Exploring IT Standards for Academic Construction

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Overview

When it comes to construction of academic facilities, information technology (IT) is more of a concern than ever. College and university campuses are building new facilities and renovating older ones, and the IT landscape is constantly changing within and around them. New standards for such things as wireless and wired networking require the latest technologies installed by competent staff or contractors. While simultaneously being used to monitor and control the environmental systems of the building, IT equipment itself might be subject to environmental system regulations. Building systems are increasingly more automated, and the IT administrator now needs to understand such things as security systems, environmental monitoring, and even vending and laundry systems, all of which use IT infrastructure and have their own sets of challenges. Most importantly, the IT expectations of faculty, staff, and students might be characterized as unforgiving: we all expect IT systems to function properly and effectively all the time, every day, and we fully expect them to serve our current and future needs flawlessly.

This bulletin will help IT administrators determine how to document, verify, and think about IT standards for academic construction, including renovations and new construction for academic, residential, and administrative buildings and public spaces. While it does not address specific technical specifications or building codes, the bulletin does discuss methodologies to help administrators make effective, long-term choices for IT infrastructure. Standards and best practices are constantly changing, and IT administrators should avail themselves of the best information when they are making infrastructure decisions for building construction or renovation.

Conducting research about IT and campus buildings requires one to focus on a moment in time, since architectural developments, like information technologies, change very rapidly. This bulletin focuses on IT issues in buildings on a typical U.S. university campus today—largely on planning for IT in renovations and new construction—while recognizing that architectural advances and increasing adoption of smart building technologies will ultimately alter the landscape tremendously.

Highlights

Over the past 30 years, IT at universities has gone from something only available from “computing centers” with high-priced mini or mainframe computers, through individual PCs on desktops, to the current always-connected world of laptops, handheld devices, mobile phones, scientific instrumentation, and platforms that are yet to be invented. Today’s students expect connectivity everywhere, for everything. Residence halls must be outfitted with the latest high-speed technologies in wired and wireless forms to support such things as on-demand video and music services. As faculty members continue to enrich their courses with instruction that takes advantage of broad-based media technologies, virtual reality, simulation, and the creative uses of social networks, our campus networks must be able to deliver music and video—not just for entertainment but for academic requirements. Classrooms must support the use of laptops and mobile devices in class by both faculty and students. Some universities
might have a public mission that requires them to have connections available for members of the community. Cell phones are no longer a luxury but a necessity that doesn’t tolerate dead zones inside buildings. Student centers need connectivity to support high-bandwidth video and the latest display and presentation technology. Underneath it all are building systems ensuring safety and energy efficiency, as well as advanced security systems controlling and monitoring access. Buildings must be interconnected with sufficient capability to support all these systems.

At Drew University, Embury Hall provides office space for the Center for Holocaust/Genocide Study and for Classics Department faculty. At the rear of the building is the university’s grounds department.

It is often considered easier to plan for and integrate technology into new construction than renovations, but most universities have a sizable number of older or historic structures that bring unique challenges in updating them for current technology needs. Older structures are generally less transparent to radio frequency signals of all kinds, don’t have easily usable pathways for communications cabling, and often have outdated electrical systems both within building spaces and in feeder cables to buildings. All must be addressed collectively in a technology upgrade.

Looking ahead, we can expect an increasing number of new academic buildings to be designed to take advantage of renewable energy and sustainable resources. At the University of Pennsylvania, a wall of windows in the engineering building has built-in blinds that are adjusted by a computer program that tracks the sun’s path. In Washington, D.C., a new middle school installed a system that shuts off the air conditioner when a window is open. As buildings get “smarter,” they become increasingly dependent on sensors and information technologies to monitor, track, and control the systems that keep them smart.1

Building Systems Dependencies

In the past 20 to 30 years, there has been an increase in the use of building automation systems, and in the past 15 years these applications have more and more used data communications networks to operate. The typical modern residence hall, for example, is likely to have all the following systems:

- Access control (electronic door locks, door alarms to discourage propping emergency doors open)
- Security cameras (fixed or remote pan-tilt-zoom cameras, standard or HD video)
- Fire safety systems (smoke/heat detectors, audible and visual fire alarms, panic alarm pulls, all with central station and lobby monitoring and alerting)
- Vending systems (snack machines, copiers, printers, laundry systems, etc.)
- HVAC control systems (for remote configuration, notification of system abnormalities, and continuous energy use monitoring for LEED compliance)
- Other building systems (elevators, lighting, A/V control)

All of these systems can be designed to access either wired or wireless Ethernet networks or, in some cases, to connect over serial or telephone protocols. Some only dial out when necessary, while others need a continuous data connection to a central server, which may be installed in the building or at a central location. Many of these systems have very little application-level security. Building systems are usually protected with a simple password (frighteningly often left as the factory default), and they do not use native encryption. Our current best practices isolate these systems on their own independent virtual LANs (VLANs) in order to minimize security risk and exposure to other users and applications. In some cases, end-to-end application encryption can be accomplished with a firewall or other custom hardware. The good news is that with the possible exception of video cameras, the applications themselves consume very little bandwidth, and cameras that use MPEG compression can use very little active bandwidth due to mostly observing static scenes with perhaps a handful of students moving through the frame at any time. It is important to discuss bandwidth considerations with the vendors and installers of these systems and software before configuration and installation time.

The Building Design Process

One of two main undergraduate classroom buildings, the Drew University Hall of Sciences is home to the biology, chemistry, mathematics and computer science, physics and psychology, and economics departments. Specialized facilities include a greenhouse, a research-grade telescope, a laser holography lab, a microscopy and imaging suite, and the Research Institute for Scientists Emeriti (RISE), as well as classrooms and labs for the natural and mathematical sciences.

It is very important that IT staff be involved with new construction planning at the early stages of the building planning process. IT considerations must be taken into account on a variety of levels, including building systems (power, cooling, security, telecommunications, and so forth), space (for telecommunications closets, networking equipment, wired and wireless access points, and so forth), and layouts for classrooms, dormitory rooms, laboratories, lounges, dining facilities, hallways, and other places in which information technologies will be used. The degree to which your building meets the IT needs of your community is determined by how early IT needs are decided as part of the design process and how well your strategy is articulated and developed as the building is designed. IT staff should review every draft of the building plans, ensuring that conduits and pathways are in place for data cabling, that the number and locations
of jacks in all rooms are appropriate, and that power and network drops are planned for wireless networks.

There are various ways that building projects are coordinated on college campuses. Many colleges have in-house facilities staffs, and some have external contractors on campus providing the facilities management function. In either case, an in-house or externally contracted project manager can be involved. Those project managers usually hire an architect who might be part of the facilities management organization or, more frequently, a professional architecture firm, hopefully one with experience both with academic construction and modern in-building communications technologies. Even today, you will find that architecture firms vary widely in their knowledge of how to integrate modern technology in building construction. At one extreme is the architect who doesn’t understand why you might want networking in your building, and at the other is the architect who tells the CIO that IT needs are the most important consideration in the design of a new building or branch campus.

The diversity of relationships in the facilities and project management functions of the university require an organized IT response. First, IT must be charged by an executive of the institution to be involved in construction planning and implementation. IT must be organized with the skills and staff necessary to respond to requests. This function could be met by anyone ranging from the CIO to a director of networking, a director of telecommunications, a manager of IT planning, or a task force comprising several IT staff members. However such a function is organized, they must have clear standards for how IT is deployed in campus buildings. A standards document should include minimum specifications for in-building and extra-building connections (fiber and copper—both twisted-pair and coax, as appropriate), but more importantly it should be a rubric for defining the usage of various campus buildings and how IT will need to be targeted both at building dedication as well as providing for a growth path for future needs over the life of the building and its communications systems. Such a document should be as specific as possible—even going so far as to specify a standard vendor for such things as structured wiring systems and rack hardware. It should define buildings or building spaces by their primary function and discuss the standard IT infrastructure for those spaces. It should define support spaces for IT infrastructure—building closets, conduit paths, and access panels. This document should have the ratification of the executive staff of the institution, and as much as possible it should define the “law of the land” for building construction. Because the document might describe specific

The Rose Memorial Library at Drew University underwent a $2.2 million renovation in 1982, and a $4.4 million Learning Center was added.
technologies and systems, it must be reviewed periodically and kept up to date, preferably in an enterprise knowledge management system with change tracking.

With IT staff assigned to the task of participating in a construction project, a ratified set of technology standards for construction, and a well-defined working relationship between architects, facilities staff, contractors, and IT, the project can proceed on a solid foundation. IT and other project staff may need to engage the community in conversations about specific uses of this space and identify special or unique needs. As much as possible, IT staff should be aware of building codes and construction standards, especially as they could impact IT functionality. Conversely, facilities and architecture staff will be best served by a working understanding of IT standards and expectations, and it might be necessary to share experiences and knowledge to ensure success. There must be a clear understanding of the abilities and limitations of IT and construction standards.

**Built in 1870 as one of three buildings to provide residences for faculty members of the new Drew seminary, Drew University’s Wesley House is the home for the admissions offices of the College, Graduate School, and Theological School.**

As the project progresses, there will be decisions to be made with respect to balancing project costs, architectural issues (both aesthetic and practical), and further compliance with relevant standards. These issues are usually resolved during periodic project meetings, and it’s extremely helpful if IT has a regular seat at those meetings. Some project managers and general contractors might not be used to this, but if IT is not there, it is almost certain that aspects of the project that impact IT will be discussed without important input from the IT organization. For instance, in a recent residence hall construction, where the building was being built for LEED Silver certification, IT was not involved in discussions when power was being brought to the building, and a building-wide electricity monitor was not installed at that time. The consequence was that the monitor had to be installed later, at additional cost and inconvenience.

**Practical Recommendations**

**Wired or wireless?:** Although this is typically one of the first questions to be asked, it is actually an imprecise question. While pervasive, high-speed wireless is likely a requirement for any campus building—the user communities demand it, and it’s the only way to support mobile learning—wired networks still provide higher bandwidth and better performance. A better question, perhaps, might be “How much wired, and how much wireless?” While you might be tempted to remove the wires in residence halls, students are likely to bring devices that hook up to wired connections for streaming media. Or you might find yourself using IP-based set-top boxes, and even the best wireless networks will be unable to handle the bandwidth needed for dozens of users streaming HD video.
signals at once. If the campus is a laptop campus like Drew University, you might still want to have classrooms with a wired network drop per desk or every other desk to support high-bandwidth classroom uses. Laboratory spaces might need wired jacks to mitigate effects of interference from or on laboratory equipment. Another thing that people—especially nontechnical people—seem to forget is that all those great wireless access points ultimately have to connect to a wire somewhere, which connects to a switch, which will usually have additional ports that can be connected to other wired jacks for a minimal incremental cost. For instance, our residence-wide 802.11n wireless local area network rollout also necessitated the upgrade from 100 Mbps switches to 1 Gbps switches. The incremental cost of adding ports to support our existing wired connections was small, so it made sense to add them with this iteration. In most cases, wired/wireless is still not an either/or question, and your specific needs and changes in the technology will determine what you need and where.

Conduit paths: Even in situations where you are not pulling Category 6 cable to each residence hall pillow, it is always cost-effective to install cable paths and conduits when a building is built or renovated. Installing conduit to each room ensures that your building is future proof (or at least future resistant) and will lower the cost of cabling later if circumstances and technologies change. This is also true about running underground conduit to new buildings. The incremental cost of running five four-inch conduits is not much higher than running three, and five will enable you to support future communications technologies.

Power: One of the most fascinating discussions about campus facilities revolves around access to electrical power. Even laptops and mobile devices that can access the Internet without a wire need access to electrical power to recharge their batteries, and people often forget this. Additional power outlets are needed to support the growing number of “wireless” devices. Of course, such consumption trends have an impact on the overall power budget of the building, and architects and electricians should be well briefed on the impact of computing on the spaces so that electrical systems are sized accordingly. You should also consider backup power for the data closets and access points (the latter likely provided by Power over Ethernet technology from a central data closet), with both UPS units and perhaps a building generator. Usually a generator installed for emergency lighting and systems can be sized to additionally support computer networking in the building. This is especially important if life safety systems depend on networking.
What It Means to Higher Education

Every time a construction project is begun on campus, it is another opportunity to ensure that the institution’s physical plant articulates the institution’s IT strategy. Having a well-documented IT strategic plan is the first step to understanding IT needs for new construction. From that, an IT standards document outlining guidelines for IT systems in building construction will enable the design process to proceed smoothly.

The primary IT organization of the institution must have expertise in IT-based building systems and some knowledge of construction standards. It must be able to collect and evaluate information from the user community about the functions and purposes of new construction and use that information to determine a specific deployment for a given project while meeting campus-wide standards. It must do this in concert with design, construction, or other project management staff.

Cost, of course, is often an overarching concern, and IT staff must be able to clearly identify costs and potentials for cost overruns. In the event that a space serves a function for the public as well as the institution, security, access, and other concerns should be addressed by the implementation plan.

Given that institutions of higher education exist in the public sphere and are often looked to as leaders in the innovative use of technology, having buildings and infrastructure that reflect that philosophy helps us achieve our goals.

Key Questions to Ask

- How does our institutional mission statement reflect its values related to IT?
- How do IT concerns and standards get incorporated into campus facilities decisions, including construction projects? Who provides oversight for this?
- Does our institution publish standards for IT infrastructure?
- How does our institution ensure that IT is involved at the earliest possible stage of building planning?
- What mechanisms are in place to ensure that IT has appropriate working relationships with other campus decision makers during the construction process?
- How does our institution assess whether IT staff members have sufficient knowledge of building systems that require use of the IT infrastructure?
- At what point in construction planning do we gather information about needs for technology in the building?
- What part of the project management process ensures that IT is being properly implemented in new construction?
Once a construction project is done, how do we determine successes and failures, including refining standards and procedures for the next project?

Does ongoing support/maintenance of the building reinforce the design goals of the IT infrastructure?

How do we allocate appropriate IT resources to supporting building technology, both in terms of budget and personnel?

Where to Learn More

- EDUCAUSE Constituent and Discussion Groups
  - CIO Constituent Group, [http://www.educause.edu/groups/cio](http://www.educause.edu/groups/cio)
  - Network Management Constituent Group, [http://www.educause.edu/groups/netman](http://www.educause.edu/groups/netman)
  - Learning Space Design Constituent Group, [http://www.educause.edu/cg/learnspace](http://www.educause.edu/cg/learnspace)
- Standards organizations:
  - Institute of Electrical and Electronics Engineers (IEEE), [http://www.ieee.org/](http://www.ieee.org/).
Endnote


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