Configuring closets for high reliability and manageability requires careful selection of a range of products. In many cases, this doesn't have to be done for each specific closet. Developing a standardized configuration for a closet, which also allows for customization in some areas, can simplify the process of retrofitting or expanding a distributed network. Vendors who provide a full range of small space infrastructure solutions, can often provide complete configurations through a single part number.

Vendors now also offer factory integration, in which the UPS, rPDU and other infrastructure systems are fully integrated with the rack prior to shipment. The integrated system arrives on site IT-ready to enable faster and simpler deployment.

For More Information

For more information on Vertiv solutions for healthcare closets, review our application brief, https://www.vertiv.com/en-us/campaigns/vertiv--building-a-stronger-foundation-for-the-future-of-healthcare/

Vertiv.com | Vertiv Headquarters, 1050 Dearborn Drive, Columbus, OH, 43085, USA

CS-00260 (R04/20)