Delivering Integrated Services In University City, Philadelphia

By Andrew Marshall ■ *Campus Technologies Inc.*

University City, Philadelphia is typical of an urban campus environment, with many students, faculty and professionals directly or indirectly related to the University living in an off campus area clustered around the 269 acre main campus. The accommodation in the off campus area is a variety of types of buildings—mid-rise apartment buildings, small row homes, large Victorian homes and smaller apartment buildings in an area of around 40 city blocks.

Although this case study relates directly to delivering services to urban off campus housing, the knowledge gained and the techniques applied are highly applicable to other private telecommunications providers in a wide variety of deployments.

At first glance, the off campus area is highly attractive to technology service providers. The University of Pennsylvania is an Ivy League school with 20,000 students in 12 schools (among which are the prestigious Wharton School, Law School and School of Medicine) and 5,000 post graduate students, fellows and faculty commanding half a billion dollars of research funding each year. Of this population, at least 5,000 live in rented accommodation off campus resulting in a sophisticated, technically savvy target market living and working in a relatively small geographic area.

A large number of these off campus properties are owned and operated by a small number of property management companies, operating complex portfolios of different types of housing dispersed around the various blocks that make up the off campus area. This

makes for a unique set of property management challenges and an even more unique set of technology delivery problems for private providers.

This case study examines the story behind the largest private property owner in University City, Campus Apartments. At the start of this analysis, Campus Apartments owned some 156 separate buildings in a geographic area covering approximately 25 blocks, with over 2,000 tenants, mainly students, faculty and University support staff.

Campus Apartments has been growing at an astounding rate, and its management team is renowned for its visionary approach to the development of its portfolio. Four years ago, Campus Apartments tenants were being serviced by relatively expensive and in many cases unreliable, slow connections to the public Internet serviced by the local RBOC and cable franchise holder, and limited choice for tenants in TV programming and in telephone service.

Today, Campus Apartments tenants are served by the fastest residential Internet service in North America with direct connection to the University of Pennsylvania, with sophisticated telephony, and video programming choices available, increasing the choice and cost effectiveness of telecommunications services at the properties. Campus Apartments properties have directly benefited from these services, with their buildings carrying the desirable 'smart wired' plaque being in the highest demand.

The journey over the last four years in building the network in place today has been complex. In some cases, the technology in use had to be developed, and in other cases integrated in ways that had not previously been envisaged. However, the end has resulted in a solid, direct, business enhancement for the property owner.

The problems

The problems facing the design and implementation of the Campus Apartments network were substantial, and in the opinion of some providers, insurmountable. In summary:

Rights of way: The urban environment and distribution of the portfolio necessitated the crossing of public rights of way.

Distributed buildings: Potential sub-

scribers were spread over many different buildings, increasing the complexity of network design.

High turnover and install peaks: Because of the resident demographics, up to 60% of residents could turn over and move in simultaneously over a single weekend. The staff required to potentially install 1,200 cable modems or 1,200 DSL modems (or for that matter 1,200 telephone connections) over a period of a few days in such a confined area would be impractical and cost prohibitive.

Competitive edge: The services offered had to provide both cost and service level benefits over existing providers to ensure adequate penetration.

Demanding user base: The potential subscribers would be educated and technically sophisticated, demanding service levels in excess of those generally available.

Cost and profitability: The overall network proposition had to become profitable within a five-year period and not be a financial burden on the property owner.

The solution

The design of the solution was a complex process given the problems documented above. The overall design was subdivided into four general areas: Internet, Telephony, Video and Administration.

The design criteria for each of the four areas were as follows:

Internet

- Provision of bandwidth to the end user orders of magnitude in excess of any likely competition
- Self install plug and play provisioning
- User accountability (making sure that network users have paid for access)
- Facilities that make a unique selling proposition
- A totally Ethernet 'MAN/LAN' configuration

Telephony

- Full service features

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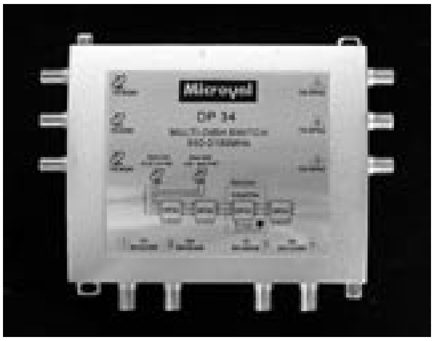

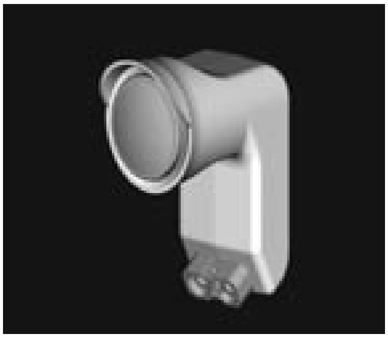

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- Low entry level cost
- Reduced provisioning costs
- Common delivery network

Video

- Low entry level cost
- Maximum programming choices
- Limited or eliminated provision costs

Administration

- Single customer service contact for all services
- Single invoice for all services

After considerable analysis and examination of available technical options, the majority of traditional network designs and technology solutions had to be abandoned. Over a period of many months of testing and modeling, a broad design was decided upon.

Geographic analysis showed that many properties were adjacent, and could be wired together to create 'virtual' MDU's. This resulted in each block being treated as an MDU from a network design perspective, even though it may contain various types of dissimilar buildings.

A design was built up with a single Super PoP (Point of Presence) to aggregate all external feeds and to house central electronics in a mid-rise, 80 unit MDU on one block. Several sub PoP's were designed at strategic locations around the required coverage area, providing a backbone of PoP's in each block with a high concentration of residents. The overall design was thus a central main PoP, with a backbone network connecting other smaller PoP's, and each smaller PoP connecting to one or more 'virtual' MDU's.

This in turn gave rise to some unique challenges: how to connect the PoP's in a backbone while crossing public rights of way, and how to avoid building three networks for voice, video and data. In addition, the clustering of buildings into a virtual MDU meant that external wiring was required, outside the distance limitations of traditional Ethernet topologies.

To meet the design criteria, the backbone network needed to be capable of transporting data at the highest technically available rate (Gigabit at the time), with high reliability. This left only two options for the backbone transport: dark fiber, or Free Space Optics (FSO). In some locations, the fiber could be leased, but after lengthy examination the FSO option was discarded as the cost of provisioning Gigabit speeds was high, and some of the locations were unsuitable.

After exhaustive research, we discovered that Terabeam was rolling out a Gigabit Ethernet product operating at 60GHz—similar in operation to microwave but in an unlicensed band and with exceptional price performance. This was the final component required to design the backbone network for data. After an extensive systems assurance process, we had a Gigabit Ethernet backbone providing the reach required.

Moving on to voice, it was clear that a central phone switch was the only operationally feasible solution. However, transporting the telephone signal to the Sub PoP's would be a problem. 60GHz radios were available that provided T1 connectivity along with Ethernet, but not at Gigabit speeds. Using an OC-12 Terabeam solution would involve moving away from Ethernet in the backbone, and complicate the electronics involved.

Following review of available solutions, it was finally decided to use a Cisco AVVID architecture phone system, using the VG-248 analog interface. This allows the backbone to be run as Ethernet, with VG-248's distributed around the network providing 48 POTS connections on each device. Costing the solution, centered around Cisco's Call Manager softswitch, it was apparent that it was also surprising cost effective as well. Using this technology allowed us to use VoIP technology in the internal network, and deliver regular POTS interfaces to subscribers.

For video, fewer choices were available. Local franchise rules prevented crossing public rights of way with video signals, and the individual 'virtual MDU's were not large enough to sustain an individual cable headend in each block.

The final design was a compromise. The larger 'virtual MDU' blocks had independent headends with a 750MHz cable system and addressable tap, carrying Echostar QAM signal and three tiers of regular cable programming, while the smaller blocks were installed using Echostar's MDU delivery technology with each subscriber having a Dish Network receiver. The revenue model in combination was profitable without requiring huge investment.

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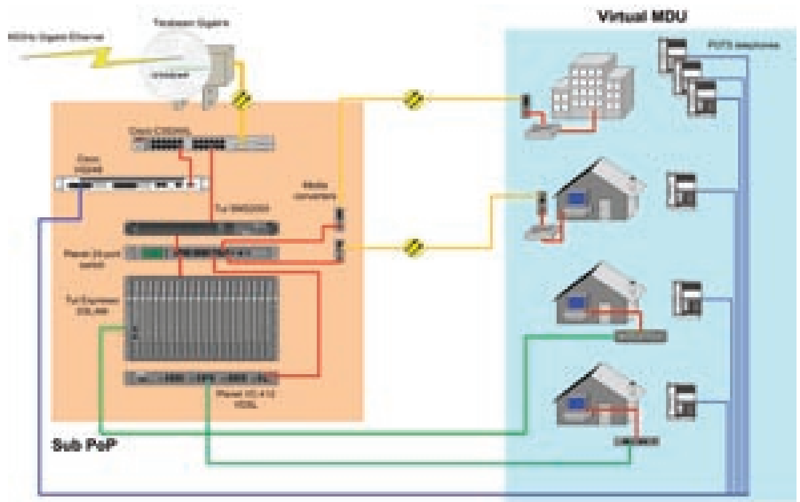
It is worth mentioning that Terabeam is developing a version of its gigabit 60GHz radio that will transport a 1 GHz video signal up to 1 kilometer. If this device had been available at the time of design it is likely that it would have been used.

With a base design for the backbone and transport of the three services, attention was turned to the individual blocks or virtual MDU's. Outside wiring was necessary because of geographic dispersion, and existing interbuilding wiring was non-existent. In the initial phase of the build, commercial grade 100 and 200 pair wiring was constructed between buildings to carry voice and data, with hardline or coaxial cable for video transport where applicable, terminating in a building demarcation point on the outside of each building. The intent was to provide telephone service directly on the copper wiring, and use the same wiring to transport Internet bandwidth to each building using VDSL. In later phases, the copper wiring was left to be dedicated for telephony only, and multi mode fiber was added to the bundle to provide the data connectivity.

"Although currently profitable, the current situation is one of continual evolution and expansion."

Campus Apartments began a process of gradually upgrading the internal wiring in each building as upgrades were performed in other areas. The upgraded buildings provided Cat-5e and coaxial outlets at each wall outlet, terminating in a building demarcation point. The demarcation contained an Ethernet switch and 66-blocks for telephone termination, and video distribution hardware. These buildings were branded 'smart-wired' and allowed for services to be provisioned without entering the subscriber's apartment.



Virtual MDU technical architecture

To avoid truck rolls for installations, Tut Systems SMS-2000 subscriber gateways were deployed to allow for plug and play Ethernet connectivity.

This was used in conjunction with a RADIUS server to provide subscriber authentication. This gateway is used to provision both the newer all-Ethernet buildings and the legacy VDSL and DSL subscribers on the network.

From an administration perspective, no software was commercially available to provide subscriber management and billing of multiple services and to provide Telco level billing of telephone calls. This application, including work orders, billing, subscriber contact management and asset management was developed specifically for this project, and has subsequently been successfully deployed in other communities.

Although currently profitable, the current situation is one of continual evolution and expansion. The success of the project is due to several key-enabling technologies that have been integrated to deploy the solution:

- The availability of reasonable cost, highly reliable, high bandwidth 60GHz radio links (Terabeam)
- The ability to transport telephony over the backbone using IP (Cisco AVVID technology)
- The availability of low cost, high quality Ethernet electronics and fiber optic media
- A purpose built, multi service, web enabled customer management system
- A reliable, high throughput subscriber gateway device (Tut Systems SMS2000) ■

About the Author

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