# The Converged Closet: Considerations for VoIP

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Looking forward to a converged network? Are your LAN and WAN networks ready for converged data, voice, and video? The industry consultants are speculating that 40+ percent of the data networks are not ready for VoIP. Most of the attention has been directed to the wide area network (WAN). There will also be an investment in the closets, cabling, AC power, and air conditioning. These may be hidden costs that will make the organization and network designer think twice about the total cost of ownership (TCO) for VoIP.

The cost of procuring, operating, and maintaining any system or network must be predicted if financial approval is expected. When you choose to write a TCO it should include:

1. Maintenance over the installation lifetime
2. Depreciation over the installation lifetime
3. Replacement parts over the installation lifetime
4. Electrical power budget and possible UPS requirements
5. Floor/closet/rack space requirements
6. Training (salary, instructor fees, lost productivity, certification, staff testing)
7. Downtime factors (mean time between failures (MTBF), mean time to repair (MTTR), scheduled downtime)
8. Any changes necessary to implement or accommodate the expenditure
9. Monetary inflation over the installation lifetime

This article will focus on items 4, 5, and 8.

### VoIP Operational Goals for the Closet

Several operational goals for VoIP will be affected by the closet design including:

1. Produce reliability as high as the legacy telephone systems
2. Limit failures
3. Restore service quickly after a failure
4. Diagnose and reduce/prevent recurring problems
5. Ensure backups work

The cost of these goals should be included in the TCO calculation and planned for rather than become “gotchas” after the VoIP procurement decision is made.

### What to Consider: Elements of an RFP

If a VoIP request for proposal (RFP) is written for the closet, cabling, electrical power, and air conditioning necessary for the move to a converged network, the following issues must be addressed:

1. Will the IP phones require separate cables?
2. Will the existing LAN cabling have to be upgraded to Cat 5 even though the IP phones are supposed to work on Cat 3 cable?
3. How much of the legacy cabling and IDF and MDF closets will have to be retained for devices such as faxes, modems, alarm systems, security devices, telemetry and lifeline, and 911 connections?
4. Will there be a separate LAN or VLAN for VoIP?
5. Can the new closets and equipment support video over IP in the future?
6. What will be the power requirements for LAN switches, voice gateways, servers, and IP phones?
7. Will air conditioning have to be installed in the closets?

8. Will the closets have to support non-communications technology such as video surveillance cameras and environmental controls?

### Cables, Closets and Space Planning

Unless the closets do not yet exist, as in a greenfield installation, there will be existing cabling, AC power, and air conditioning installed in the closets. The intermediate distribution frames (IDF) and main distribution frames (MDF) will be changed or possibly abandoned.

Table 1 compares the cabling environments for legacy and IP phones. Several conclusions can be drawn. The cables for legacy phones can be Cat 1 and span thousands of meters. The LAN cables will be 2 or 4 pairs of Cat 3 or 5 data-grade cable with a maximum coverage of 100m.

The LAN closet may assume the functions of the IDF for IP phones. It is unlikely that the IDF can be abandoned, because there will still be some requirements for supporting legacy devices. The MDF will be required for carrier connections. The voice gateways that connect to the legacy phones and other devices can be located in the IDF or centralized in the MDF. In any case, there will probably be some modifications required to both the legacy and LAN closets.

Space planning will be different for VoIP than it is for legacy phones and PBXs. Until all of the legacy phones and devices are moved over the VoIP gateways, the PBX will have to remain. The MDF room may then be oversized, because most of the VoIP cabling will be terminated in the LAN closets on each floor rather than running through the IDFs to the MDF. LAN closet space may have to be expanded, or more LAN closets will have to be arranged per floor. If the IDF is used, then rack space for the new equipment will be required.

**Table 1. Cables and Closets**

| Component | Legacy Phone | IP Phone |
|---|---|---|
| Legacy Phone Closet | | |
| MDF | Use as is | Use for trunking only |
| IDF | Use as is | Abandon |
| LAN closet | Not used | Expanded |
| Cabling | 1 Pair voice grade | 2 to 4 Pair<br>Category 3 to 5 |
| Power | From switch<br>110/120 volts | From LAN switch, Gateway,<br>Power Bar |
| Air Conditioning | Switch room,<br>not MDF or IDF | LAN closet |
| Distances | 1,000–2,000 meters | 100 meters |
| Closets | Same as before | Multiple per floor |

Conduit space between floors is consumed with the legacy cabling. It is likely that LAN-to-LAN closet and server connections will use fiber optic cables. Is there room for the fiber cables, or does the legacy cabling need to be removed or new conduit installed? Abandoning the old cable and conduits may not be a viable choice.

### Power over Ethernet

Power over Ethernet (PoE) can be implemented as a standard offering as defined by the IEEE 802.3af committee, or it can be proprietary like that offered by Cisco. In either case, the data cable carries the power to the device at the end of 100m of Cat 3 or Cat 5 standard cable. This is referred to as in-line power. The two standard versions of PoE use different cabling arrangements. When the power is generated by the LAN switch, called end span, the power is carried on the data wires used by the LAN NIC, pins 1, 2, 3, and 6. The spare pairs are not used.

The second standard configuration, called the mid-span design, uses the spare wires, pins 4, 5, 7, and 8. The mid-span version has an external power supply placed between the LAN switch and the end device (IP phone). The mid-span solution will probably require rewiring inside the LAN closet to accommodate the power supply. Cisco uses the end span design with negative voltage while the 802.3af standard uses positive voltage.

LAN switches are available in many configurations. Some support all three PoE versions. There are other LAN switches that provide PoE to some but not all the LAN ports. The standard is designed to deliver up to 12.95 watts to the end device. Power is lost passing through the cable, therefore the PoE LAN switch output is designed to deliver 15.4 watts at the LAN switch port. This is enough to power IP phones but not PCs or laptops. Working back to the AC side of the LAN switch, this means that a maximum of 17 to 18 watts may be

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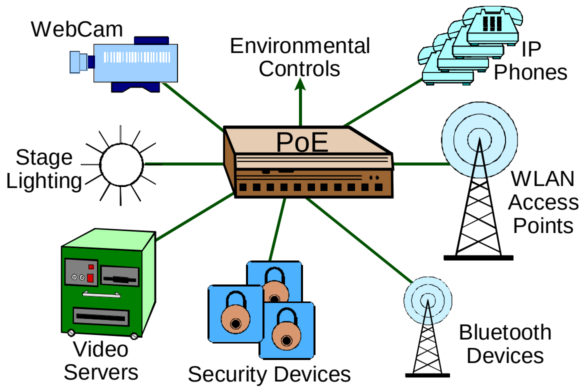
**Figure 1. A power utility**




consumed per LAN port. This seems like very little power until it is multiplied by the number of IP phones. Most IP phones need only 4 to 8 watts of power. The total power can easily exceed 1,000 watts per PoE switch.

A non-redundant Cisco Catalyst 6000 LAN switch requires 1,300 watts for operation supporting 240 PoE ports. The redundant power supply version consumes 2,500 watts for the same 240 PoE ports. The Avaya Cajun LAN switch supporting 24 PoE ports consumes 375 watts for the switch and an additional 150 watts for 24 PoE ports. This consumption of power will affect the air conditioning and backup power for VoIP. Are the closets powered by 110VAC? This is not enough power for larger PoE LAN switches. The closet must be upgraded to 220VAC with new receptacles, and the available amperage must be increased to support the larger PoE switches.

PoE should be thought of as a power utility rather than an IP phone powering system. The closet power designer must take a long view of PoE. The LAN switch is evolving into a significant provider of services. The LAN switch will be delivering QoS and security services that are also part of the IEEE 802 standards family. There are specific wireless LAN switches on the market that power wireless access points (APs) and deal with the problem of roaming wireless users. The WLAN switch keeps the session or call up as the user moves from AP to AP.

There is more to PoE than just VoIP. Think beyond the IP phones and APs. (See Figure 1.) If the closet design does not anticipate the other devices that will eventually connect to the PoE switch, then another round of closet modifications, air conditioning extension, and AC power upgrades will be required. The future of PoE devices will include video cameras, surveillance devices, Bluetooth devices, security sensors and access devices, lighting controls, and environmental controls.

### Safety Issues: 911, E911, Lifeline

Ensuring that a victim can be located quickly and accurately by EMS personnel in an emergency will depend on the functioning of the 911 and E911 services. Supporting 911 will require outside legacy circuits to the public safety access point (PSAP). These circuits will be terminated in the MDF and then must be connected to the VoIP equipment that issues the 911 call.

This will not be a problem when the VoIP equipment and IP phones are all in the same location. When there are teleworkers and telestudents using IP phones on a WAN connection, which PSAP should be contacted? Even if the VoIP system can identify the caller's location, the VoIP system will probably not have a connection to the person's local PSAP. This is a problem yet to be solved. The solution will go beyond the closets on the VoIP site.

E911 produces an even greater problem. The ability of users to physically move their phones without requiring a cable change to another LAN connection is attractive. This move, however, will require instant updating of the location information with the PSAP. PSAPs are not ready for this rapid change, nor are they ready for a direct VoIP connection. This problem will only worsen when a campus deploys voice over a WLAN where there is constant location change during the call. Before these 911 and E911 problems are solved, a working solution is to have some legacy phones that do not pass through the VoIP system placed in strategic locations and connected to the carrier central office (C.O.). This will require that more of the internal legacy cable be retained, and the MDF will have to remain in use as well.

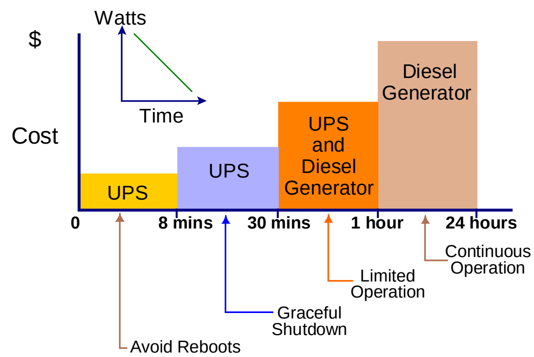
Lifeline is a different issue. Most telephone users expect the telephone to work during a power outage. That is because the PBX and C.O. have battery backup and possibly diesel power generators. A lifeline connection is a selected group of phones connected directly to the C.O. that will work when there is a total failure of the PBX and/or power. Unless all the associated VoIP equipment and LAN devices have backup power, phone service will cease to operate during a power failure. Lifeline connections to the C.O. will still be required because the VoIP system—for example the call server—can fail.

### Backup Power

Electrical power has actually become less reliable and has produced very long outages in the past few years. When the power industry published statistics on their reliability several years ago, an IT department would have about 15 interruptions a year. This would cause a reboot of the IT devices if no uninterruptible power system (UPS) were connected. Ninety percent of the outages lasted less than 5 minutes; 99 percent lasted less than 60 minutes. The overall reliability was 99.98 percent. (See American Power Conversion Technote # 26 at www.apcc.com.)

If the telephone service was restored at the same instant that power was resumed, there might not be any complaints. However, this does not happen with VoIP systems unless UPS is installed. The budget for UPS grows as the number of supported devices increases. The VoIP server outage continues while it reboots its software after a power failure for 2 to 20 minutes depending on the configuration and vendor design. No phone calls can be made during the software reboot. Therefore all call servers must have UPS support to avoid this reboot period.

**Figure 2. Run-Time Evaluation**




This does not include the voice gateways, IP phones, softphones, and LAN switches. When these are down, no calls can be completed. There is no dial tone. When power is restored, the IP phones, softphones, and voice gateways have to re-register to their server before a call can be completed. This re-registration time can vary greatly. The registration rate is vendor dependent and can vary from 20 to 60 IP phones and gateways per minute. The larger the network, the longer it takes to restore service to all users. At the moment there is no way to preselect which devices can register first. If the calls off campus pass through the routers, not through the C.O., then they must be included in the power backup plans.

There are three types of UPS on the market. The least costly unit just provides backup power and is called *Standby* or *Off-Line* UPS. This unit has no power regulation. Power regulation compensates for power fluctuations that are not outages but are variations in the voltage delivered by the power utility. Power fluctuations can damage the IT equipment. The next type, called *Line Interactive*, provides backup power and limited power regulation. The best unit, the *On-Line* type, provides full power regulation and backup power.

The next decision to make concerns the length of time the UPS will operate during a power outage. (See Figure 2.) As noted earlier, 90 percent of the outages are less than 5 minutes. A minimum UPS power backup of 8 minutes would avoid most software reboots and would prevent device re-registration. If the backup requirement extends to an hour or more, the air conditioning, heating, lighting, and other power consumers must be operational. This leads to the decision to install a diesel generator. The small graph on Figure 2 shows that as the run time increases, the power available from the UPS decreases.

### Air Conditioning

The typical IDF has no air conditioning. The MDF may have air conditioning for the PBX and associated equipment, but it will probably be inadequate for the new VoIP servers, gateways, and PoE LAN switches. Planning the air conditioning facilities depends on the closet equipment installation. This will then determine ▶

Cooling the Closet

The IDF telephone closet has little or no equipment that produces heat. The light bulb, temporary test equipment, and humans were the heat sources. No air conditioning (AC) is required. With the advent of voice gateways and PoE LAN switches, the heat generated has increased to a point where attention must be given to AC. The following formula for determining the heat generated in watts was derived from White Paper # 69, found at www.apcc.com.

Determining Heat Output

| | |
|---|---|
| 1. Sum up the watts consumed by IT equipment | ___________ |
| 2. Sum up the PoE LAN end-span switch input power x.6 | ___________ |
| 3. If a mid-span PoE is used, sum up input power x .4 | ___________ |
| 4. Sum up the full lighting in watts | ___________ |
| 5. Multiply the UPS power rating by .09 | ___________ |
| ADD WATTS ALL TOGETHER TOTAL | ___________ |

The next question is what does the total of the watts mean. The answer depends on the result of the calculation. The table below provides guidance for the closet designer.

| TOTAL WATTS | RECOMMENDATION |
|---|---|
| 100 to 500 watts | Place grill vents at the top and bottom of the closet door that connects to an area that already has air conditioning (HVAC). |
| 500 to 1000 watts | Place a ventilation fan above the closet door and install a grill at the bottom of the door that connects to an area that already has air conditioning. |
| 1000+ watts | Install the equipment in an enclosed rack with a hot-air exhaust scavenging system so that the hot air does not recirculate. An air intake grill from a HVAC area will also be required. |
| 1000+ watts | If the HVAC is <u>not</u> accessible, then a separate HVAC system should be installed adjacent to the equipment. |

the heat output and whether the present cooling capacity is adequate. Guidelines for planning are provided above in "Cooling the Closet."

### Closet Thinking

The investment in VoIP will expand to include a number of physical plant considerations: closet size and number of closets, power, UPS, air conditioning, cabling, and conduit space. It will probably be impossible to eliminate the IDF and MDF closets. Some of the legacy cabling will still be used, and the connections to the carriers will continue to exist in the MDF.

Once the design for the physical plant is finished, the questions you should ask yourself are:

1. How did you satisfactorily demonstrate that the physical installation works properly and to specification?
2. How long did this verification take, and was it worth it?
3. Could this effort be reduced in the future?
4. Were there incorrect assumptions made when planning the closet changes?
5. Did the vendor(s) forecast the physical changes necessary for their products?
6. Should a single closet be set up first to work out the problems? This would be very useful if there are going to be many closet changes in multiple building locations.
7. Is the closet design really future proofed? For how long?
8. Will changes in converged technologies antiquate the new design? As equipment becomes smaller, will the power consumed and heat generated per square foot of closet space increase considerably?

The institution has to build a better road (physical plant) before new types of vehicles (converged devices) can travel faster and safer on it.

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