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# College Services

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# Wiring Students for the Future

## A Primer on Structured Wiring for Student Housing

by Orrin Charm

*Networked Apartment Communications Gateway™*

When I was a college student (farther back than I care to admit) living in a dorm at NYU, we had one pay telephone at the end of the hall. Punch-card machines in the Computer Center were as close to being "on-line" as we ever got (our computer usage was doled out in milliseconds), and television was something we watched when we went home on weekends.

Times and technology have certainly changed since then. Today, many students will not even consider living in a place without high-speed Internet access, private telephone lines, and 100+ channels of digital video. Many universities are now requiring that all students have personal computers and Internet access, to get class information, to do research, and to communicate with professors and teaching staff. Some of them are even extending their internal Internet and high-speed data services to students living off-campus in private residences. Getting all of these services and other amenities to students requires an additional level of wiring and construction – beyond the traditional mechanical, electrical and plumbing that have been installed in the past. Communications wiring is now an intrinsic part of all new residential construction, and is being rapidly retrofitted to existing housing as well.

### How much wiring is enough?

That is probably the number-one issue among developers and construction managers today. In fact, college students are among the highest users of new technology services, The penetration rates of digital services in student housing exceed and often double traditional multifamily. What may be sufficient even for luxury housing might not be enough for residences on- or off-campus that cater primarily to students.

In many parts of the country, DSL and Cable Modem services are providing homeowners with their personal high-speed links. However, these services have proven inadequate for student residences. Even recently built multi-housing projects have been forced to rewire to provide adequate Internet access. Highly touted new Wireless data services have also proved inadequate in these environments.

The problems are issues of bandwidth and density. The basic form of data communications between computers uses a standard called Ethernet®. Ethernet provides connection to a computer network at speeds ranging from 10 Megabits per Second (10Mbps or 10BaseT), to thousands of Megabits per Second (using Gigabyte Ethernet and even faster protocols). These speeds require special high-speed cabling, designated as Category 5 and higher, and strictly limited distances (a maximum of 100 Meters, or about 320 feet, for Category 5, 5e, and 6 wiring). To travel over longer distances requires fiber optic cabling.

These requirements mean that ordinary telephone wiring cannot be used for Ethernet communications. In order to leverage their existing investment in telephone wiring, telephone companies developed methods of encoding or modulating Ethernet data so it could be transmitted over ordinary telephone wiring, similar to the way in which low-speed data can be transmitted using modems over dialed-up connections.

### Limitations of DSL

While the newer encoding technology, called Digital Subscriber Line or DSL, is much faster than a dial-up connection, it cannot approach the speed of Baseband (unmodulated) Ethernet, and has considerable limitations of its own. Those restrictions include speed – DSL usually tops out at 1Mbps under optimum conditions, distance – DSL only works for users less than 15,000 feet from the Telephone Company Central Office serving their location, and density – not all of the existing cable pairs can be used for DSL, so there are limits to the number of users in any service area.

These restrictions have led to situations at some multifamily sites, where the local telephone company was offering DSL to residents, and could not provide services to new users as the demand increased! In situations with high demand, such as Student Housing, this is a recipe for disaster.

*Building Communications Distribution Closet*

### Cable Complications

Cable System Operators countered with a different technology, designed to use the coaxial video network to provide Internet access, using devices called Cable Modems to convert the encoded data to Ethernet. Because the coaxial cable network has intrinsically higher bandwidth than telephone wiring, delivering high-speed data to users is less of a problem. However, the Cable TV systems were designed to provide only one-way transmission, and the Internet requires a return path from the user to the Internet servers, so that users can "surf" or search for the data they need.

Today, many students will not even consider living in a place without high-speed Internet access, private telephone lines, and 100+ channels of digital video.

This means that the Cable System Operators have had to upgrade their systems to provide two-way communications. The upgrades have been expensive and time-consuming. In addition, their distribution architecture does not lend itself well to two-way communications. As the signals go "upstream," they suffer from the effects of congestion and noise buildup, and from a host of security issues.

While Cable Modem services are not subject to the hard limits imposed on switched telephone-based services, Quality of Service suffers as the number of users increases. Cable Modem services can be blindingly fast when usage is light, but slow to speeds less than dial-up service when usage is heavy. Users who are downloading music or video files, or playing interactive games place a particularly heavy load on the system. In a college

environment, Cable Modem Quality of Service dips to unacceptable levels at times students need it the most.

**Networking without a Wire**

Wireless technologies, such as 802.11b or "WiFi," suffer from the same issues as DSL and Cable Modems – limited bandwidth and range in an atmosphere of high usage and a large number of users. While 802.11b works very well in an office environment, in a multifamily residential environment the bandwidth is too low to support a large number of heavy users, and the range limitations require a large number of access points – relatively expensive wireless transmitter/receivers that must also be interconnected with Ethernet cabling.

All of this points to hard-wired Ethernet as the most practical, manageable and cost-effective means of providing Internet and data access to students.

Wireless service quality is variable, depending on the distance from the user to the nearest access point, and the interference from walls, furniture and other objects. Many cordless telephones that share the same frequency bands can easily "jam" 802.11b signals, greatly reducing performance. In addition, the cost per user is rather high, as each user needs a wireless receiver for each computer they use. 802.11a provides greater bandwidth, but significantly shorter range (meaning more Access Points) and higher cost. Other 802.11 versions are still on the drawing boards.

Security is a large issue, especially with wireless systems, but also with Cable Modems and to a slightly lesser extent with DSL. Users should always use hardware or software firewalls.

Another factor to consider is that DSL, Cable Modem service, and Wireless systems all require some type of device for each connected user, to convert the signal to Ethernet. These devices are relatively expensive ($100 - $300 each), are proprietary to the system being used, and must be managed and inventoried as residents move in and out. They often become obsolete faster than they can be depreciated. Installing, removing and repairing these devices often involves service truck rolls, and adds significantly to the operating costs.

Calculating the cost of service per resident, the cost of equipment that must be installed at each computer in each unit, and the cost of installing infrastructure, property managers have found that DSL, Cable Modem and Wireless services usually cost more in the long term than a hard-wired Baseband Ethernet installation, even in retrofit properties, and have a lower asset value.

**The Hard-Wired Facts**

All of this points to hard-wired Ethernet as the most practical, manageable and cost-effective means of providing Internet and data access to students. This generally entails installing a Category 5e cable and wall data outlet at each student bed space, as well as common areas such as living rooms or kitchens.

To connect, users only need a Network Interface Card, which costs less than $20 and is built into most late-model PC's. Windows 98 and newer versions, as well as Macintosh operating systems, support Ethernet directly. Users are connected whenever their computers are turned on, and their telephone services are unaffected by the data connection.

Because of the distance limitations, the cabling must run to a data distribution location located within 100 meters of the farthest outlet. The data distribution room is preferably a secure closet or similar space, with adequate electrical power, grounding, ventilation and lighting. In some locations, additional heating or cooling may be required to keep the equipment within its operating temperature range. These rooms are usually interconnected with fiber optic cabling running to the location where the actual Internet or University Information Services connections are made. This central location is called the Internet Point of Presence (POP). The actual connection is usually made via one or more digital connections from the local telephone company, over T1 or higher speed circuits. These must be ordered well in advance of the installation date.

Data backbone distribution typically uses a type of fiber cable called 62.5/125-micron multimode fiber cable. Some installations are now using 50/125-micron multimode fiber, or even single mode fiber cable. The ISP or University IS department will often specify the preferred cable types. A pair of fiber strands is required for each connection, and it makes good sense to specify a 6 or 12-strand cable to allow for future expansion.

To lower costs, a small data switch can be installed in a common area in each residential unit, and a single Category 5e data cable run to the data distribution room. The switch can be located in a secure cabinet or Gateway recessed into the wall, similar to a circuit breaker panel. The cabinet requires electrical power for the switch. Putting a data switch in each unit also allows the residents to network their own computers and to share printers and other peripherals.

Where telephone and video cabling are also being installed or retrofitted, this Gateway can be the central wiring location for all services in the unit, and also provide distribution for telephone and video service.

**Designing for The Future**

This design provides many advantages for the future by facilitating interconnection of voice, data and video services as these services converge over time. The cabinet can also house an alarm system and energy management devices that enable monitoring and control of heating, air conditioning, hot water and appliances over the data network. The Gateway cabinet should be secure and located in an area that offers access by maintenance personnel if required.

Phone wiring generally uses the same Category 5e cable that is used for data, although a different color is often used to avoid confusion. Category 3 cable can be used for phone, but the cost savings rarely justify the lower-grade cable. The ANSI/TIA 570-A Residential Cabling Standards that serve as a guideline for communications wiring strongly discourage using the same cable for both phone and data services. Although split wiring is sometimes used, especially in retrofitting older buildings, it limits future performance and expansion.

Generally, as a minimum, at least one telephone cable pair should be provided for each unit, plus one for each resident or bedspace for a private line. Spare pairs should be provided for FAX machines or second lines, although many students have cell phones, which has reduced the demand for additional telephone services.

The telephone wiring can follow the same distribution path that is used for data. In some areas, the telephone company can deliver telephone service over fiber instead of copper wire pairs. However, this will increase the size and service requirements for the distribution rooms, which may need to provide backup battery power for telephone services. While the telephone and data services use similar technology, in most cases they cannot share the same fiber cable by tariff restrictions, and may use a different type of fiber altogether.

The TIA-570-A standard allows the use of 8-pin modular jacks for telephone wiring. This can lead to confusion, so the smaller 6-pin jacks are often preferred. Installing separate jacks for common and private telephone lines can also reduce confusion among residents. All data outlets should be wired to the TIA 568-A configuration.

**Video Game Plan**

Video distribution should use quad-shielded Series 6 (also called RG-6) cable. This cable has a distance limit of only about 150 feet, so additional distribution points may be required for video. The video distribution points are interconnected by a heavy rigid coaxial cable called "hard-line coax," although in some cases, and at higher cost, they can be interconnected with fiber. Another alternative for runs between 150 and 250 feet is Series 11 (RG-11) coaxial cable, which is larger and heavier than Series 6.

The video signal can be distributed within each unit by a passive device called a video splitter. Most cable system operators prefer that no more than four users be split from a single feed, so a second coaxial cable may be needed if more than four TV outlets are specified in any unit.

If you anticipate ever installing a Satellite (DBS) system, dual Series 6 coax should be used, and the coax should be tested and rated for at least 2.2GHz bandwidth.

Leakage and interference from CATV signals can be a problem in multifamily installations, so all cabling should be quad shielded, and low-leakage compression "F" connectors should be used, rather than older hex-crimp types. Unused cables should be terminated, either with terminator caps at the splitters or outlets, or by using self-terminating "F" connectors on the wallplates.

**Up Against The Wall**

Wallplates that contain outlets for telephone, data and video – called multi-service or Multimedia Outlets™, offer several advantages over individual plates. Wiring is simplified because all cabling to a wallplate can be run at once. There are less wallplates to clutter up the walls. And many devices require more than one service connection- a Cable Box may often require a telephone connection for example, or a video outlet may be needed at a computer.

*Multimedia Outlet*

Every communications wallplate should be near an electrical outlet, although the low-voltage and electrical wires should be kept as far apart as possible inside the walls. Wallplate height, color and finish should exactly match the electrical outlets.

All wiring must be home run from the outlet to the Gateway, or Distribution Room if a Gateway is not installed. Never loop between outlets.

**Security & Energy Management**

Security is on everyone's mind these days, and electronic burglar alarm systems are becoming a very desirable amenity, especially in off-campus housing. Many of the available Gateway cabinets can also house the central control panel for an alarm system, and take advantage of the available connections for AC power and a telephone line or Internet connection for monitoring. This eliminates the need for an external plug-in transformer that is easily disturbed.

Provisioning for Energy Management can be as simple

as installing a piece of Category 5e cable between the thermostat location and the Gateway cabinet. Many alarm systems are capable of connecting to a proprietary thermostat that allows the heating or cooling to be turned off or set back when the alarm is armed. Other more advanced thermostat systems can be controlled over the Internet connection, with the control hardware also mounting inside the Gateway cabinet.

For new construction, planning for communications wiring should begin at the earliest stages of architectural design. This is because the communications systems require spaces within the property to house distribution equipment and cabling management, and they also require pathways from those distribution spaces to every outlet, and back to the service POP. These pathways and spaces need to be clear of interfering pathways for mechanical, electrical and plumbing ductways, away from electrical wiring, and safe from vandalism or tampering. The distribution spaces need to be located in order to minimize cable run distances, and stay within length limitations. Once the architectural design is finished, it is often difficult to add these provisions later.

Many architects and engineering firms are still unfamiliar with the detailed requirements for these systems. The assistance of an outside firm familiar with the requirements, applicable codes and standards for all of the low-voltage systems should be considered. In many cases, service providers will offer to do the design themselves but that is rarely a good arrangement for the developer, and the designs will often favor the incumbent providers and offer few or no alternatives, should there be a change in providers or services in the future.

The design should conform to recognized standards and meet the requirements of all applicable codes. In particular, in buildings that are over two stories tall, riser-rated cabling may be required by fire codes, and firestopping will be required wherever cabling penetrates fire walls.

Where the systems are interfacing with existing University telephone, data or video systems, additional requirements may apply. Providing adequate security and authentication for off-campus residents may require extensive collaboration between University IS and an outside ISP, especially if the resident population includes any non-students.

Any Ethernet network for student access should offer Dynamic Host Configuration Protocol (DHCP) for enrolling new users. This saves time and greatly reduces user configuration issues, which can be critical when enrolling many new users in a short time.

**Installation & Testing Considerations**

Once the design is complete, it should be offered to bid by qualified installation contractors. Too often, the project is just given to the existing electrical contractor as an "add-on," which can cost several times what a bidding contractor would charge. Low-voltage cabling also requires careful handling and testing, which are often beyond the skill-set of an average electrical contractor who is not experienced in this field.

The low-voltage installation must be coordinated with the other construction trades, and may require some additional time in the project schedule. Rushing the installation may result in shortcomings and cable damage that will be expensive to correct later, and experienced wiring technicians may be in short supply if the project runs behind schedule.

All cabling should be thoroughly tested long before residents move in. Allow time for the service providers to get their distribution systems and outside connections completed and tested before connecting them to the units. Since college students all tend to move in within a few days, it will be a disaster if wiring or system errors are not found and fixed in advance.

Category certification testing for all of the data cabling is an option that is advisable if there are any doubts about the quality of the wiring; otherwise, it is a good idea to spot-check the system with a certification tester. All outlets should be tested with a wire map tester, which will locate shorts, opens or miswiring. All cabling must be properly labeled and documented, or it will be a nightmare when service is required.

**Retrofitting Existing Buildings**

For existing older properties, retrofitting communications wiring is now a cost-effective option. There are many companies that specialize in this type of work. Property owners and managers should not wait until they start to lose residents to properly wire their sites – getting old residents back is much more difficult than keeping them in the first place.

Depending on the type of construction and the age of the buildings, retrofitting wiring can be relatively easy, or very complex. It is usually cost-effective to upgrade the telephone and video cabling at the same time new data cabling is being installed. Retrofitting usually involves cutting holes in walls, and drilling between floors, so follow-up plastering and painting is usually required. For housing that rents by the school year, the renovations can be scheduled for the summer months when the buildings are unoccupied. For properties that rent year-round, construction will need to be carefully coordinated to minimize disturbance to residents.

If wiring is being done in occupied units, the installation crews must be particularly careful to respect student privacy. Work should be scheduled to avoid interference with residents' sleep or study needs – recognizing that students' sleeping habits can be very unorthodox. Any workers that may be working inside residences, or come into contact with residents should have thorough background checks, and be bonded. Otherwise staff or maintenance personnel should accompany them.

Often, new wiring can be coordinated with kitchen renovations, or other work that will make it easier to hide the wiring as well. New wiring can also be run inside hollow molding, or a soffit chase can be constructed in hallways. It is best to keep all cabling inside of the building shell, rather than on the exterior or on the roof, where it is subject to weather damage.

Often in a garden-style retrofit situation, the cost of connecting all of the buildings to the POP location is significantly higher than the cost of wiring within the buildings. Trench access may be blocked by pavement, parking lots and landscaping. In these situations, alternative technologies to Baseband Ethernet may be considered. Long-Reach Ethernet, short-haul cable modems, or even point-to-point wireless can be deployed as backbone technologies, if underground wiring is not feasible. From building distribution points, Baseband Ethernet would run to each data outlet.

If new underground cabling is installed, it should be put in cable innerduct inside of 4" PVC conduit, never directly buried. Separate conduits should be installed for telephone, data, and video cables, plus a spare empty conduit as a backup. Underground vaults and hand-holes are less unsightly than above-ground pedestals, but the best choice is to bring the conduits up inside the distribution closets. Trenches will have to be dug very carefully, to avoid damage to existing conduit, plumbing, drainage and irrigation piping, and to minimize damage to existing landscaping.

Despite the difficulty, bringing an older property up to current wiring standards can provide a substantial boost in revenue and occupancy, and pay for the cost of construction in a relatively short time.

**A Few Final Tips**

When planning for new construction wiring, or retrofitting, two issues will make a critical difference in ensuring the success of the project:

First, it is critical that the new systems work properly on the first day that residents move in. A bad experience by a resident will color that resident's impression of the services offered, and bad experiences by dozens of residents on move-in day will badly impact the property leasing and maintenance staff, so be sure to allow plenty of time for testing, and repairs if necessary, and for all the providers that must coordinate to bring the services to the residents. Be aware that POP connections, such as T1 lines or fiber, can take many weeks to install after orders are placed.

Second, to ensure success you must market the new services to new and existing residents. Advertise your new high-speed Internet services, and use the Internet itself as a marketing tool. Make sure your staff is familiar and comfortable with the new technology, so they can sell it with enthusiasm. Providing on-site staff members with complimentary services is one way to increase their comfort level, providing incentives for them to sell service offerings along with leases is another. Consider buying video and data services in bulk, and providing them to every resident either bundled with the rent, or as a mandatory technology fee.

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Yes, much has changed in the last few years, and a modern college campus cannot ignore the demands of new technologies. With good planning, you can easily embrace the new technologies and enjoy them. ◆

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InfiniSys delivers technology services to residential Multifamily and Student Housing Communities. The Company specializes in Electronic Architecture, Technology Assessments and Project Management.

Student Housing Properties that have used the innovative InfiniSys designs have won many industry awards on a national level. Customers include JPI (Jefferson Commons), First Worthing (University House), DTN Management, Post Properties, and many others.

The corporate office of InfiniSys is located in Ormond Beach, FL. InfiniSys also has engineering locations in Daytona Beach, FL, Woodland Hills, CA, and Frederick, MD.

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