Merging of Voice, Video, and Data Over a Single Cabling Infrastructure

James B. Dronsfield  
Duke University  
Durham  
North Carolina

A detailed description of the construction methodology to integrate into a single project the design, construction phase, and operations of a residence hall rewiring project. This project provides full 82 channel video capacity with educational and entertainment offerings, 10 base-T Ethernet connectivity to the desktop, Category 5 UPT cable, and RG-6 coaxial cable.

The combination of using multimode fiber in all building riser systems, horizontal Category 5 cable within 300 feet of any intermediate distribution closet, and single mode fiber for campus-wide distribution will be described and slides depicting the installation process will be provided.

The use of composite cable with an approved UL sheath reduced the labor costs on the overall project by one-third. The composite cable consists of two four pair Category 5 cables and one RG-6 coaxial cable terminated in a multiport jack.

The cable television portion of the project will be outlined including the use of a unique PC based addressable tap system used to control customer turn on and turn off as well as tier selection of program offerings.
Duke University is a private institution located in Durham, North Carolina, on approximately 8,000 acres of property with 6,000 undergraduate students, 3,500 graduate and professional students, and employs over 22,000 employees at the University and Medical Center. Duke University is a relatively new university being founded in 1925 through an endowment of the Duke family. Many of the buildings were constructed during that era which included most of the campus quad, residential areas, dining facilities, and the classroom buildings.

Duke University Tele/Video Department is charged with the responsibility of furnishing voice, video, and data connectivity to the campus and the Medical Center. We presently operate a AT&T #5ESS Central Office Switch with 18,800 lines in service. Included in the 18,800 lines are approximately 5,500 basic rate interface ISDN lines serving our academic and administrative areas.

In 1992 after much discussion and debate, it was decided that Duke should improve the intrabuilding wiring structure to upgrade its older and undersized copper wiring plant which carried voice and data over it. At that time, there was a modest cable television distribution system on campus utilizing a coaxial cable network distribution and RG-59 intrabuilding wiring into some commons areas of residence halls and a few administrative areas and meeting rooms. However, it was under funded and did not have a significant channel offering. The students of Duke University were very interested in increasing the availability of cable TV into the dormitory rooms and enhancing the entertainment channels available to them. It was through this interest and desire by the academic areas to enhance data connectivity, that the intrabuilding wiring project was launched in 1992.

There was extensive design work provided in developing an RFP to be sent out to various vendors to bid on the construction and operation of a CATV system. At the same time that the construction of the CATV system was to be undertaken, a category 5 copper cable plant enhancement was to be installed concurrently with RG-6 for cable TV and category 3 cable for telephony use. The bidders had some extreme concern with the various types of difficult construction that needed to be accomplished on the Duke campus which included older Gothic buildings as well as several asbestos laden frame buildings that needed to be wired. The results of the bids were inconclusive in that out of nine invited bidders only two chose to respond. One was at $6M and the other $3.8M to wire 3,400 rooms in the campus network. Duke Tele/Video estimated the work to cost $3.2M.

Duke University Tele/Video Communications decided that it would take on the project internally and act as a general contractor hiring electrical firms qualified in wiring the residence halls to proceed with the work. The other logistical problems beside the construction constraints were the logistics imposed by the use of the housing facilities almost on a twelve month basis. Special arrangements had to be made to coordinate with Housing available times that major work could be performed within the residence hall facilities. The Board of Trustees approved the project and permitted internal borrowing and the repayment schedule.
In the first summer of 1993, much of the work was done in unused residence halls and moved relatively smoothly. We were able to provide wiring for approximately 1,200 rooms the first summer. The whole project was estimated to cost $3.2M when done under the auspices of Duke University Tele/Video Communications. This included the actual purchase of wire, labor, closet construction, outlets, miscellaneous materials and the basic electronics for a 10 base-T Ethernet distribution system to each residence hall room. The basic equipment was provided by our Data Communications Department under another project, but it was only for building a single entry piece of data equipment and did not include intermediate and other data equipment requirements. The DukeNet project did, however, provide the fiber based connectivity to all of the residence halls and the cable system was designed around a fiber distribution system with fiber transmitters serving eighty per cent of the construction locations. Also multimode fiber was pulled into the new closets on all floors of the residence halls so that no data outlet was more than 300 feet from fiber distribution or its associated electronics. As was mentioned, the total cost of the project through Tele/Video Communications was $3.2M and included the construction of complete CATV headend including a 160 foot tower and eight satellite dishes for programming reception.

The second year of construction accelerated the project and the headend was complete as well as an additional 1,500 rooms completed. Both in the summer and throughout the academic year we were able to make considerable arrangements with Housing to work over break periods and vacation slots and were to accelerate the project. In August of 1994 our new headend was complete and a 33 channel entertainment system was put into place. The students reacted enthusiastically to the availability of this enhanced programming. We were able to meet our projected sign-up rate to support the entire project fiscally for repayment. The $3.2M authorized by the Board of Trustees is to be repaid over a fifteen year amortization period, and we anticipated the first three years to be in a deficit position. The entire fiscal plan was built on a 40% sign-up rate at the $19.85 per room charge for entertainment and academic cable TV.

The first year sign-up was a very encouraging 55% of our entire residential student body at that level. There was desire on the part of many academics to provide "educational tier programming" that would be academic in nature and would be available to the majority of the student body both in the commons rooms, classrooms, and lobbies for viewing at a very low rate. It was decided that we would dedicate the first twelve channels on the system to this educational programming in order to provide for this need at a level of only $5.00 per month. This was subsequently dubbed our "EdNet" tier and our entertainment tier was appropriately named "DevilVision".

Because of this channel mix requirement, a simple way to provide this for people who wanted just the lower tier required the addition of an addressable tap system. We investigated several companies that provided an addressable tap system and
found that most were geared towards a residential type system that you would find in a residential community. There was, however, one company that looked at an apartment type or residence hall type group housing and provided units that were designed for bulk addressable tap equipment. These were built-in units of eight, twelve, and sixteen which could be grouped together in larger residence hall closets in order to provide a true addressable tap system at the residence hall location. This addressable tap system would allow an operator from a standard PC located in the CATV office of Tele/Video Communications to initiate service from the PC over the carrier wire to the addressable tap and signal it through a series of digital commands. This would allow the operator to turn the signal on, turn the signal off, provide tiers of service whether it be EdNet, DevilVision, or our premium tiers which include such channels as HBO, Showtime, or Home Team Sports. This made the whole operation very efficient and provided very little truck roll or installation crew requirement to visit the residence halls to adjust for tier purchases or tier assignment. The additional cost of the addressable tap system will be quickly recovered within a two year period on savings of maintenance and truck roll. It was a very ingenious solution to a difficult requirement.

We decided to have two local originating channels from Duke Tele/Video inserted onto the system. We have a dedicated channel 5 which we have named the academic channel. We provide at no cost redistribution of the faculty members requested video tapes, specialized copyrighted material that has been cleared for redistribution and some live interviews on academic matters. In addition, we use it as a public service channel announcing Public Safety reports, use of emergency phones, computer hook-up instructions and specialized downlinks of an academic nature from time-to-time from around the country and the world. This has proved to be a very valuable information outlet for the University in general and is utilized continually.

Our second local channel is known as channel 31 and is our "movie channel". We have entered into separate contractual arrangements with movie suppliers to provide first run movies on this dedicated channel originating from the Tele/Video CATV office. In that office is a piece of equipment that is designed for multi tape playback and for graphic interaction on the screen with various graphics indicating time and date for the movie production. These are timed out and require little intervention on the part of the operator. There are twenty movies per month available on channel 31 and they are repeated throughout the month at various times throughout the day and evening so that the subscriber can see these movies at their convenience. It is proven to be very popular channels with the students, and we honor many of their requests for first line movies.

We were also fortunate during the construction of our satellite farm to receive a special grant from the Political Science Department authorizing us to construct a large 6 1/2 meter dish to bring in a direct feed from Moscow for the TV Network from Russia. This was a very difficult construction project since the Russian satellite being utilized is only eleven degrees above the horizon and has a definite wobble in its orbit. Therefore, the dish was mechanically constructed not only to
lock on to the satellite with a laser pointer but it had to have additional motors installed so that the satellite dish could actually move with the wobbling of the Russian satellite. The quality of the picture is excellent considering those constraints. We distribute the Russian signal over our channel 43 for our students. This has proven very popular with our foreign language majors and visiting graduate Russian students and others who find the Russian programming to be very timely and appropriate.

We have also been traditionally involved with SCOLA, the foreign language broadcasting network which we have placed on our educational tier and is again very popular with the foreign language majors and provides language broadcasts from numerous countries around the world. Our Russian satellite signal quality is of such value that we tape much of the Russian programming and send our tapes to McClellen, Iowa where the SCOLA network actually uses Duke University's tapes for much of their rebroadcast of the Russian network to their 3,500 world-wide downlink subscribers.

The construction of this total project was a difficult one, but we were very proud of the results. We have utilized a double gang outlet with two RJ-11 jacks, two RJ-45 jacks, and an RG-6 CATV outlet in each box located in each residence hall. There are some examples where there are single gang outlets in residence halls where there has been remodeling completed by the Housing Department and in two new residence halls constructed during the project. In those instances, each side of the room had their own single gang outlet with one RJ-11 jack, one RJ-45, and one CATV RG-6 outlet. However, the RG-6 outlets are grouped together at the intermediate closet location and has a single addressable tap unit. If students sign-up for CATV in the room they have two working outlets but only pay for one subscription.

We also had other difficult construction constraints in other locations in the University beside the Gothic architecture. We have a group of 515 apartments in a complex known as Central Campus Apartments which were built with Federal funds over thirty years previously. They were wired into the living room for telephony only and had no bedroom outlets of any kind. We made the decision to extend our standard wiring into each of the bedrooms as well as the living room and provide additional data, voice, and video connectivity in each of the bedrooms. Because of these extensive wiring requirements there were no interior building closet spaces available in any of these structures. A very unique design was utilized to provide this connectivity. In many cases, exterior wall chases were developed so that cable could be pulled up through an attic area and down through an exterior wall chase into a separate building structure that was air conditioned and housed the data equipment and CATV amplification equipment for several buildings. These structures had to be approved by an Architectural Design Committee on campus and were designed to resemble the Central Campus facilities and did not stand out against the other type of architecture in this particular area. It did require a great deal of trenching and a great deal of conduit pulls to provide the interconnectivity for the Central Campus Buildings. This was the most expensive part of the
rewiring project but has proven to be a good decision in extending the number of outlets required into the bedroom areas.

The success of the rewiring project is very evident from the rapidly growing direct 10 Base-T Ethernet connectivity experienced in the residence halls. During the first year of availability of this type of connectivity only 550 students of the 1,200 outlets that were available took advantage of a direct connection to the fiber backbone and 10 Base-T Ethernet speed capability. However, this past academic year with the wiring complete with 3,400 rooms available for connectivity, over 2,200 students have been directly connected to the network. The others, of course, still have dial-up modem capability but we are encouraging them to directly connect to the backbone. Each incoming student is automatically given an e-mail address and is automatically included in the campus directory with their e-mail addresses provided on a campus-wide basis. The popularity of the use of their connections is obvious from the traffic patterns generated on our data network. In addition, their phone service is on a voluntary basis and we have a 98.1% sign-up rate for all residence halls on campus. The direct connection to the Internet has not diminished the demand for telephone service, voice mail, or other services provided on the telephony side. The sign-up of CATV has also exceeded our projected goals with over 1,750 sign-up for the DevilVision tier this current semester including over 350 premium subscribers.

All of the subscribed services are provided under one merged Office of Information Technology. Our new Vice Provost for Information Technology, Betty Le Compagnon, arrived on campus on October, 1994, and was extremely anxious to merge and enhance the overlapping services provided various departments on campus. The reorganization has provided a mechanism to address all of the challenges of merging voice, video, and data together under one organization. It has proven to be very successful during the past year. She has taken on the additional initiative of presenting to the Board of Trustees in May, 1995, A $15M project to complete the rewiring effort in the residence halls and provide a similar project in the rest of the 167 academic and administrative buildings on the Duke University campus. This will be a four-year phased approach to the rewiring and we have initially begun the first year of the intrabuilding wiring project for the academic and administrative facilities. A similar wiring design is being utilized which includes 4 pair Category 5 both for voice and data, RG-6 coaxial cable and in some cases dark multi mode fiber to the desktop. This will be deployed in the School of Engineering which consists of three buildings which will have the standard wiring plan plus dark fiber pulled with the cable to the outlet in each engineering facility unterminated at the outlet and closet end. No electronics will be provided at this time. However, in the immediate future with the requirement for higher and higher speeds the dark fiber could be activated and the labor saved at this time will be realized at that time.

The Intrabuilding Academic Wiring Project will cover some 167 buildings when it is complete and will provide the 10 base-T Ethernet connectivity presently used and will have capability of 100 megabit switched Ethernet and higher. Again, the
general scheme is to develop closet spaces no more than 300 feet from any outlet and 300 feet from any electronic background equipment. The fiber optic ring is complete for the entire campus network and is operating well at the present time. We are moving up to FDDI capabilities on the ring as well as 10 Base-T Ethernet. It also supports some current 4 megabit token ring and 16 megabit token ring LANS which are slowly being phased into the Ethernet world.

When this massive project is complete, we hope to bring Duke University up to a general standard that is flexible, and can migrate to higher connectivity speeds as we move forward in the data world. It also provides video capability to most areas and provides a pathway so that any new technology that does develop such as ATM can be accommodated. For the future, our infrastructure will be in a position to migrate to these new technologies without the massive replacement and construction that we have had to endure during this project.

We also see the potential for wireless technology developing and do not discount the possibility that wireless can provide data connectivity on a very ubiquitous campus-wide basis. However, our investment in the infrastructure I have described will have a definite usage life of ten to fifteen years or more and provides the ability for higher speeds that are anticipated in the wireless world with continuing lowering of electronic costs for direct connection. The use of surface mount conduit and above ceiling open wiring troughs will allow us the flexibility to allow additional specialized cable that may develop as technology moves forward. We feel that at Duke University we have provided a plan of structure and action to bring Duke University into the 21st century of technology.