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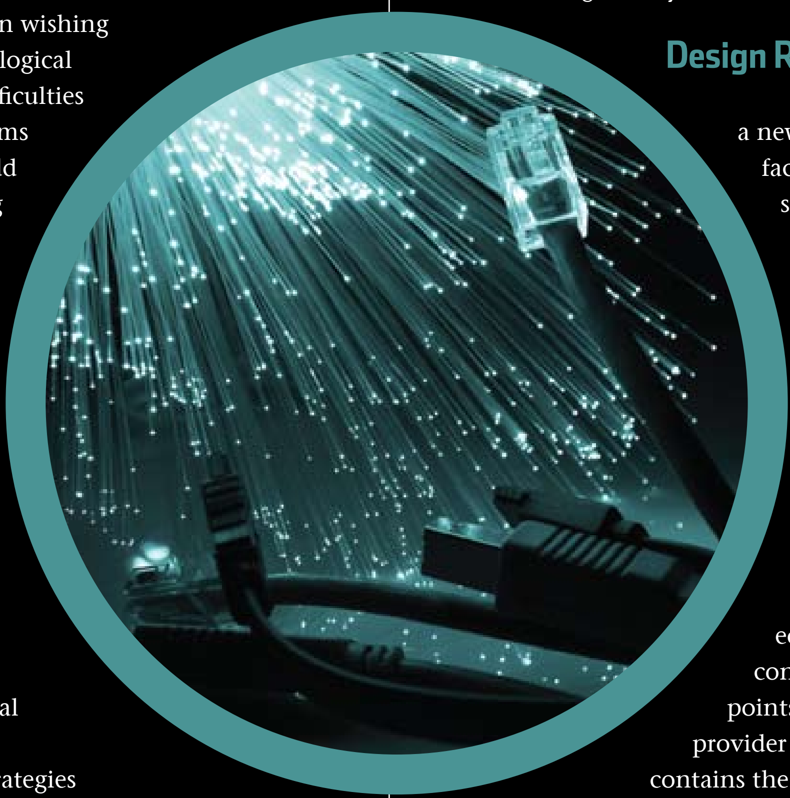
MULTIPLE TECHNOLOGIES, MULTIPLE DISCIPLINES

Challenges integrating ITS with building design. BY BRUCE TURNER, RCDD

The information transport systems (ITS) industry continues to witness the rapid development of new and improved technologies. New design approaches are often presented to designers, installers and end users as discrete applications. An organization wishing to integrate multiple technological advances may encounter difficulties interfacing the various systems with the building design. Add the difficulties of integrating multiple technologies to the complications of the interdisciplinary design process, and you get a picture of the task currently confronting the ITS designer. It is important that the infrastructure designer considers each technology as part of a larger, single system rather than as isolated components. Doing so will help to avoid potential integration difficulties.



This article examines strategies taken to integrate voice over Internet protocol (VoIP), fiber to the enclosure (FTTE) and power over Ethernet (PoE) into a new educational facility. It also points out potential complications that may be encountered when applying multiple ITS technologies simultaneously. The project design decisions relating to the building footprint, equipment room locations and emergency power influenced the deployment of the desired ITS technologies. The challenges encountered substantiate the need to thoroughly integrate ITS and building infrastructure designs early in the design stages of a project.

Design Requirements

The school district built a new 77,000-square-foot facility that consists of two separate, nearly parallel wings—academic and activities—connected by two elevated walkways. The academic wing houses nearly all of the classrooms, the administrative offices and the library. Also included in the academic wing is the main telecommunications equipment room (ER), containing the demarcation points (DPs) of the service provider (SP). The activities wing contains the gymnasium, multipurpose room and music and drama classrooms.

The school district imposed the following design constrains:

- The structured cabling system would employ FTTE with an enclosure in each classroom and each office area.
- The voice system would utilize VoIP.

- Telephone handsets would be powered using PoE technology.
- Emergency power would be provided via uninterruptible power supply (UPS).

FTTE Design

As dictated by the school district, the structured cabling system included the FTTE topology, which consists of radial optical fiber cabling from a central ER to telecommunications enclosures (TEs) located near network end users. This topology provides an advantage against a single point of failure. With a network switch installed in each TE, failure of a single switch affects only a small portion of the entire facility. FFTE also pushes the high-bandwidth portion of the network closer to the end users and reduces the amount of building floor area dedicated to the ITS.

The disadvantages of deploying FTTE include decentralized maintenance and potentially higher electronic equipment costs. For the school project, distributed enclosures also mean that maintenance must either disrupt classes or wait until after classes dismiss for the day. The cost of a smaller switch in each TE is potentially higher than the cost of fewer, centralized large switches—the aggregate number of switch ports purchased using FTTE can exceed the quantity of ports that would be purchased under a centralized scheme. However, when the cost savings due to reduced building area is considered, the increased equipment cost for FTTE is partially, if not totally, offset.

For the school project, optical fiber cables connect the main telecommunications ER to each classroom/office TE through a cable tray system above accessible corridor ceilings. Nonmetallic, flexible raceways within the tray system protect the optical fiber cable against physical damage. The cable distance advantage afforded by fiber distribution allows a single ER to serve the entire facility.

Metallic raceways within the walls connect the cable tray system to the TEs and provide a pathway for the optical fiber cabling. Per bonding and grounding (earthing) recommendations, a copper conductor bonds each TE to the telecommunications bonding backbone (TBB) located within the cable tray system, and the TBB bonds to the telecommunications main grounding busbar (TMGB) back in the ER.

Each classroom TE contains a network switch with a fiber uplink and Category 6, unshielded twisted-pair (UTP) ports. Radial Category 6 UTP cables provide network connections from the enclosure to workstation outlets located within the respective classroom or office area. Metallic raceway provides a cable path from each workstation outlet to above an accessible ceiling where cable hooks support the UTP cables. In addition to workstation outlets, classrooms also contain Category 6 connections for wireless access points (WAPs) and video projector management.

In the FTTE application, radial optical fiber cabling from a central ER connects to network switches located in each of the TEs.

The space above the accessible ceilings is an environmental air plenum, which reduced the required amount of sheet metal ductwork for the heating system but necessitated the specification of plenum-rated cable and flexible raceway. It was determined that the additional cost of plenum-rated cable would be more than offset by the reduction in heating, ventilating and air conditioning (HVAC) ductwork costs. The ceiling air plenum also reduced the potential for physical conflicts between the ductwork and cable tray.

Installing the TEs in classrooms mandated consideration of the Americans with Disabilities Act (ADA), which requires that no projection from a wall be more than 100 millimeters (mm [4 inches (in)]) when located within a zone generally accessible from the floor. In order to provide easier access for maintenance, the owner specified an enclosure height that fell within the zone governed by ADA. However, it was necessary that

To comply with the ADA protrusion requirements and maintain appropriate enclosure depth, the enclosures were recessed into the wall.

the depth of the FTTE enclosures exceed 100 mm (4 in) to accommodate active electronic equipment.

To comply with the ADA and maintain the appropriate enclosure depth, the enclosures were semirecessed into the walls. This arrangement concealed the cabling but made it impossible to locate the TEs back-to-back within the same wall. In addition, because the enclosures were partially recessed, the building design had to include special wall construction to allow proper ventilation of the enclosures. An internal fan aided ventilation, and to negate any noise produced by the fans, sound dampening was necessary within each enclosure. Placing the TEs in classrooms and offices required close coordination with the project architect to produce the necessary building details.

Deploying VoIP

In parallel with the design of the new school, the school district began developing a new wide area network (WAN) to link all district buildings together via optical fiber. As part of the WAN development, the district decided to deploy a VoIP telephone system rather than use a traditional private branch exchange (PBX) platform. The VoIP system provides a simplified dialing plan for all faculty and staff within the district regardless of the building location. However, the VoIP system itself could not meet all of the district's voice requirements.

Analog lines were still required to provide central reporting from the fire alarm system, the security system and the elevator. The lighting system installer programmed the lighting control system remotely through a modem with an analog connection. The school also wanted a voice paging system accessible through the telephone handsets, and an analog port on the VoIP server provides the necessary interface to the paging system. Manufacturers of equipment requiring traditional analog voice connections have not been quick to adapt their systems to a digital format. Until ancillary systems can accommodate VoIP, analog voice service will remain a requirement for most commercial buildings.

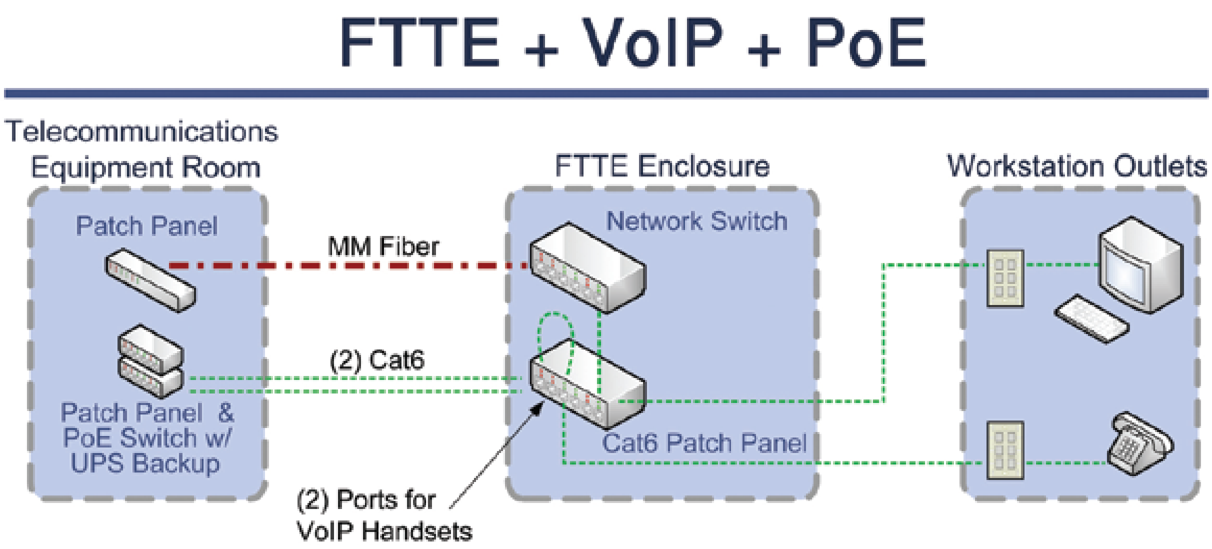
Powering Devices with PoE

Along with the decision to deploy a VoIP system, the school district decided to include PoE technology to simplify the power supply requirements for the telephone handsets and for the WAPs located in each classroom. The district needed to make the VoIP system available for emergency communications in the event of a utility company power failure. Since an emergency generator was not included in the project, the alternative for providing backup power for PoE switches in the TEs was multiple UPS.

The first UPS approach considered included distributed units in each TE. Rack-mounted UPS providing 30 minutes of reserve power was available for installation in each TE. However, the district required 90 minutes of backup power for as many telephone handsets as possible. Unfortunately, UPS able to provide 90 minutes was too large for the TEs. To meet the 90-minute requirement, the design ultimately had to incorporate a central UPS in the ER with centralized PoE switches. While this provided maintenance and first-cost benefits, UTP cabling was now required between the ER and each TE to support VoIP and PoE.

Providing Emergency Power

The new school also was required to conform to the *International Building Code®* (*IBC*), which requires emergency electrical power for exit/egress lighting and the fire alarm system. A central emergency generator would have met this requirement and provided emergency backup power for the PoE switches, but the school district had made an early decision to provide individual battery-powered units rather than a central generator.



Hybrid Solution

In order to integrate FTTE, VoIP and PoE within the constraints of the project, the design team eventually developed a hybrid FTTE system. The hybrid design designated two ports on each patch panel in the TEs as "voice" ports. Any workstation port in a classroom or office can be connected to a VoIP/PoE channel using a patch cable at the TE patch panels. Category 6 UTP cable connects these ports to a central PoE switch in the ER where a central UPS provides backup power to the PoE switch and the VoIP server. The remaining patch panel ports in the TEs are available for connection to the local area network (LAN) and WAN over fiber through a network switch located in the TE.

This hybrid approach limits one of the advantages of FTTE—increased backbone lengths. However, it allows for longer emergency power backup for the VoIP handsets than would have been possible with smaller UPS units installed in the TEs. The hybrid approach ultimately enabled the ITS to support FTTE, VoIP and PoE while honoring the school district's request that an emergency generator not be included in the project.

Summary

FTTE is a viable topology for educational facilities primarily because it extends the high-bandwidth portion of the network closer to the end users and reduces the building area required for the ITS. However, VoIP/PoE deployment in conjunction with FTTE requires the system designer to consider the need for, and the application of, emergency power. VoIP likely will become more common in the near future, but until building systems that now require analog voice circuits are capable of using digital connections, ITS designers also must accommodate traditional voice circuits. It is clear that ITS designers must effectively interface with other members of the building design team to ensure the successful integration of all building systems.

This school project demonstrates the potential difficulties encountered when implementing multiple ITS technologies. It also reveals how building design decisions can affect and constrain ITS options. As building design and ITS design become more tightly integrated, and as design teams better understand how one affects the other, the application of integrated technologies will become easier. ■

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