The Network Master Plan

Connecting
UConn 2000
With
UConn 21st Century

"Secure data transmission, data anytime anywhere, video anytime anywhere, research completed in hours not days, classes extended to anywhere in the world, mobile communication"; all of these and more are in demand and could be delivered with a fully integrated state-of-the-art communications network.

In the last 15 years the University computer network has grown from a technical novelty used by only a few researchers scattered across the Storrs campus to a necessary component of how our students communicate, our faculty educate, and our staff do business. Currently, state-of-the-art communications networks are being deployed in new buildings funded with capital money, but networks installed in existing buildings are left to degrade well past their lifespan, or are upgraded on an ad-hoc basis. This creates an inconsistent network where a professor in a new building can collaborate effortlessly with researchers at Universities across the globe, but not with professors on campus in older parts of the network. A student in a new residence hall can view live video streams from across the country, but can't show their advisor the same video across campus where older networking equipment is installed. Staff can easily check their email in a new administrative building, but when they plug the same laptop into a colleague's office across campus they may have trouble accessing the older, more congested network.

To remedy this UITS has created a detailed plan for a communications network that would put UConn on par with our peers in the research and academic communities. Our goal is to create and maintain a network that is transparent to our users, allowing them easy access without having to worry about the underlying technical complexity. Our plan delivers a common network infrastructure to all University buildings across the state, including aggressive upgrades to sub-standard portions of the network and consistent standards for construction projects slated within 21st Century UConn. The Network Master Plan breaks down the network into its three component parts: network hardware, network wiring, and communications room infrastructure. Ninety-two percent of the buildings are lacking in at least one of these three categories, and it will take an initial year to plan and a minimum of two years to enhance the design and deploy a consistent network across all University campuses and properties.

The Network Master Plan will create a world-class communications network to mirror the world-class physical facilities built by the UConn 2000 and 21st Century projects. A reliable, consistent network allows emerging communications technologies to spread rapidly across campus. The network becomes the accelerant to technological growth at the University instead of the inhibitor. Faculty need equitable access to online material no matter where their office is on campus, just as students need reliable access to course materials any time of the day or night, no matter where their classroom is located across the state. Deploying a centrally managed, modern network across all of our campuses facilitates mobile access to the Internet whether it is walking from Arjona to Northwest Campus, or video-conferencing from Avery Point to a boat in Long Island Sound. Budgeting for the continued funding of an ever-evolving network supports the ability of that network to allow fast file transfers today, steady video streams next week, and wireless virtual study groups next year. Building a consistent University communications network across the state of Connecticut will attract top students and top researchers who understand that a world-class network is a necessary requirement for education, business, communication, and life in the 21st Century.

Current State of the Network

The evaluation of the current state of the network was based upon three criteria: network electronics (hubs, switches, routers), infrastructure (communications rooms, conduits, pathways) and wiring (fiber, copper, coax). Using these criteria and associated published standards, an assessment was made of each building on the Storrs, Depot and Regional campuses. UConn recognizes and adopts industry standards and practices as interpreted by BICSI (Building Industry Consulting Services International). The implementation of these standards ensures a flexible, uniform communications environment that allows for the high speed and high bandwidth growth required by specialized applications used in higher educational environments.

After all of the buildings were reviewed only 25% of the buildings have electronics equipment that meets the current standards. 33% have communication rooms that would be acceptable based upon current standards. 14.5% have wiring that would be acceptable based upon current standards. That leaves only 8% of UConn's buildings as fully compliant based upon current standards, while 92% need some type of upgrades to their electronic equipment, communications rooms, wiring, or some combination of all three.

The following attachments will graphically demonstrate the current state of the network:

Attachments A1 & A2: are graphical representations of the currently installed network electronics. ***A1*** represents the status of the Storrs campus and ***A2*** represents the status of the Depot and Regional campuses. Buildings colored green represent compliant network electronics. Buildings colored red represent non-compliant network electronics.

Attachments B1 & B2: are graphical representations showing which buildings have communications rooms that meet today's published standards. ***B1*** represents the status of the Storrs campus and ***B2*** represents the Depot and Regional campuses. Buildings colored green represent compliant communications rooms. Buildings colored red represent non-compliant communications rooms.

Attachments C1 & C2: are graphical representations showing the wiring condition of the buildings. ***C1*** represents the status of the Storrs campus and ***C2*** represents the Depot and Regional campuses. Buildings colored green represent compliant wiring. Buildings colored red or yellow represent non-compliant wiring.

Attachment D1, D2 & D3: graphically represents all three criteria together and shows which buildings are fully compliant based upon the published standards. ***D1*** represents the status of the Storrs campus and ***D2*** represents the Depot and Regional campuses. Buildings colored green represent fully compliant buildings. Buildings colored red represent non-compliance in one or more areas. ***D3*** is an inventory by building of all the network electronics, communications rooms, infrastructure, and wiring at the Storrs and Depot campuses.

University Community's Projected Needs

Based upon input from users in the community, standard networking features should include such things as video in the classroom, differing levels of service based upon need, mobile computing and distance learning. Implementing all of these features will require the entire network to be brought up to base line standards to allow for end-to-end delivery and management. This will also help in improving equality between the Storrs and Regional campuses.

Residential areas need the same network access as the rest of the campus. In order to deliver educational services across the network, student areas must be able to receive instructional materials efficiently, just like academic areas must be able to send the material. There are also pockets of staff offices within the residential complexes that need the same network services that are delivered to the staff offices in other parts of campus. Finally, critical services such as building access controllers and environmental regulators are increasingly reliant on the network for communication, so the residential areas need to have the same baseline of service deployed to support these devices.

All of these improvements can result in better services for the University community and allow the *technology* of communications to become transparent. As a result, communication becomes the actual exchange of information, not the process of establishing the communication itself. Just as users don't consider what is happening within the Telephone Switch when they dial the ten-digit number on their telephone today, rich multi-faceted communication on the University Network should not require any more knowledge than the identity of the recipient of the communication.

Advanced features and increased speeds will allow users of the University Network to communicate and collaborate without complicated technology hampering the communications. Security in the applications and network devices on the University Network should allow confidential and accountable transactions to occur. The University Network should be managed to allow the necessary resources required to be available where and when needed on the campus.

Some of the advance feature sets include but are not limited to, VLAN (Virtual LANs) support, QoS (Quality of Service) support, Multicast support, VPN/Firewall (Virtual Private Network) support, Streaming video capability, wireless capability, VOIP (Voice Over Internet Protocol) capability, I1 (Internet 1) and I2 (Internet 2) access.

Planning Factors

In order to support advanced features the network design must accommodate the increasing demands placed upon it. The key to improving network performance no longer has to be simply adding more bandwidth. To support real time voice and video applications the University Network will require high redundancy, minimal interruptions, little to no delay of the information (latency), and the ability to prioritize traffic. A full-featured network will need to dramatically improve its fault tolerance, resilience and recovery time to fully meet the expectations of the University community.

Today the primary role of network management is to keep the network up and running and to provide an acceptable level of network performance to all customers. Tomorrow different customers and applications may have very different network resource requirements, particularly in a full-featured network. Over the years, the network has operated on a best effort basis with all customers having access to the same service level, and with some over provisioning built in to provide room for growth in network utilization. This model will prove to be unsuitable in the future. It is likely that active management and allocation of network resources will be necessary. In the future University Information Technology Services (UITS) must be able to manage differentiated service levels, and control access to those service levels dynamically throughout the network.

Meeting these goals requires a secure, robust network infrastructure capable of supporting both user traffic and management traffic and maintaining the privacy and integrity of management information. It will also require performance management, accounting management, and configuration management software systems.

Future Needs

Another key aspect of the infrastructure is to ensure that it will support converged (voice, data, and video) services and the use of a common cable from the communications room to the work area outlet (WAO) in the room or office. The current industry standard is Category 6 data grade cable.

Our design calls for all buildings on the Storrs, Depot and Regional campuses to be provided with electrical power outlets with backup power in all Building Distribution Facilities (BDFs) and other communications rooms. It is also our intent and to provide both commercial and emergency power to the environmental systems in core distribution areas. One of our requirements for future network design is to evaluate sites in existing or new buildings that have adequate electrical capacity on their emergency generator in order to support the power demands. Should this not be possible the appropriate wiring must be in place to provide power from a portable generator.

Physical security of the network is critical to the reliability of the network. All communications rooms across campus should be secured with a unique lock accessible only to UITS and appropriate emergency personnel. No communications room will be shared with any other department for multiple functions.

Relationships Between UITS and Departmental Networks

Design Standards

Wherever possible, UITS Network Engineering should be responsible for network installation, design and management. UITS should set the standards for the physical and logical design with input from the user community. This design should also drive the standards for equipment selection and building design. In a meeting with Architectural Engineering Services (AES), it was agreed upon that UITS would maintain and update the design document. Major changes will be posted on a semi-annual bases, with the use of posted addendums for any minor changes during the interims.

On a semi-annual bases UITS and AES will meet to discuss the proposed changes. UITS will be responsible for making the document available to the University community and any outside vendors that may require it. AES will be responsible for incorporating the Design Guide into their Planning & Design Standards document that they distribute to Architects and Construction Managers. Jointly, UITS and AES will provide and educate any on-call Communications Design Consultants that perform work at the University.

Both AES and UITS will be responsible to enforce and police the University's Telecommunications Standards. With this posted document and any accompanying addendums, as well as with submittal reviews and inspections, both parties will make sure the University community, contractors, and installers will adhere to the Standards.

Differing Service Levels

There are different levels of network service that UITS is capable of providing. The base level of service (10/100 Mbps over Cat 5e) is sufficient for the majority of network users. There are users or departments that might have needs above and beyond this base level of service. UITS has anticipated this, and with this plan it can provide the following enhanced levels of service: Gigabit client access, server farm access, departmental server farm access, redundant network access, powered network access, secure network access, and guaranteed network delivery. Enhanced levels of service are only available in buildings that have been upgraded to at least the base level of service of wiring and building infrastructure – if the building has older wiring or communications rooms, these enhanced services are not available.

Gigabit client access allows for local area network speeds of 1,000 Mbps instead of the base level of 10 or 100 Mbps. Departments that manage their own servers are encouraged to co-locate them in the UITS Server Farm, where redundant network access, backup power, and off-hours monitoring and physical security is provided. UITS can also provide server farm-like network access and redundancy for departmental servers, if the department wishes to physically locate their servers in their own building. The base level of service provided to all buildings is minimally redundant – there may be times when a local network or power outage causes an entire floor to lose network access for a period of a few hours. If departments wish, they can request network access that is either fully redundant, has backup power available, or both. It is important to note that if a building loses power, computers connected in that building would have

to have separate backup power available to them in addition to backup power for the network – a computer without power cannot use the network.

Departments can also request enhanced security for their network. If they chose to do this, they can either request a default security profile, which is sufficient for most users, or work with UITS to perform a detailed security audit and get a customized security profile for their network. Departments can also request guaranteed network delivery on the UConn campus, useful if a department has critical network needs between buildings or with other departments and wishes that traffic to have a higher priority than normal network traffic in those areas. Departments can also request guaranteed Internet access for their servers or users – to ensure sufficient off-campus bandwidth for a critical service, or to have custom Internet policies for their users.

Where there are special needs, departments should be allowed to maintain and manage their own networks consistent with University standards. However, Service Level Agreements (SLAs) need to be established between UITS and the department enumerating the details of the arraignment. This will ensure that features are transportable across the entire network.

Implementation Strategies

The recommended Network Master Plan calls for a phased approach to the upgrade. The entire upgrade will occur over a five-year period, within the 10-year scope of UConn 21st Century. The first 18 months will be used for initial planning and for upgrades to the network electronics in the academic core. This will allow the above-mentioned feature set and baseline standards (***Attachment I1)*** to be implemented at an early phase of the project.

The estimated cost is $40 million dollars to complete the Network Master Plan, with an immediate need for $3.5 million to upgrade key areas of the academic core, and an additional $36.5 million over the next two to five years. An estimated $2 million per year is required to maintain the network after completion of the initial installation.

After review of the preliminary report of 21st Century Projects, actual new money to implement the plan would be approximately $9 million over this 5-year period. The rest of the funding comes from existing sources for new buildings, renovated buildings and deferred maintenance.

Approximately $2.5 million should be allocated during this first 18 months of planning and initial implementation. By upgrading outdated electronics at all the campuses many of the advanced feature sets become available in academic and residential buildings. This allows early technology adopters a chance to exploit these new and advanced features and provides more consistent network access to all faculty, researchers, and students, especially in older areas of the network.

Attachment I2: shows the detail of this implementation. The work is broken into four phases, which will take place over the first 18 months. These phases have a priority set for them and each phase identifies and prioritizes the upgrade for each building within the phase.

Summary of Costs:

	Storrs & Depot	**Regional/Law Sites**
Equipment Costs	$ 5,831,910.45	$1,196,280.50
Wireless Costs	$ 1,400,000.00	$ 300,000.00
Building Infrastructure	$ 20,183,313.19	$3,384,443.60
Storrs Campus Infrastructure	$ 2,500,000.00	
External Consulting Service	$ 4,050,000.00	$ 495,000.00
Total	$ 33,965,223.64	$5,285,718.10
Total Project Cost	$ 39,250,951.74	

Attachments F1 & F2: provide more detailed budgetary breakdowns for the Storrs and Regional Campuses.

Attachment G: is the detail that went into calculating need and estimated cost. Equipment pricing may change and discounts on these rates may be available.

The next set of priorities will come out of this planning effort. Working with AES and some outside planning consultants we will map the wiring and infrastructure efforts with the campus Master Plan. A schedule could be followed to complete this part of the plan in five years, taking into account building construction projects that take place in the 5 to 10-year window of 21st Century UConn.

Attachment H: shows a proposed schedule to be followed.

Annual Hardware Maintenance

The entire core and distribution layer devices should be covered by proper vendor maintenance contracts, which run on an annual cycle. Should a device fail the contract should call for a guaranteed replacement to be on site within 4 hours. We should keep on site spare equipment for each device type within the core of the network. If failure occurs the failing device will be replaced within the 4-hour window.

The cost for these maintenance contracts is not expected to exceed $200,000 per year. Of this cost approximately $75,000 will come out of operating funds and $125,000 will come out of capital funds.

Annual Hardware Replacement

Once the installation is complete the core, distribution, and access layers of the network will be evaluated, since these will be in the fourth year of their lifecycle. Industry standards state the lifespan of networking equipment is 3 years, and our current network has much equipment reaching a 10-year active lifecycle. We feel a compromise at 4 to 5 years for equipment replacement is reasonable.

The cost of the annual revolving replacement of network components should not exceed $2 million per year. This cost could vary somewhat in future years depending on how many new connections get added to the network. The breakdown for this category has $600,000 coming out of operating funds with the remaining $1.4 million coming out of capital funds.

Replacement of Network Wiring

Industry standards state wire installed to support the network has a 10-year lifecycle. However, the contracts with our wiring installer extend this to 25 years. This does not mean that the wire will support the technological advances over the next 25 years – we will most likely need to replace it all 10 years from now.

Money has to be budgeted for to anticipate wiring changes that are 10 years out. This could be done on a yearly basis or in one lump sum. Since the infrastructure needed to support the wiring will already be in place the cost would include only the wire itself. The amount needed to replace the wiring should be approximately $8.5 million. This figure is not included in this document, and a replacement strategy will need to be evaluated approximately 8 years from now.

Summary of Risk

The risk of not upgrading and maintaining the University network will result in UConn being left behind in technological advances – advances that are crucial in order for us to maintain our position as a world-class educational facility. The University must assemble a strong infrastructure of communications related facilities and services throughout the campuses, tailored to meet the needs of our faculty, researchers, staff, and students. If it does not, the result will be vast inequities between faculty, researchers, staff, and students at UConn, especially as compared to their peers in other institutions.

The University must be committed to advancing a communication rich learning infrastructure that benefits students and faculty across all schools and fields of study. UITS, in collaboration with members of the community, must anticipate these technological advances and be prepared to support them before they are needed. If we leave things unchecked, "the technology will run us over".

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