

SPECIAL REPORT

# Finding the Right Cooling and Power Solutions for VoIP

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As corporate America migrates to VoIP, technical decision-makers face new challenges, and new factors, in ensuring continuity of voice services. In particular, they need to reassess the systems currently protecting IP network equipment from power outages and fluctuations, and excessive temperature.

A recent survey of nearly 100 attendees at the Data Center Users Group, an industry organization sponsored by Liebert, found that data center managers' top three concerns were density of heat and power (83%), availability (52%), and space constraints/growth (45%).

Unfortunately, those same concerns are now being felt outside the data center. VoIP network infrastructures, particularly those that include Power over Ethernet (PoE), tend to have far more stringent cooling and power needs than data-only IP networks.

"Implementing IP telephones and ethernet switches raises power consumption and heat generation, particularly in a confined space where ventilation is limited," says Jay Lassman, a research director at Gartner. Failing to address these requirements can result in service interruptions, high maintenance costs and premature equipment obsolescence.

Furthermore, interruptions and failures become far less acceptable when VoIP is introduced to an IP network. "When the lights go out in the furthest reaches of your plants, people won't be conducting much business," reports Sue Umnus-Talo, a vice president at network systems integrator Electroline. As a result, "We've found that before installing VoIP, a lot of companies were just using low level UPSs, or nothing, in their wiring closets." That level of protection may prove insufficient when employees' ability to dial 911 during an emergency depends on remote network equipment.

This report is designed to give IT managers a better understanding of the needs of VoIP applications, and help them evaluate their existing power and cooling infrastructure and address gaps in an effective and cost-efficient manner.

## Weighing the factors

Back-up power and precision cooling requirements will vary from company to company and site to site. Among the factors to be considered:

- The nature of the space: cubic feet, ventilation, presence of other electrical equipment, and existing cooling and power systems, if any.

Companies may need to perform only minimal power and cooling upgrades to data centers, which may already have redundant UPSs, back-up generators and precision cooling systems. Typically, the impact of installing a VoIP switch and related servers in a large data center adds less than 5% to the overall heat load of the facility.

However, the vast majority of VoIP switches reside outside the data center. While traditional PBX infrastructures are centralized, VoIP utilizes a distributed IP network architecture. In addition to the main distribution frames, which handle inter-building

connections, there may be dozens or hundreds of intermediate distribution frames and wiring closets that deliver voice, and possibly power, to users' IP telephony devices.

These smaller switches need to be close to the populations they serve. With office space at a premium, they tend to end up in small rooms or even coat closets with little ventilation. Deploying VoIP and PoE can double or triple the power requirements and heat generation in such spaces.

- Cooling and power demands of VoIP equipment, particularly if PoE is involved.

PoE enables a VoIP switch to power IP phones over standard Category 5 or 5e LAN cable. This eliminates the need to provide each IP telephone with its own electrical outlet and UPS. Only the IP switch requires its own primary and back-up power sources. PoE is an international standard, IEEE 802.3af, which ensures interoperability across multivendor installations (for example: a Cisco VoIP switch and a Mitel IP telephone).

However, by turning a VoIP switch into a power distribution unit, PoE significantly increases the switch's power consumption and heat dissipation. PoE can increase input power requirements by as much 600%. Ten percent to 15% of PoE power is consumed by the switch, effectively doubling the heat a VoIP switch generates.

- The different types of cooling and power solutions that can be used to protect VoIP switches.

UPS systems employ different topologies that affect the level of protection they provide. They also can be configured with varying battery capacities and other options that can impact performance and manageability. A range of precision cooling systems also are available.

- System availability and service-level objectives.

Planners need to consider the potential costs of failing to protect VoIP systems from power outages, and power and temperature irregularities. What level of availability

is acceptable for the VoIP switch and the devices connected to it?

When power fluctuations cause IP switches to drop data packets, users tend to put up with a momentary slow-down in response time or a bounced e-mail. They are far more apt to complain when dropped voice packets result in a bad line quality or worse, a dropped call. The legacy voice network is designed for fine nines of availability, which is the level of service most users have come to expect.

When determining availability requirements, take the time to quantify as much as possible the cost of a service disruption or downtime. Calculations should include equipment replacement and maintenance, as well as lost business and productivity and decreased customer satisfaction due to interruption in voice services.

## Choosing the right power protection

All IP switches should be protected by a UPS system. The UPS serves as a source of back-up power in the event of an outage. If a back-up generator is available, the UPS provides uninterrupted power to the switch while the generator is started. If no generator is present, UPS battery capacity

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determines how long the switch can operate during an outage. Power monitoring software can monitor UPS battery capacity and execute a clean shutdown of the switch when necessary, to avoid equipment damage and packet loss.

UPS systems also condition the power being used by the switch, removing sags, noise and other power quality problems that can damage equipment or degrade performance.

Finally, the UPS provides real-time remote monitoring of protected equipment. Ethernet-based communication systems allow for monitoring of remote power devices and provide real-time event notification and alarms.

The following should be considered when deploying a power protection infrastructure for VoIP systems:

**Redundancy requirements**

There are four basic power protection architectures. These are shown below.

<b>Tier 1</b>	No UPS, just surge protection (three nines availability)
<b>Tier 2</b>	Single UPS, with one active power path to protected equipment (four nines availability)
<b>Tier 3</b>	Redundant UPS with one active power path to protected equipment (five to six nines availability)
<b>Tier 4</b>	Redundant UPS with two active power paths to protected equipment (seven to eight nines availability)

Many data centers are designed with Tier 3 or 4 power architectures, which should adequately support a VoIP implementation. However, if a data center does not at least have redundancy at the UPS level, the move to VoIP may provide a decision point for reevaluating and upgrading the critical power system.

Smaller facilities, such as network closets, have traditionally not employed UPS redundancy. The power systems of such sites may also need to be reevaluated when VoIP is deployed, based on the availability objectives of the VoIP systems. High-performance rack-mount UPS systems are available in sizes

as small as 2U, making it easier to implement redundancy (in rack-based systems).

**Power System Sizing**

One of the most important steps to configuring UPS systems for a VoIP network is determining the power requirements of each VoIP switch. When PoE is being used, requirements also include IP telephones and any other powered devices the switch will be serving.

Switch power supplies can be configured in redundant or combined mode. Combined mode lets more PoE ports be powered by the switch, but increases risk. "If power supplies are used in a combined mode [capacity] and one fails or if the user oversubscribes the PoE [plugs in too many power devices], the power supply shuts down and the system goes down until the situation is corrected," Cisco stated in a recently published white paper.

The PoE standard lets devices be classified based on their power requirements, allowing the switch to deliver less power to those devices that require less power. Power consumption per IP phone ranges from less than a watt to 13 watts, depending on phone size, number of buttons and size of display, according to Jay Lassman, a research director at Gartner. However, not all devices currently support the PoE standard and it is likely that device power requirements will increase in the future. Consequently, the best practice is to size the power system so that it can deliver 15.4 watts of power to all PoE ports.

**Battery Capacity Requirements**

When planning desired power availability for a VoIP switch, consider whether a generator is present; and if not, how long UPS batteries need to power the switch. Cisco recommends battery back-up times of one to two hours. Calculations of optimal battery capacity also should take into account the ambient temperature in a given space, according to Electroline's Umnus-Talo. "UPS batteries last longer in a temperature-controlled environment."

## Type of UPS

There are three types of AC UPS system:

**Passive standby systems** provide outage protection but little power conditioning and are primarily used for non-critical desktop systems.

**Line interactive systems** filter a line current to the power load and convert a trickle of DC power to the battery, to keep it fully charged at all times. Operational at all times, the UPS does not need to turn on during a power failure, but rather switches from the standard utility source to the back-up battery. Line interactive UPSs provide some power conditioning, but rely on their battery systems to condition power. This can shorten battery life and reduce battery capacity available for outages in areas where power quality is especially erratic.

**Online double conversion systems** convert incoming power from AC to DC and back to AC. The conversion process isolates the IP switch from power surges and other damaging anomalies, so that even if the UPS is taken out by a major surge, the switch is unaffected. Unlike line interactive UPSs, double conversion systems provide continuous conditioned power. Furthermore, they use significantly less battery for day-to-day power conditioning, preserving capacity for outages.

With PoE, the majority of power being consumed by the switch is -48direct current voltage. Consequently, DC power supplies are better able to fully power all PoE ports in larger switches. DC UPS systems have emerged as cost-effective, reliable and efficient alternatives to AC-based UPS systems in switches with DC power supplies. The DC UPS converts incoming AC power to DC for use by the DC power supply. A DC back-up power system can provide six nines or better availability, and operates more efficiently (90% plus) than a comparable AC solution, so it uses less energy and generates less heat. In addition, it provides extended back-up time: between one and four hours.

The choice of UPS will be dictated by availability objectives and application requirements. Online double conversion UPSs cost more than line interactive UPSs. However, they provide a more consistent and reliable level of power protection than line interactive systems.

“If a line interactive UPS experiences component failure, it simply shuts off, taking the load with it,” and leaving the VoIP switch without power, Electroline’s Umnus-Talo says. In contrast, a double conversion UPS experiencing a failure automatically bypasses itself, switching the VoIP equipment over to utility power.

“If voice is important, but not critical – that is, if business won’t come to a screeching halt if a device goes down – we may recommend a line interactive UPS,” Umnus-Talo says. For applications where voice services are business-critical, online double conversion UPS systems are recommended.

Other factors to consider when choosing a back-up power system include:

- Quality of incoming power. Erratic power feed will cause a line interactive UPS to draw frequently on its battery system, reducing capacity to ride through a power failure.
- Is the UPS system supported by a back-up generator? Generator start-ups cause frequency variations that can create problems for line interactive UPS systems.
- Battery runtime requirements. When there is no generator, as is the case with most remote VoIP sites, extended battery runtime becomes crucial. Most UPSs are designed to keep a server cluster or network switch up and running



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for brief periods of time: generally up to fifteen minutes. This keeps the system going long enough to ride through a brief power outage, conduct an orderly shutdown or transfer power to a backup generator. If a switch supports critical voice systems, however, and has no generator, it may need to run on battery through blackouts that last several hours.

"It's a matter of what the customer is comfortable with," Umnus-Talo says. "Usually it's [battery runtime of] at least half an hour, enough time for employees to use the phone to call 911 and get out of the building."

### UPS features to look for

Apart from basic considerations like reliability and capacity, companies should consider the following features when selecting and configuring power protection for VoIP:

**External maintenance bypass** allows the IP switch to continue operating, temporarily without power protection, while the UPS system is down for maintenance. For some applications, this can be a cost-effective alternative to having redundant UPS systems.

**SNMP support** enables the UPS system to be remotely monitored via virtually all leading network management platforms. As long as IP networks only handled data, many companies had a laissez-faire attitude that came down to, "If the UPS beeps, we'll do something about it," Umnus-Talo says. However, the business-criticality of voice services, coupled with the difficulty of managing remote sites with limited IT staffs, has made centralized UPS monitoring a must-have feature for many VoIP installations. IT administrators can sit at one network management station and monitor VoIP equipment across the enterprise, including whether a system is running on UPS or utility power, and how much battery capacity is left.

"SNMP monitoring is major for us," says Brad Thomas, a network specialist at the University of Wyoming. The system notifies network administrators if the power is out at a given site "and whether we need to be concerned about it," Thomas says. Critical VoIP sites can be equipped with external sensors that monitor humidity and temperature, and report problems

to technical personnel via e-mail or a cell phone call. They also monitor the switch itself, "So if a VoIP's SNMP module dies, the sensaphone can tell us the switch is having a failure it can't tell us about," Thomas says.

**Clean shutdowns, automatic restarts:** A UPS system should be able to perform an orderly shutdown and restart without damaging the VoIP switch, and without requiring manual intervention.

The University of Wyoming's Thomas can attest to the importance of this feature. It's the university's older UPS systems, which are used to protect IP data switches, that do not always come back online after a power outage. "We have over a hundred wiring closets," Thomas notes. After an outage, "We had to run around turning UPSs back on — not all, but many. It took us about five hours." In one case, the university got hit with a second power outage before IT could bring everything back online.

### Choosing the right cooling system

Most corporate IT managers are aware that excessive heat can damage electronic equipment. They may not, however, be aware of how sensitive network and computing systems are to irregularities in temperature and humidity. In order to avoid reduced performance and premature failure of components

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and batteries, they should optimally be maintained in a stable environment of 72 degrees Fahrenheit (F), plus or minus 2 degrees. According to The Uptime Institute, for every increase of 18 degrees F above 70 degrees F, long-term electronics reliability falls by 50%.

The optimal relative humidity for an environment housing electronic equipment is typically 45% to 50%. Higher humidity levels can corrode switching circuitry and cause expansion and contraction of circuit boards, damaging circuits and edge connectors. Too-low humidity is conducive to the buildup of static discharges, which can cause data loss or damaged semiconductors.

Data centers are typically equipped with precision cooling systems that are specifically designed for electronic environments. When it comes to smaller remote IP switching sites, however, many companies make do with comfort cooling systems: regular air conditioners that are designed for offices and other human habitats.

Comfort cooling systems may provide adequate protection under some circumstances. However, when total power consumption exceeds 1.5 kilowatts in a small space it is generally advisable to move up to a precision cooling system. Often, the move to VoIP and PoE drives remote environments above that threshold.

Comfort cooling systems are less effective and less cost-efficient than precision cooling

systems, when it comes to maintaining optimal temperature and humidity conditions for electronic equipment. Designed for office environments that are humidified by people and outside air, they typically expend between 30% and 40% of their energy removing humidity. Precision cooling systems, in contrast, are designed for the drier environments that house

### University of Wyoming addresses the VoIP cooling and power challenge

Prior to installing VoIP, the University of Wyoming had no overall strategy for providing adequate cooling and back-up power to its network infrastructure. IP switching sites were served by a mixture of line interactive and double conversion UPSs. Outside of the data center, cooling was done by primarily regular office air conditioners.

"I knew in the back of my head that double conversion was superior," says Brad Thomas, a network specialist at the university. He also knew that overheating was shortening the lifespan of IP switches, particularly in small wiring closets that were too small to fit an air conditioner. "We stress tested some equipment and it was running way too high."

The university also experienced occasional IP switch failures due to overheating and power surges. In a worst-case scenario, when one of the switches in the stack died and a staff technician tried to take the top one off, the other two also came off because the rubber had melted, gluing them together. Those three switches had sat in a small wiring closet with little ventilation for about three years, according to Thomas.

As long as the switches supported only data, however, the IT staff and users put up with the occasional service interruption. "If power goes down in one of our buildings, end user computers go down too," Thomas points out. Even if an IP switch goes down because the UPS didn't work, technicians can bring it back up long before the PCs come back up. As a result, the IT staff saw no immediate need to upgrade cooling and UPS systems.

Their attitude changed, however, when the university began deploying VoIP. IP switches would now be supporting the on-campus 911 service. Additionally, "How can we report our power is out if we don't have phone service?" Thomas says. A goal of five-nines availability was set for VoIP systems. In order to achieve it, the group determined that all VoIP switches needed to be equipped with Liebert double-conversion UPSs, precision cooling systems and adequate ventilation.

Located in an area plagued by electrical storms, the university needed to protect VoIP equipment from power surges. After double-conversion UPSs were installed, one building was hit by lightning. "More than one computer got fried, but our VoIP equipment was fine," Thomas reports.

So far, only buildings that are new construction or being remodeled have been equipped with VoIP switches. "Our problem is that many spaces that currently house IP switches are too small to fit a cooling unit," Thomas says. His group is now using the benefits of VoIP to motivate occupiers of buildings to find enough space for adequate cooling and UPS systems. "We say to people, 'Let's work together, find some floor space,'" he says.

Full VoIP deployment is likely to take years. Thomas is hoping to get the funding he needs when the university's Nortel PBX reaches the end of its lifespan. "We can either spend million of dollars replacing the PBX, or use the money to deploy a VoIP infrastructure," including new wiring closets and adequate cooling and power systems, he says. "I'm pretty sure we'll do the latter."



electronic equipment. Precision cooling systems only utilize 5% to 15% of their energy removing humidity.

As a result, comfort cooling systems need to spend more energy than precision cooling systems to maintain temperatures within acceptable parameters for electronic equipment. Furthermore, they tend to over-dehumidify an environment, wasting more energy and potentially creating static-related maintenance problems. Precision cooling systems, in contrast, can be programmed to maintain both temperature and humidity at optimal levels, decreasing or increasing humidity levels as needed.

Precision cooling systems also deal more effectively with dust and other air pollution, which can damage electronic equipment. They are equipped with air filters that are 20% to 30% efficient, and compliant with American Society of Heating and Refrigeration Engineers' standards. Most comfort air systems, in contrast, use air filters that are only 10% efficient.

Reliability is another factor to consider in choosing a cooling system. Unlike comfort cooling systems, which are used seasonally, precision cooling systems are designed to operate continually year-round. Built-in redundancy at the component level coupled with a redundant system configuration ensures continuity of operation in the event of failure.

### Choosing a cooling configuration

When most IT managers think of precision cooling, they probably think about the large systems deployed around the periphery of the data center that deliver cool air through the raised floor. In fact, there are a wide variety of precision cooling systems, including many designed specifically for the small spaces being impacted by VoIP and PoE. When calculating cooling requirements for a VoIP implementation with PoE, be sure to factor in the 10% to 15% of PoE power that is converted to heat within the switch and any heat generated by support equipment, such as the UPS.

There are two approaches to cooling small clusters of electronic equipment: open or closed. The open approach cools the entire room or space in which the equipment is operating. This can be accomplished through a ceiling- or wall-mount precision cooling system.

The closed approach isolates equipment in a closed space and provides cooling for that space. This can be a very effective approach for one or two racks of equipment operating in remote environments, as vendors have recently rolled out integrated rack enclosure systems that provide power and cooling support for high-density switches in a single enclosure.

### Conclusion

Ensuring appropriate availability and reliability of VoIP switches requires making an informed decision that takes into account the unique power, cooling and reliability requirements that VoIP and PoE bring to an IP network site.

"More of our customers are saying, 'look at the benefits we get from VoIP, and the risks we take if we don't protect it,'" Electroline's Umnus-Talo says. "The way we see it, computers, servers and network switches are like the brain and nervous system; the cooling and power protection infrastructure is the heart. If the heart isn't pumping, the brain's not working."

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