Copper Applications

A Case Study

TELECOMMUNICATION

An Old Timer Gets a Nervous System Transplant

The 86-year-old Philadelphia Museum of Art building gets updated to the 21st century

Designing a voice/data/video infrastructure for a new building is challenging, but bringing an existing building up to speed is an even bigger challenge — but it is well worth the effort because there are far more existing buildings to be updated than new ones on the drawing boards.

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The Philadelphia Museum of Art is a beautiful old building with a world-class art collection. (It even appeared in the "Rocky" movies when Sylvester Stallone ran up its front steps.) The project to expand the space within the building is a fascinating story of challenges faced and met.

Updating an existing building means breaking into walls and ceilings to run cables, and finding space to install computer closets and more, with minimum disruption to the existing occupants. This makes it especially important to plan a system that will be flexible enough to adapt to any new technology that will come along in the next ten years or more so it won't have to be redone as soon as it's finished. The project at the Philadelphia Museum is a worst-case scenario for several different reasons. It's important for the public to still have access during the course of the work, the building itself is an important landmark, and it's filled with priceless artwork. So "if you can make it here, you can make it anywhere."

The Museum's History

The collections that are currently housed in the museum were begun at the 1876 Centennial Exhibition celebrating the 100th anniversary of the Declaration of Independence. In 1895, a competition was held for the design of a permanent museum, but the present location wasn't chosen until 12 years later, in 1907, and it took another decade to resolve issues about whether there would be a single grand building or several smaller ones and how they would be located on the chosen site. Although construction was begun in 1919, the single large building wasn't completed until 1928.

Expanding the Network

Before 1992, there were analog telephone and intercom lines, analog security cameras; an auditorium, meeting rooms, and a lecture hall, each with their own audio-visual setups; and about half a dozen computers all around the building, recalls Stephen Bikle, the Museum's Voice/Data Network Systems Engineer. In that year it was decided that the voice network should be updated and cabling for a data network installed. The first step was to pull Category 5 UTP cable to the existing offices and workspaces, although there didn't seem to be a need to extend the cable to the galleries. "We put in two main closets at that time, one for voice, housing a Nortel PBX and main distribution frame (MDF) for the voice cables, and one housing the data MDF, with a rack for servers" said Bikle. "We carved out space throughout the building for 11 IDF (Intermediate Distribution Frames) closets for both voice and data to aggregate cable drops to rooms and simplify connecting the MDFs. The cabling was Cat 5 from the jacks to the IDFs for both voice and data; with the voice cables connected to 110 blocks and the data cables to patch panels. From the IDFs to the main frame, the voice traveled on 100 or 200 pair Cat 3 cables, and the data was carried by multimode fiber optic cable," he added. Hubs were installed in the IDF closets to combine the data signals onto the fiber, and in the data MDF to pass signals from the various IDFs to each other.

"As people began to realize how useful computers were, especially when networked so that they had access to email and could share printers, more were added and because all we had was a flat network, there began to be an unacceptable number of data collisions," he went on. In order to make the expanding system workable, telecomm personnel had to break it up into smaller segments by adding switches. At first, they installed a switch in the server room. Not too long afterward, they changed over to switches in the closets and a faster switch in the server room. As more and more was asked of the network, they went to core switches with layer-three routing, which greatly expanded the amount of data they could handle. Most of the existing cabling has now been replaced with Cat 5e, or 6 and all new networks have been cabled with Cat 6a, which Bikle is confident will meet their needs for the foreseeable future.

The Network Now

The new switches currently being installed are even faster — enough to handle a 10-gigabit fiber backbone and gigabit copper with Power over Ethernet (PoE) for the horizontal runs. The next item on Bikle's agenda is to upgrade the core switches so they can take advantage of the bandwidth afforded by the cabling. The plan is to retain the horizontal runs to the desktop as Cat 6a. "The reality is that using copper transmission for the endpoints is less expensive than fiber to the desk. A Network Interface Controller (NIC) that uses copper costs much less than one that uses fiber, and in addition there is the higher cost of running and terminating the fiber at the desk," said Bikle. "They keep improving the copper," he continued "when it first got started we were thinking 10 Meg was a high-speed network, and now we're running gigabit. This combination of fiber backbone and copper horizontal runs is working well for us."

The Master Plan

It had been clear for some time that the museum needed far more space to display their collections and to accommodate more visitors. It was decided to solve this problem with expansions in a number of stages. In the year 2000 it was decided that they should buy the former Reliance Life Insurance headquarters, an art deco landmark, which was situated about 600 feet from the main building. The idea was to use it for additional gallery space, curators' offices, a conservation lab, and amenities including a study center, cafe, and gift shop. It was finally opened in the fall of 2007, as the Ruth and Raymond G. Perelman Building.

In the fall of 2006, the museum announced the second phase of a master plan for renovating and expanding the building that would ultimately add 169,000 square feet. Hiring Frank Gehry as the architect signaled the unusual nature of the project. Gehry is generally known for large, striking exteriors but in this case, the original façade of the historic building could not be altered. Gehry's solution was to blast out part of the bedrock underneath the museum and build downward so as not to alter the way the building looks from the street.

The first phase of this downward expansion was completed in late 2012. This is a new 68,000 square foot art handling facility, designed to ease the way art is moved in and out of the building, to provide greatly expanded work space, and a new home for the video production studio for the museum's distance learning program.

The Perelman Challenge

Connecting the Perelman Building to the network was one of Bikle's more challenging assignments. Yes, it was only 600 feet away, so all that was needed was to run a communication cable between the two buildings. The standard way of doing that is to dig a trench, lay in the cable and cover it over. The problem here was that between the two

buildings were two major avenues and a railroad. Digging a trench for communication cable across these barriers was logical, but as Bikle put it, "the pricing was very scary." The communications link was therefore tabled for the time being.

Meanwhile there were other problems with Perelman. The project included an addition to the building, which was going to make the existing heating and cooling systems inadequate for creating an "art grade" environment. Furthermore, there wasn't enough space to put in the chilled water plant and steam plant that would be needed.

A city engineer, who was taking part in the planning meetings to consult about the heating and cooling problem, suggested that since IT wanted to dig a trench for the communication cable, why couldn't they enlarge it and run chilled water and steam from the main building. The icing on the cake came when the electric company said that the easiest way to get the needed power to Perelman would be to tap off the feed coming into the main building. That settled it — well almost. Management still said no to the communication cable.

Bikle then argued that the hardest part, obtaining permits and permissions, will already have been done so why not put a couple of extra conduits into the trench. So they ran the conduits under the street and over the railroad. The railroad used to run below ground level in an open cut, which had been covered over years ago. There was four feet of earth over the railroad tunnel, just enough to run the service trench (but unfortunately, not quite enough for a pedestrian tunnel, so the two buildings would only be linked together virtually).

Creating One Big Network

The different phases of the project created three distinct IT networks that had to be converged: the updated networks in the preexisting space, the networks in the newly constructed areas under the main building, and the networks in the Perelman Building.

The approach was to add a core switch to the server room in the main building and to build a new server room with a core switch in the Perelman Building. They are connected together with a fiber cable to provide a 1G link between the two buildings. These two server rooms are intended to be the Main Distribution Frames (MDFs) for the network. They are primarily racks full of fiber jumpers because all of the backbone legs are fiber. They also serve as distribution closets, feeding copper cables to the areas of the building that are nearby to them.

Still a work in progress, are two legacy MDFs in the main building, which are slated to be removed during the next phase of construction. One of them is dedicated to analog communications, such as voice and fax that will gradually be converted to digital. "The other was the original server room, which we have quickly outgrown," said Bikle. It serves as the MDF for the fiber that comes into the main building from Perelman, from the security office, and from all the intermediate distribution frames (about 12 closets throughout the building). "So we have to be planning to transition over to the new MDF in the server room," continued Bikle, "but we still have a lot of telephones that are legacy, not IP, so we have a bit of work to get them switched over to IP."

Wi-Fi

"The big project we've been working on since the new art handling facility, is setting up wireless access," said Bikle. There are two wireless networks throughout the building: an encrypted one for museum employees, which connects to email and other back-of-house servers and a public network, which allows anyone who walks into the building to directly connect to the Internet. There is some thought that visitors might first be shown a login screen on their device so the museum staff would have some idea of how many people are connected.

The question of whether the public wireless network will be used to provide visitors with information, perhaps even interactively, is still up in the air — or up in the cloud. There are ongoing discussions about the details of how that should be done; including possibly doing the gallery art information over the public Internet or maybe even having it hosted on the museum website. Another option is establishing a third network just for this purpose.

"My brief was just to get the infrastructure out there first; future uses haven't been worked out yet," said Bikle. "I've just been responsible for getting the WAPs (Wireless Access Points) wired and installed and the VLANs (Virtual Local Area Networks) and the switches set up so they talk to the controller."

The wireless networks are supervised by a Cisco Systems controller that is connected to all of the Cisco Wireless Access Points. It does the frequency and power assignments based upon what it is seeing back from the network.

The WAPs are all run with Cat 6. The cost differential between Cat 6 and 6a would be enough to make a huge difference in the cost of the project, so it was decided that Cat 6 would be adequate. It didn't really seem that a 1G connection to the WAPs would be useful in the near future.

It was challenging to decide how to place the WAPs in the galleries. It would be logical to mount them above the ceilings, but there are several problems with that. Many of the galleries have finished ceilings and some are even impregnated with asbestos; though it's been abated, you can't put holes through them. Furthermore, "the curators don't like to see anything that looks 'techy' hanging above the 19th century art," said Bikle.

Experiments showed it worked just as well to put the access points above the plaster and that was doable in most of the art spaces. Some galleries even have drop, or lay-in tile ceilings, so you can just place it in that space. The only places the access points are allowed to be visible is in the offices.

Audio-Visual

"We have a fairly large sized AV Department," said Bikle. Initially the department provided public address systems, set up equipment to show slides for lectures and so on. Those were largely self-contained and locally done. Over the years the technology has changed, however, from 35 mm slides and automated projectors controlled by cassette tapes to PowerPoint computer-controlled presentations. As large-screen video has become available at reasonable costs, they've been able to create more and more video presentations in support of particular exhibitions. In the last couple of years, a lot of the control equipment has moved to an IP network so now there are a couple of VLANs set aside for AV control over IP. The IP network control allows the AV staff to control power and other settings, check the status of equipment, and even turn it on for an unscheduled tour, all remotely from their desks, saving a lot of running around a very large building.

The curators increasingly want videos to accompany the art. For example, to accompany a clothing exhibit, the costume and textile staff was able to display old footage of that clothing being modeled on the runway at fashion shows.

"We don't do much content delivery over IP yet," said Bikle. "At this point, content is still sourced from the closest closet to the room, but is increasingly carried over Cat 5 or better cable." The AV people have their video server in the data closet nearest to the room it's being delivered to. They use what they generally refer to as Cat 5 adapters, which are basically baluns that allow the video to be run on twisted pair instead of coaxial or specialty cable. Although they call them Cat 5 adapters, they can be used with Cat 6 cable for better quality and longer distances. There's cable running into the gallery—either some of the preexisting Cat 5 cable and more and more, new Cat 6 cable, to the most often used locations. Then the adapters convert the signals back to cables that are compatible with the video and audio equipment.

"For the new galleries, the audio-visual signals will have to be hardwired because wireless won't give them the bandwidth and reliability that they need for high-quality presentations," said Bikle. A problem is that the location of the screens will vary depending upon what the curators decide will be the best arrangement for particular artworks. The best solution for this problem is to install power and data connections at concentration points and then extend them to wherever they're needed in the room. The problem with that is how to run the extended wires as inconspicuously as possible. "Sometimes there's no other way to do it but to run along the surface and then use a piece of wire mold to cover the run down to the screen," said Bikle. The construction crew then paints it to match the walls. The difficulty varies with the location. The main special exhibition gallery is designed for ease of running cable. Half of it has 9-ft ceilings with removable ceiling tiles and half has 18-ft ceilings with a gridwork that blocks the view of the heating ducts and so on. There it's fairly easy to run a cable — you just have to worry about bringing it down the wall as unobtrusively as possible — with cable molding. With galleries that have concrete or stone walls, however, the only thing to do is to bring the cable to a low point on the wall and tape it down to the corner where the wall meets the floor.

Fire Alarm System

Bikle said the fire alarm system was totally "stand alone" and not part of the building's Ethernet network. A Siemens IP-based digital system has been installed to converge the Perelman building, the new underground spaces, and the legacy system in the main building. As components of the older system are slowly phased out they are replaced by the new Siemens system. Since they're all tied together, "it was a little hassle at first because if one building alarmed, the other building alarmed also." These details are being ironed out, however.

Currently, the fire alarms have their own IP network with their own switches, although they share space in a lot of the closets.
There are hundreds of alarms and pull boxes throughout both buildings. There are smoke detectors all over the main building. There are sprinklers in the basement level and the new storage areas. Almost all of the two lower levels are workspaces and storage areas that have been basically retrofitted. There are no sprinklers in galleries yet, however. That project is scary for a lot of reasons. Some are obvious: how do you protect the artwork from being ruined by water — and soaking visitors for that matter. On the other hand, it may be better to have artwork that is wet, rather than destroyed by fire. Less dramatic, but just as complicated is how to deal with the complexity of installing the plumbing and sprinkler heads.

When a smoke detector, or heat sensor, or flow rate detector on the sprinkler system triggers an alarm, it immediately alerts the staff in the security office. They react by activating a pull box and calling 911. They have two telephone lines that go directly to the fire department. At the same time, since the Siemens system can pinpoint the location of the alarmed detector, officers are immediately dispatched to the scene. When the fire fighters arrive they are met by museum personnel at a prearranged location and guided to the trouble spot. There are also audible sounders and an audio component of the system that can broadcast canned messages or connect to a live public address system.

To be Continued...

Getting to this point in the project has been quite a task but this is only the beginning. Yet to come, are the brand new underground public areas — the part of the project where Gehry can utilize the full extent of his creativity. There will be many challenges in developing new networks and integrating them into the existing building systems, even while some of the older systems are still being converted to digital IP.

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